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**

इंटेलिजेंट ट्रैफिक प्रबंधन प्रणाली घटक - स्मार्ट ट्रैफिक सिग्नलिंग सिस्टम के लिए सामान्य विनिर्देश

Draft *Indian Standard*

INTELLIGENT TRAFFIC MANAGEMENT SYSTEMCOMPONENTS — GENERAL SPECIFICATIONS FOR SMART TRAFFIC SIGNALLING SYSTEMS

ICS: 03.220.20; 35.240.60

Intelligent Transport Systems Sectional Committee,TED 28	**Last date for receipt of comments is 27/10/2024**

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 roundedoff value should be the same as that of the specified value in this standard.

Draft *Indian Standard*

INTELLIGENT TRAFFIC MANAGEMENT SYSTEMCOMPONENTS — GENERAL SPECIFICATIONS

1 SCOPE

This standard provides the details of the components of Intelligent Traffic Management System including:

a) Vehicle Actuated Traffic Signal Controller
b) ATCS Application Software
c) Subsystems and Accessories

Presently the general specifications for the Vehicle Actuated Traffic Signal Controller has been defined in this standard. Testing requirements for Vehicle Actuated Traffic Signal Controller and Subsystems of the ITMS will be incorporated further as annexures

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.

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

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

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

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

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

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

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

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.

Corridor — An arterial road with several intersections.

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

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

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

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

Season Plan — Four Season Plans are there to select a Particular week plan suitable for the season

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

Decision Support — Reports, Graphs, Traffic Simulator interface.

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) beforetermination.

Fixed Time Operation — None of the stages are preempted

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

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

Full VA — Preemption enabled for all the stages

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.

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 furtherextension.

Green Running Period — Split time utilized for the stage.

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

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

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.

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.

Loop — The sensor element of a vehicle detector.

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.

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.

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

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

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.

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

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 phaseprovide control for one of the following:

Dummy Phase : Phase without having assigned lamps

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

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

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

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

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

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

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

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.

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

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.

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.

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

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

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

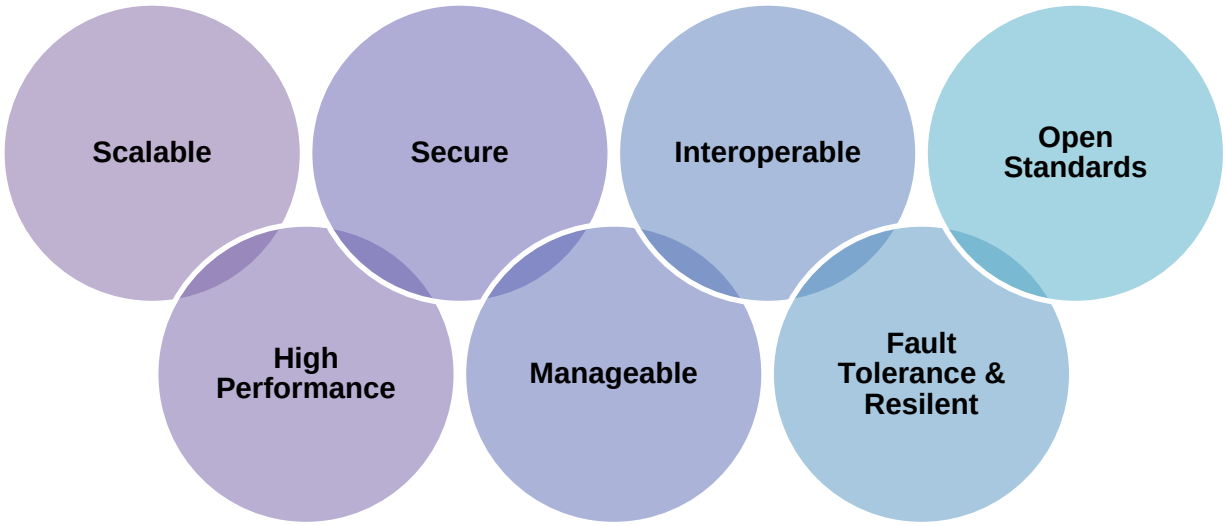
Vehicular Movements — The Vehicle phase contains three signal aspects, viz. Red, Amber and Green. The termination of vehicle phase is always with clearance amber.

