Solution Document

For

Intelligent Traffic Management System

SUBMITED BY:

Table of Contents

Preface:

Dhanbad is second-most populated city in Jharkhand with 24 Km geographic length (north to south) and 16 Km (east to west breadth). The city boasts of multiple exclusivities like having highest 4G mobile phone network availability in India (a survey of Opensignal) along with grown IT, India's Second-largest revenue generating Rail Division after Mumbai and major highways of NH 19 (part of Golden Quadrilateral) and NH 18 through city's heart, being 96th fastest growing city of the world (City Mayors Foundation), witnessing administrative turnaround from dirtiest city in the 2018 to 56th cleanest Indian city in 2019 (Swachh Survekshan cleanliness survey), the coal Capital of India having thick forests, rich mineral resources and around 112 coal mines and multiple coal washeries along with mixed demographic profile, a cosmopolitan culture and average literacy rate of 79.47% higher than the national average of 74.04%. Maithon Power Ltd is India's first PPP project (a JV of Tata Power and Damodar Valley Corporation), Dhanbad Municipal Corporation works for increasing green cover in the city.

In line with the above recent administrative feats, the city counts on a progressive administration to create efficiency in growing traffic and bring manageability to streamline.

Bonsai is being reckoned a suitable ICT player to work towards the initiatives. It is qualified for its established credentials based important projects delivery, best industry team and zero client betrayal enabled (a testimony to customer-centric DNA) has deployed Faridabad Smart City, Gurgaon Smart City and is implementing Saharanpur Smart City, Bareilly Smart City, apart from other projects. The best value propositions from Bonsai consists of qualitative service aggregators working across MSIs, OEMs, Consultants, and clients, offering across the services continuum of Plan, Build, Support, Manage, Improve, innovate for the system TCO based on entire lifecycle costs of equipment, deployment, maintenance, upgrades and ITAM.

Bonsai can integrate ICT highway of city fiberisation, public Wi-fi, ICCC & Datacentre, cyber security and cloud and Managed Services based on in-house design & engineering team, a large pool of expertise for technical implementation, project management and O&M delivery.

1. Adaptive Traffic Control System

Introduction:

The city of Dhanbad needs services from a Master System Integrator to supply, install an Area Traffic Control System (ATCS) at key junctions and maintain for 5 years, with the key features of the system being as below :

- o Adaptive system – The system shall change traffic signal timings based on inputs from non-intrusive vehicle detectors deployed at each approach of each junction.
- o Standards compliant – The system shall employ industry standard open communication protocols like UTMC/UG405.
- o Tactical traffic control – The system shall be capable of dynamically operating the traffic signals in near real-time, based on inputs from the traffic detectors.
- o Strategic traffic management – The system shall use data from a number of data sources and apply fusion models to estimate the current state of the network as a whole, employ short term prediction models and then use simulation models to strategically manage traffic across the network, before things get worse.
- o Central control centre – The CCC is expected to act as the core of the system. The system shall employ a reliable communications network to ensure maximum availability for the communication link between the CCC and the traffic signals.

Objectives:

1. Manage traffic centrally, while receiving traffic inputs from sensors
2. Optimally configure the traffic signal timings in near real time
3. Minimise traffic congestion and waiting time
4. Improve journey time reliability
5. Ensure smooth movement of emergency response vehicles like ambulances, police etc.
6. Manage the movement of VIP vehicles better
7. Manage Public Transport buses by implementing bus priority and compensation
8. Perform analytics on the traffic detector data to analyse travel demand patterns and manage traffic effectively
9. Provide real-time information to commuters
10. Improve compliance with traffic rules
11. Use advanced techniques to reduce the number of video cameras

Scope of work:

Preliminary surveys:

- Collect data of existing operating conditions, traffic volumes across various time periods of a day, which will cover all peak and non-peak hours, weekends, etc., saturation flow rates, travel times along major corridors during different times of the day. At the minimum, the following data shall be collected:
  - o Pedestrian volumes at major junctions
  - o Physical and visual characteristics of the area
  - o Additional dependencies with respect to the available infrastructure and geometry at the junctions

- Study the existing traffic management systems and processes deployed by the competent authorities, MIS reporting needs, problem areas and expectations of the city. Perform Gap Analysis and finalise the key requirements with the city.

Design and planning:
- Prepare the solution architecture and design drawings
- Seek approval of the designs from the city
- Prepare the execution plan and get it approved by the city
- Prepare work zone safety and traffic management plans

Installation and commissioning:
- Procure, supply and install vehicle detectors, controllers and other required accessories as per the approved design
- Procure, supply and install all relevant hardware, like servers and workstations in the CCC
- Connect the signal controllers to the CCC via a suitable communications media
- Install the ATCS software in the servers within the CCC
- Integrate all components of the system and configure the traffic signal plans at each of the junctions, for varied operating conditions like peak and off-peak traffic, weekend traffic, traffic flows during special events etc.

Functional requirements of ATCS

General:
- The system would be used to control traffic signals, including signalised pedestrian crossings, using a traffic responsive strategy based on real time data obtained from vehicle presence sensors.
- All signal controllers under Adaptive Traffic Control System shall be provided with inputs from non-intrusive vehicle detection cameras for detecting demand and communications equipment to send the demand data and to receive instructions on the control strategy in near real-time.
- The system shall be able to use GPS data of emergency vehicles and Public Transport buses to provide selective vehicle priority and compensation at junctions.
- The system should be extensible to add more signals whenever required.
- Any existing infrastructure at the junctions that might help in traffic control, where possible, should be integrated with ATCS.
- ATCS shall use standard communication protocols like UTMC/UG405. It should also provide the functionality of integration with on-ground hardware of any third-party traffic controller that is UG405 compliant.
- The ATCS system shall be able to optimize the signal timing for vehicular phases to provide safe and quick passes to pedestrians.

Traffic detectors:
- Non-intrusive video-based traffic detectors shall be used.
- The vehicle detection camera shall also act (if needed) as an overview surveillance camera for each approach.
- The detector shall be able to detect the presence of vehicles near stop-line in non-lane based mixed traffic flow conditions. It shall be possible to draw at least 3 sets of zones per detector camera to vehicle presence locally using open collector interface.
- The detector shall be able to generate accurate counts (more than 85%) and classification.

- A detector that does not change its status at least once during a stage execution, the ATCS application in the control centre shall be notified at the termination of the associated stage.

Traffic signal controller:

- The ATCS controller should define common inter-stage period formed by the clearance Amber and Red extension period. It shall also be possible to program individual inter-stage period from 3 Seconds to 10 Seconds.
- The controller shall have a facility to list all conflicting phases at an intersection. After configuration, a traffic engineer shall verify that the signal aspects are running as expected, for each and every program coded in the controller, before being put to use.
- 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.
- 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.
- The controller shall be able to interface with a wide variety of detectors using TCP/IP or UDP protocols.
- The signal controller shall have a police control panel with:
  - Hurry call buttons,
  - Auto/Manual selection button,
  - Manual advance button,
  - Normal/Flashing mode button, and
  - Junction On/Off button.
- The controller shall have the following modes of operation:
  - Fixed time mode - the controller shall execute a pre-set program, which does not consider the inputs from the traffic detectors.
  - Vehicle actuated mode - the controller shall execute pre-set programs that do not have fixed green times. The green time for each approach shall be bound by the constraints of minimum green and maximum green times. The actual green time is determined based on the vehicular demand obtained from the traffic detectors.
  - ATCS mode - the controller shall execute the programs determined by the ATCS application in the control centre and shall take inputs from traffic detectors to optimally split green times and adjust offset times.
  - Bus priority and compensation mode - the controller shall provide priority to buses selectively at junction based on GPS data. Once priority is provided, the traffic at the junctions could go haywire; hence the controller shall also provide compensation for the lost green time to other approaches to reduce the impact of bus priority.
- The controller shall either have a fixed operator console or a portable one to allow traffic engineers to program the controller on-site.
- The controller shall allow interfacing with the ATCS application using an industry standard protocol such as UTMC/UG405. No proprietary communications protocol shall be used, in any case.

ATCS application:

- The application is at the core of the system and shall be hosted on a server in the control centre.