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

4 ITMS Component

With ever-burgeoning vehicles on city roads, traffic congestion has become a major problem in cities nowadays. Increased air pollution, noise pollution, accidents, delay in travel time etc. are some of the problems that are faced by people living in cities. Traffic jams have severely impacted the lives of citizens. The traditional traffic lights deployed in cities are not sufficient to meet the demands of an over-growing city since these traffic lights have specific pre-determined time intervals for changing from red phase to green phase. Hence, given the exponential addition of vehicles on the city roads it has become imperative to adopt new technology to manage traffic in more effective ways.

The ITMS solutions is planned to improve traffic operations. Accordingly, the ITMS solutions have been designed considering the following guiding principles:



- **Scalable:** The system will be scalable to future growth in volume of traffic and to integrate with other initiatives and support sustainable development to meet the growing traffic demand. The IT infrastructure proposed in the System will support these scalability requirements. There will not be any system imposed restrictions on the upward scalability in number of field devices. The system will also support vertical and horizontal scalability so that depending on changing requirements from time to time, the system may be scaled upwards. There must not be any system imposed restrictions on the upward scalability in number of field devices.
- **High Performance:** The System will be up and running without any single point of failure as per the demands of various Project critical applications running on the network. Components of the architecture must provide redundancy and ensure that are no single point of failures in the key project components. Considering the high sensitivity of the system, design will be in such a way as to be resilient to technological sabotage. To take care of remote failure, the System will be configured to mask and recover with minimum outage.

- **Secure:** The network in the proposed System will have built-in security features as per good industry practices in line with the requirement for ITMS. It is required to make provisions for security of field equipment as well as protection of the software system from hackers and other threats. The virus and worm's attacks will be well defended with gateway level Anti-virus system. Furthermore, all the system logs will be properly stored & archived for future analysis and forensics whenever desired. The following guidelines need to be observed for security:
    - Build a complete audit trail of all activities and operations using log reports, so that errors in system – intentional or otherwise – can be traced and corrected.
    - Access controls must be provided to ensure that the system is not tampered or modified by the system operators.
    - Implement data security to allow for changes in technology and business needs.
    - The security of the field devices must be ensured with system architecture designed in a way to secure the field devices in terms of physical damage & unauthorized access.
- **Manageable:** The System will be seamlessly managed with centralized enterprise management software. All the network components will be manageable using open standard management protocols such as SNMP. Ease of configuration, ongoing health monitoring, and failure detection are vital to the goals of scalability, availability, and security and must be able to match the scalability of the system.
- **Interoperable** - The system will have capability to take inputs from other third-party systems as per situational requirements. All products will be open standards based and should be interoperable with different vendors' products following industry standards.
- **Fault Tolerance and Resilient:** The System should have inbuilt redundancy features to provide high availability. Redundant connectivity will be proposed for all locations to ensure that single link failure does not affect the functionality.
- **Open Standards –** The System should use open standards and protocols to the extent possible without compromising on the security.
- **Convergence –**The proposed ITMS solutions should be made scalable for future convergence.

The major components of ITMS are ATCS, Emergency vehicle preemption system, pelican controller, Count down Timers etc. The general specification of this components are listed below.

5 General Specifications of Adaptive Traffic Control System (ATCS)

The Adaptive Traffic Control System has the following major building blocks.

a) Vehicle Actuated Traffic Signal Controller
b) ATCS Application Software

5.1 Traffic Signal Controller

- The Traffic Signal Controller equipment is a microcontroller/microprocessor based controller with solid state traffic signal lamp switching module and a inter & intra conflict monitoring facility to ensure that conflicting, dangerous or disallowed traffic signal movements.

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

- Should have the facility to get Vehicle occupancy and count data through API calls as well should have dedicated isolated inputs to read from dry contact output of any Vehicle detector hardware.