- The application should allow creation of green corridors to ensure priority movement of Emergency Response vehicles, such as ambulances, fire engines and police vehicles.
- The application shall interface with a popular microscopic traffic flow simulation software for pre- and post-implementation analysis and study of the proposed ATCS control strategy.
- The application shall display the counts data for every junction in a tabular format.
- The application should be capable of running in the following four modes:
  - o **Remote manual operation mode:** This mode should allow police personnel and traffic managers to manually operate the traffic signal remotely from the control room using the ATCS interface.
  - o **Coordinated fixed-time mode:** This mode should enable traffic police personnel to remotely select a coordinated fixed-time plan for a group of junctions from a stored library of pre-entered plans and run the selected plan using the ATCS interface. The system also supports automatic selection of a plan from the library of plans based on the time of day and day of the week.
  - o **Automatic plan switching mode:** The system should be configured to run the most appropriate signal timing plan for a group of junctions from a library of signal plans based on real-time traffic conditions. The plan selection logic should be based on user-configured rules that use near-real-time traffic detector data and/or data from other ITS data sources (e.g. journey time from ANPR).
  - o **Optimisation mode - tactical:** Signal timings (cycle time, split and offset) for a group of junctions should be optimised for pre-defined performance indicators, like delays, travel times etc. The ATCS algorithm should estimate these performance indicators to determine optimal signal timings using near-real-time detector data. Upon request, the software shall provide priority for buses and other selective vehicles at traffic signals using real-time GPS data of the buses sent to the ACTS software, followed by compensation of lost green time to other approaches after the passage of the selective vehicle. The software shall have the functionality to optionally provide priority and compensation only when the buses are running late using schedule adherence data made available to the ATCS software.
  - o **Optimisation mode - strategic:** The system shall have a strategic traffic control layer on top of the tactical control logic. The strategic control layer should monitor traffic detector data and performance indicators in near-real-time, compare them against average values for the given time of the day and day of the week (profiles) and generate operator alerts when an anomaly is observed. In addition, the system should predict the values of traffic variables and performance indices into the short-term future (5, 10 and 15 minutes ahead intervals) and generate warnings before the onset of anomalies where feasible. When anomalies are detected, the system shall evaluate potential traffic control strategies using faster than real-time modelling using a traffic simulation software and suggest appropriate strategies to the traffic operator. The strategic control should also be able to dynamically change the base signal plans used by the tactical control based on near-real-time detector data based on user defined rules. The strategic control layer should also estimate the state of the road network, including an estimate of traffic state on links without any detection, using data from traffic detectors and other data sources such as ANPR and GPS (if available) to provide a unified operational view of the road network.
- The application shall have a Graphical User Interface (GUI) with an underlying GIS map that shall display the network and the traffic signals, traffic cameras/detectors, Variable Message Sign (VMS) boards and Public Address (PA) systems deployed.
- ATCS application should also be capable of displaying live video from CCTV cameras that have been deployed for traffic detection & surveillance.
- The GUI shall provide:

- o   Flexibility to the operators to zoom and navigate with ability to interact with objects on the map.
- o   Interoperability across multiple platforms.
- o   Web browser-based access, requiring no local setup on the
- o   Graphically present signal plan execution and traffic flow at the intersection on desktop
- The GUI shall have the following features:
  - o   User login – Operator authentication shall be verified at this screen with login name and password.
  - o   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.
  - o   Live video feed – The operator shall be able to see the live video feed from CCTV cameras that have been deployed for traffic surveillance.
  - o   Traffic Control Display – This online display shall indicate the current traffic state with animated arrows, mode of operation, stage number being executed and elapsed stage time.
  - o   Saturation Snapshot – This display shall show the current saturation levels of all intersections in a corridor.
  - o   Reports Printing / Viewing – This link shall allow selection, viewing and printing of different reports available under ATCS.
  - o   Time-Space Diagram – The time-space diagram shall display the current stages being executed at every intersection in a corridor with immediate previous history. Junctions shall be plotted proportional to their distance on Y-axis and time elapsed for the stage in seconds on X-axis.
- The solution should include the following reports at a minimum:
  - o   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.
  - o   Cycle Timing report – The report shall give details of time at which every cycle has taken place.
  - o   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.
  - o   Cycle Time switching report – The report shall give details of time at which a cycle switching has taken place.
  - o   Mode switching report – The report shall give details of the mode switching taken place on a day.
  - o   Event Report - The report shall show events generated by the controller with date and time of event.
  - o   Plan Change – The report shall show the time of change of plan either through keypad or remotely through a PC or Server.
  - o   Mode Change – The report shall show the time when controller operating mode is changed either manually through keypad or a remote server. The typical modes are FIXED, VA, FLASH, LAMP OFF and HURRY CALL.
  - o   Traffic Data: The count & classification data from each junction shall be displayed for the different times of the day along with the location.
  - o   Detector/Camera Failure Report – The report shall show the date and time of detector failure with detector number and associated phase.
  - o   Conflict – The report shall show the conflict between lamps (RED, AMBER, GREEN) in the same phase or conflict between lamps with other phase.
  - o   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.

o   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.

Technical Specifications of ATCS components

Traffic signal controller

Traffic signal controller should be able to run any ATCS algorithm having demand actuated dynamic signal timing plan selection. The communication between the controller and the ATCS software shall happen over industry standard UG405 or NTCIP protocols. The following specifications are to be adhered with:

1. Power supply: 230 V AC @ 50 Hz
2. Communication protocol: UTMC/UG405
3. Processor: 64bit, 1Ghz
4. Number of signal groups: 16 Minimum
5. Number of signal head outputs: 32 Minimum
6. Number of phases: 16 Minimum
7. Number of signal plans: 32 Minimum
8. Number of stages per plan: 16 Minimum
9. Signal head compatibility: 12/24 V DAC
10. Hurry Call Buttons: Minimum 4
11. Police Control Panel: Yes, with hurry calls and push to change buttons
12. Temperature: 0°C to 60°C
13. Communication standard: UTMC/UG405 protocol over TCP/IP
14. Media interfaces: 1 Ethernet interface
                                                        2 x USB 3.0 host ports
15. RAM: 2 GB SDRAM minimum
16. Storage Capacity: 8 GB minimum
17. Timing Resolution: Minimum 100 msec (input resolution to 2ms)
18. Input for detectors: Direct interfacing over TCP/IP or UDP

Traffic sensor

1. Lens type: Wide angle
2. Location: 15-20m before the stop line; looking towards stop line or at the signal pole as per the solution
3. Count: Counts with at least 80% accuracy
4. Frame rate: 30 fps or higher
5. Temperature: -10 °C to 60 °C

Traffic signal aspect

● Maximum power consumption for any colour aspect - 14 W
● Diameter: 300mm
● Units operate at 12/24 V DC
● Operating temperature: 0°C to 60°C
● LED module ingress: IP 65
● ISO 9001 certified OEM
● UV Stabilised Shield

Countdown timer

- Power Consumption: 20 - 30 Watts per lamp
- Input Power: 230 V AC @ 50 or 12/24 V DC
- Operating temperature: 0°C to 60°C
- Humidity: 0% to 95% Relative
- Countdown timer head ingress: IP 55
- ISO 9001:   Certified OEM
- Colour: Dual (Green & Red)
- The timer shall be self-learning with advance adaptive feature
- The timer shall display alternate 'STP' or 'GO' with alternate time in the fixed time mode
- The timer shall display 'STP' or 'GO' in the learning or adaptive modes.

Pedestrian Lights

- Power Consumption: Maximum 20 Watts per lamp
- Input Power: 230 V AC @ 50 or 12/24 V DC
- Operating temperature: 0°C to 55°C
- Type: Multiple LEDs Matrix
- Dimension: 300mm diameter
- It shall be an integrated adaptable timer unit. It shall display the red man during pedestrian red stage and the green man along with green time for the pedestrian green stage.
- The timer shall work even when the pedestrian red time keeps on changing as the signals are adaptive