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

- It shall have touch screen based User Interface for Signal Plan viewing, editing and committing via software plan download application

- The controller shall have the facility to update the RTC time from ATCS server (TMC), GNSS and through manual entry at site

- The controller shall be capable of communicating with the ATCS server through Ethernet on a managed leased line or, 4G/5G.

- It shall have the facility to apply lamp dimming based on configured time.

- It shall support emergency vehicle priority using CV2X or cloud based systems.

- Support Bus priority system, Red light violation detection and health monitoring of existing street furniture

- Shall have minimum of 8 MOSFET based extra driver outputs for interfacing and controlling of other third party devices

- Shall have wifi and Bluetooth connectivity for interfacing Laptop or Mobile handset for

configuration and viewing

- It shall support pedestrian push button and audio interfaces

5.1.1 Traffic signal controller Hardware specification

CPU	: Minimum of 32 Bit Microcontroller
Memory	: RAM 2GB or above
External memory	: SD Card support 8GB or above
Real Time Clock	: Onboard RTC with at least 10Year Battery Backup
RTC update	: GPS/GNSS Enabled / ATCS Server Time
Time resolution	: 100mSec
Output switching	: Solid state, 24VDC 5A
Signal Lamp output	: Minimum of 64 and expandable up to 128
Detector input	: 16 or above (Physical I/O s) / SDK /API integration
Ethernet Interface	: Gigabit
Police Control Panel	: Through physical switch as well as through mobile App for easy remote operation. Supported switches are Lamp OFF, Forced Flash, Manual selection, advance, 4 - 8 Hurry-calls and all red
Self-Diagnostic	: Hardware/Software watchdog, System Failure detection, Lamp Conflict Monitoring, lamp status
Plan configuration Facility	: webserver based configuration through mobile/laptop/remote server
Firmware update	: Ethernet or wifi (via webserver)
Communication Protocol	: UDP, TCP, HTTP, RS232 for dynamic CDT, CAN etc.
Input Voltage Monitoring	: Voltage and Board Current Monitoring
Others	: USB OTG support, Wi-Fi support

5.1.2 Police Panel

The controller shall provide the following facilities in a separate panel with provision for lock and key arrangementsfor use by the Traffic Police. This police panel operation shall be activated from a mobile application also when the police operator is near by the junction.

a) *Minimum 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; Extendable up to Eight Hurry Calls

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

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.

f) All red switch--- Activation of this switch should force the signal to All Red condition

5.1.3 Modes of Operation

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

g) *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;

h) *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;

i) *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;

j) *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;

k) *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;

l) *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

m) *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 Cycletime 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 thefollowing from the Central Computer at TMC.

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

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; Configurable from Centralized Application
   ii) Flashing Amber / Flashing Red – 30 Minutes; Configurable from Centralized Application and
   iii) Junction Off – 30 Minutes.
   iv) All Red – 5 minutes

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

   i) Green time actually exercised for each approach (stage preemption timing) against theGreen 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.

5.1.4 Traffic Signal Controller Operating Parameters

n) *Phases* — The controller shall have facility to configure 48 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 witha 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;

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

p) *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;

q) *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;

r) Week Plan — Facility to configure 4 Week Plans

s) Season Plan — Facility to configure 4 Season Plans

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

u) *Starting Amber* — During power up the controller shall initially execute the Flashing Amber / FlashingRed 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 limitsat the site;

v) *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 2 Seconds to 20 Seconds;

w) *Minimum Green* — The controller shall allow programming the Minimum Green period from 2 *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 programmabilityof 1 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

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
2) Vehicle Actuated mode with fixed offsets.