2. PA System and ECB System

SYSTEM BLOCK DIAGRAM
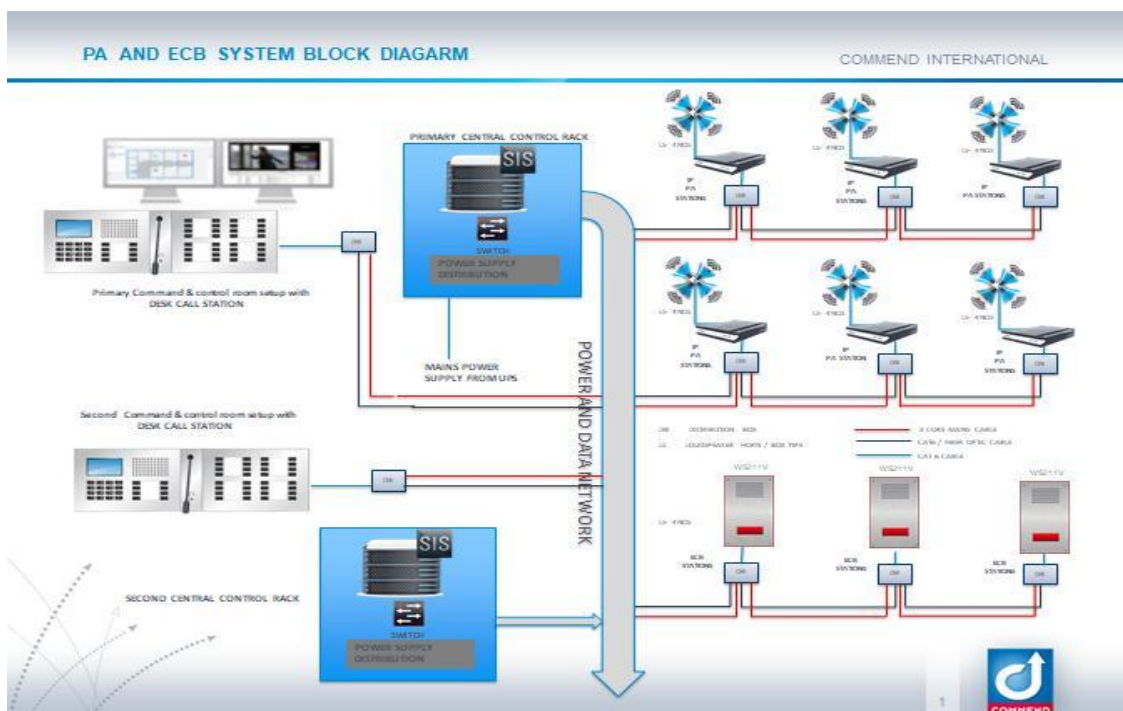
SYSTEM DESCRIPTION

Public Address (PA)and Emergency Call box (ECB) system for smart cities is a communication link between the people in city and Security force. To manage harmony in city operation, it is very essential to have effective management of traffic and incidence on the road. Direct communication to and from people makes this easier and effective. IP based PA and Emergency communication system in Smart Cities provides service for same.

PA and Emergency communication system are integrated systems. Their operation can be described as below.

PA SYSTEM:

IP based PA communication system works on the city-wide distributed IP backbone. Each important junction and roads are covered with PA equipment. PA Equipment's consists of following

i.   **Speakers –** It is used to convert audio signal into speech and mounted on poles to address required areas. Speaker power and quantity is designed to meet the required audio levels requirement at streets as per audio standards. Placement of speakers is to be planned such that audio announcements will be clear, unambiguous and loud enough to address street people. Proposed solution will have outdoor horn speakers

which can provide maximum sound pressure level of 119 decibels. Speakers are outdoor horn type with weather proof rating of IP66. Speaker audio level will be directional; as well audio power reduces by 3 decibels for every 1 meter from speaker location; so to address all direction of squares and roads, placement of multiple speakers will be planned. Number of speakers at any place will be planned as per area requirement.

ii.   **IP Amplifier -** Broadcasting audio signal will be received by this device and amplified to provide it to speakers with required power. These are IP based devices so it can be easily deployed over wide city areas without complicated cabling network. High level Audio line

output used to drive multiple speakers. There are various power capacity options available in IP amplifier i.e. 50 W, 125 W, 250W. IP Amplifiers power ratings will be planned as per number of speakers required. As per Project requirement capacity of IP amplifier is used for addressing city road squares and for on road area coverage.

iii. **Control Desk Station:** Security control desk station is IP based call station. It is used for PA/ECB announcements on city wide system. There is provision for manual and recorded PA announcements. Manual announcement will be made by security personals through control desk call station.

With pre-programmed key press, desired area will be selected for PA announcements and operator can make live announcement or play pre-recorded message. Audio will be broadcasted on selected area PA speakers via IP Amplifiers. System can have multiple control desk call stations. Control desk stations will be connected to system via CAT 6 cables. GUI will display the status of broadcasting audio areas over city map. Automated pre-recorded announcements will be controlled through PA system software.

iv. **Monitoring and control software:** All system elements are IP based and system has facility to manage all system element configuration and status monitoring through software-based applications. There is different software module available as per need of application which are as follows,

1. CCT – centre configuration tool – This is windows-based software. It can access system from any point in network and used for configuration of system. System configuration includes controlling volume levels, call station parameters e.g. Name, call numbers, group / Zone numbers, pre-recorded messages to be played, change of recorded messages, setting network parameters i.e. IP address, subnet and router, gateway address etc.

2. Command & Control system interface – With interface to Command & Control software. It provided interactive user interface to PA system. There is provision for display of system elements with interactive ICONs, on multiple plan levels. Plan levels will have background images of city map or system deployment maps. Icons represent individual elements of PA system e.g. IP Amplifiers, Speakers, Control desk stations, Integration hardware, central controller hardware etc.

Further, these icons are linked with PA elements to indicate status i.e. Working, not working, busy in which type of calls etc. There are control icons also which can be used for establishing calls in conjunction with
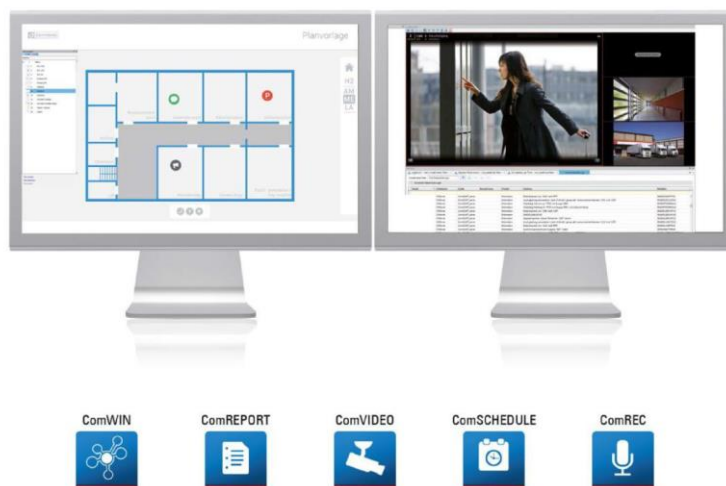
control desk station. PA announcement zones can be selected from GUI map and pre-recorded message can be played in that selected area or manual announcement can be broadcasted in selected area through hardware control desk station microphone. Further there is submodules as following to support efficient handling of PA System,

a. **ComREPORT – reporting and statistics** – Reporting module which will record all the events happening in system and generate an automatic report. There is provision for filtering events based on event types. Different type of events recorded are as below

    i. PA calls with time, call type, name and details of callers,

    ii. System diagnostic times and result of diagnostics. e.g. Healthy devices, Failure devices with type of failure e.g. Microphone, speakers, IP Amplifiers, network disconnection etc.

    iii. Filters for logged events to generate alerts for based on event type.

    iv. Email of automatic event logs as per schedule or on critical events.

b. **ComSCHEDULE – time-scheduled planning and control** – This software allows operators to schedule different activities in PA System e.g. To make automated pre-recorded message broadcast at pre-defined locations at particular time intervals. There is provision for scheduling events for years with day & hours, minute settings. Over thousands of events can scheduled and stored in software.

c. **ComREC – audio recording**- ComREC is a software-based recording solution, which can handle up to 100 simultaneous recordings and stores them in a single database for further use. The Windows®-based software uses the standard protocol RTP.

Audio recording for all communication happening from the control desk station will be recorded with time and date stamps.

There is SDK available for data interface with Command-and-Control software. Command and control centre software can do above functionality with interface data.

V. Intercom Server:

Server is heart of system and it is controlling all the system functionalities. Software intercom

server proposed is proprietary software of commend. License server housing has capacity of up to 1112 IP devices and further with additional housing it can support connectivity up to 25000 devices. It consists of software subscriber licenses for required IP subscriber devices in PA & ECB system. Software operates on virtualization platform to provide high availability operation.

It also consists of hardware and licenses for data interface with other 3rd party system like central VMS and ITMS management Software.

VI. Emergency call box (ECB) Usage:

Wall or poll mounted emergency call box is IP operated device. It is used for two-way communications between the people on street and security control room. In emergency, people on roads can approach nearest ECB, RED button on the ECB is programmed to connect with security control desk. There is immediate response from ECB

with audio visual indication about call connection with security control desk. Security control desk get video(optional) on display from calling ECB. Security control desk can handle multiple calls simultaneously.

Emergency call box is with built in camera and audio module operates on POE. Vandal proof, IP 66 weather rating device ensure proper operation in outdoor environment. Built in DSP functionality reduce background noise and ensure clear audio communication from noisy streets to quite control room. Built in microphone and speakers provide clear audible handsfree communication. Speaker audio levels is adjusted automatically with respect to background noise.

VII. Optional Soft call Stations usage:

Soft calling stations are useful for moving security personals. It works same as hardware control desk. It can be installed on Wi-fi or GSM operated devices e.g. Laptops, Tablets, Mobile phones and connect to PA system IP network. Live PA announcements and pre-recorded messages playing and two-way audio is possible via soft call stations.