5.1.5 Parameters Range of values

Stage time	: 5-240 sec
Cycle time	: 30 -240 sec
Start-up Flash	: 3-10 sec
Start-up All Red	: 3-10 sec
Amber Time	: 2-10 sec
Red Extension Time	: 0-10 sec
Min. Green Time	: 2-10 sec
Max. Green Time	: 5- 240 sec
Manual Mode Min Green	: 3-10 sec
Pedestrian WALK time	: 1–50 sec
Pedestrian FLASH time	: 1-10 sec
Offset	: 0-300 sec
Gap time	: 1-10 sec
All RED time	: 1-10 sec

Intensity	: 25% to 100%
Time Update	: GPS, GNSS, Server, Local
Conflict	: 64

5.1.6 Input and Output facilities

x) *Lamp Switching* — The controller shall have Minimum of 64 lamps and by adding additional cards it should be possible to extend up to 128 lamp. The signal lamps shall be operable on 24VDC / 12VDC ±10%;

y) *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. Controller should also be capable enough to take detector inputs through SDK and API provided by the Detector (video ,Radar ,Ultrasonic)OEMS

z) *Communication Interface* — The traffic signal controller shall support Ethernet interface or inbuilt 4G/5G to communicate with the ATCS server

aa) *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;

bb) *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 duringpower 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; Or through NTP from TMC+

cc) *Display & Keypad (optional)* — The traffic signal controller shall have a touch screen based HDMI monitor for configuration and viewing purpose. If inbuilt monitor is not available it should be possible to configure parameters using Laptop/mobile through WiFi connectivity.

5.2 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 helpof 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 strategiclocations at the intersections controlled by the system.

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

5.2.1 The ATCS application software shall do the following:

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

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

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

gg) 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;

hh) 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;

ii) 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;

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

kk) 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

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

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

5.3 Reports

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

5.4 Graphical User Interface

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

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

mm) *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;

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

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

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

qq) *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 inseconds 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 bothdirections;
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.

rr)
ss)
tt)

5.5 Central Control Room (CCR)

The Central Control Room required hardware and facilities 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

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

uu) Switch OFF / ON an intersection;
vv) Select / De-select Forced Flash at an intersection; and
ww) Select / De-select Hurry Call at an intersection

5.5.1.2 Decision Support

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

5.6 Emergency Vehicle Priority System

The emergency vehicle priority system gives priority green signal to emergency vehicles such as ambulances and fireengines and stops the conflicting vehicle movements. The system should have Vehicle Mount Unit fitted on the dash board of the emergency vehicle and the traffic signal controller shall be capable enough to take inputs from emergency vehicle through CV2X radio or through cloud solutions

The specifications of Vehicle Mount Unit is given in Table 3.

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

Sl No.	Specification	
		(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.	Device Connectivity	GNSS/ Support Indian Regional Navigation Satellite System (IRNSS) Should support Sterlite based augmentation system (SBAS)
V.	Positional Accuracy	min 2.5 m
VI.	Communication	Device should have internal antenna Device Shall have Embedded Sim
VII.	Status Indication LEDs	ON/OFF, Radio Transmission, GPS/IRNSS active
VIII.	Programmable parameter	Vehicle ID
IX.	Supply Voltage	Operate b/w 8 V to 32 V DC on vehicle battery
X.	Temperature	0°C to +55° C
XI.	Relative Humidity	95% RH Non- condensing at +40 ℃
XII.	Mounting	Should be inside the vehicle
XIII.	Storage	Non-Volatile to store 40,000 positional logs
XIV.	Battery backup	4 Hours Internal battery – at a transmission frequency of 60 Sec
XV.	Ingress Protection Rating	IP65 (high dust protection & protection of low water pressure)
XVI.	Quality Standard	as per Automotive Industry ISO/TS 16949
XVII.	Standard	As per AIS 140 Standard

6 Pelican Controller for pedestrians

Normally Pelican controller gives right of way green signal to the pedestrians upon pressing a push button. This greentimings 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. The controller shall be most useful at mid-block crossings in road stretches, in front of hospitals, markets, schools, etc. where pedestrian crossings are more.

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.

6.1 Specifications

The specifications of Pelican controller 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 thepush button
viii)	Pedestrian Detection Inputs	Push Button Switch, RFID Reader and Ultrasonic Sensor
ix)	RF ID card Supported	125 KHz with EM4102 protocol /UHF 865- 868 MHZ
x)	Smart cane supported	Any smart cane with 40 KHz ultrasonicpulse
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/ 3G/4G
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

6.2 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

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

INTELLIGENT TRANSPORT SYSTEMS, TED 28

(Will be Added Later)