Prominent Features of PA and Emergency Call System:

1. Live PA announcements from control desk in individual zone, selected zones, all zones PA speakers.
2. Individual PA points (IP amplifiers) will be addressed with call number and names. Further it will be grouped to make PA zones. E.g. PA Zone1, PA Zone 2etc.
3. Pre-recorded messaged stored at server memory used to play at different zones simultaneously at scheduled time. Scheduling of pre-recorded messages playback at different zones can be done through user friendly software application. Scheduling can be done for complete year with data, time and number of repetition intervals.

4. Recorded message announcements via control desk.
5. Self-diagnostics of all PA system & Emergency calling system elements.
6. Audio recording for all PA and ECB calls from central control desk.
7. Monitoring of all PA and ECB system elements on GUI.
8. Disaster or standby control desk functionality through soft control desk station operated on wireless data network.
9. Remotely volume and call functions control through configuration software.
10. ECB can link to IP camera video to display and recording on VMS software through integration.
11. Enhanced HD Audio quality i.e. 16 KHz audio bandwidth.
12. Excellent noise cancelling and automatic volume adjustment features for communication from noisy streets.
13. Vandalism protection and auto diagnostics of speakers and microphone ensuring 100% availability of ECB and PA system.

3. Integrated Traffic Management Solution (ITMS)

Expertise:

- All the solutions designed are utilizing Deep Learning Methodology involving State of Art DNN (Deep Neural Networks).
- Though the system uses DL Methods and requires GPU/CUDA based compute/processing power but the same has been optimized on normal CPU and windows machines as well to reduce the costs involved.
- The Accuracy of the solutions is always higher than solutions in competitions globally.
    - Proprietary OCR engine is trained over Indian vehicle dataset for more than 5mn of images to achieve the best possible ANPR system for Indian roads and traffic conditions.
    - Accuracy of ANPR system is upto 100% and at-least 15% more accurate than open-source OCR library which all the common solution providers use.
    - The Solutions work with the "Most optimized server sizing" or least Hardware requirements as compared to the competition when comes to centralized processing of 1000s of cameras.
    - The Solutions provide results in milliseconds and hence the results are in almost real time even on a normal CPU/LPU instead of competition where results take 2-3 seconds of time.
    - Our solutions are built upon progressive ML techniques and never stop learning.

4. Need Assessment

The vision of the project is to implement a citizen friendly, holistic, integrated and responsive Video based proactive Traffic surveillance system. The project envisages transformation of the traffic management for a city by implementation of video surveillance system in accordance with the highest standards available for monitoring the traffic across the City. The objective of the project is to ensure safety and security and manage the traffic law enforcement for the citizens, particularly among the violators through a comprehensive video surveillance system.

5. Proposal Overview

Bonsai Enterprises is pleased to provide this proposal with **Artificial Intelligence and Deep Learning based ANPR System and Traffic Video Analytics systems for the ITMS Project.**

This subsequent sections in this document provide a detailed description of the proposed software components proposed as the exhaustive solution for **"Integrated Traffic Management System"** covering all the functionalities of the system mapped with the department's requirements. The solution also includes all the sub-components of the system contributing in framing exclusive solution for the problem statement at hand.

In the proposed solution, BEPL offers State of the art software system to cater to the requirements. This document will provide information about the technical aspects and the corresponding implementation process and scope of work to be undertaken by BEPL using the proposed software packages as laid-down in the **Solution Architecture** section of this document.

Integrated Solution Design Philosophy

Design Considerations

a. **Scalability:** Due to rapidly growing quantum of data, the platform proposed can scale the solution upwardly to accommodate the increase in data being parsed and churned out. It also allows the addition of increment in the processing of data clusters with minimal or no service interruption

b. **Security:** The proposed solution also provides secure and controlled access for the users. The data processed or accessed through the system will always be kept confidential. The system provides a highly secure role-based access to features and will maintain access logs for verification as and when required.

c. **Interoperability and Customization:** The system is tightly coupled and works seamlessly with all the other components offered as per this proposal. The system is also customizable with respect to API integrations with any application that should communicate with the solution proposed. The system also allows customization in terms of tuning of existing features, ingestion of additional feeds and use of existing data. The system provides exhaustive supported APIs/interfaces/web surfaces, etc.

d. **Upgradation and Patches:** while in the support period, shall provide all the patches and upgraded versions of the software to the procuring agency based on industry standards and latest technology being globally utilized.

e. **Backward Compatibility:** Newer version of the platform will be compatible with the existing data housed and maintained in older versions. These will also ensure cross-version veracity of the data being handled.

f. **Ease of Use:** The system is highly user-friendly and the features controls inside the framework are self-explanatory. Besides, any issues will be catered by the staff supporting in the post-deployment phase.

g. Data Integration from different platforms

Video Intelligence Platform

Organizations today are striving to understand and incorporate all the various dimensions of available data to come up with better actionable insights. Apart from the structured, semi-structured and unstructured datasets, also arises the need to understand the pure-unstructured form factors of data as well. In the digital era organizations are overwhelmed by the number of images and videos available with them. Although an extremely critical piece of information, it requires advanced and specialized tools and technology, to decipher and convert to actionable insights. Law enforcement Agencies are no exception to this and in fact, are one of the prime consumers of video feeds.

Law Enforcement Agencies across the world rely heavily on video content for investigation and analysis. With more pronounced emphasis on safer cities, larger geographical areas are now being covered and monitored by hundreds and thousands of CCTV cameras. This leads to terabytes of digital video content streaming at any given instance and maybe petabytes of archived video content. It is humanly impossible to sift through such incomprehensible volumes of data. On top of that the digital media repository of enforcement agencies is filled with static imagery and offline video content extracted through various sources like forensics, social media, open source, public repositories and contributions etc. Organizations need this data predominantly for:

A. **Criminal Investigations**
B. **Strategic, Tactical and Operational planning**
C. **Near real Time Emergency Response**
D. **Person & Vehicle Identification, Tracking and ANPR**
E. **Identifying Missing Persons**
F. **Post Crime Analysis**
G. **Generating Alerts for outliers like violence, weapon detection, crowd gathering, eave teasing, etc.**

BEPL Proprietary AI based ANPR system leverages GPU powered High Compute infrastructure running advanced State of the Art Deep Learning algorithms to understand the computer vision dimension of data. It is a highly scalable system, capable to incorporate video and imagery content from various sources and processing them in near real time to churn out actionable intelligence and cater to the high demand of parallel investigations.
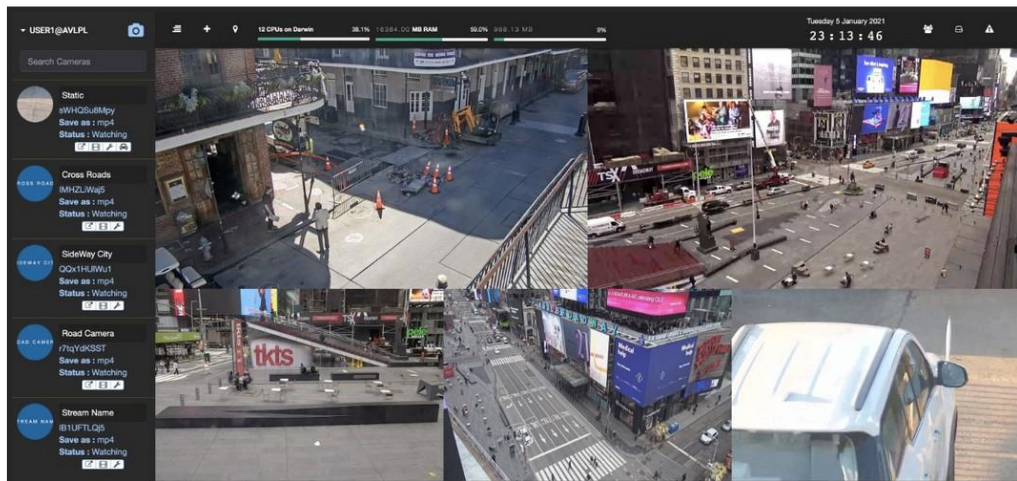
ANPR System

Automatic Number Plate Recognition (ANPR) system automatically captures the license plates of any vehicle(s) in the field of view (FOV) of a camera and stores them in the dedicated database and hence the details of the vehicles are available at any point in time for reference with incident footage clip. If there is more than one vehicle in the camera FOV, then all of them are independently processed and their license plates are recognized irrespective of the type of vehicle – private car, taxi, bus, truck, auto rickshaw, motorcycle etc. The system offers incident detection analytics applications – all in a single, unified, monolithic systems architecture. It automatically generates alerts when any vehicle captured within the camera FOV is recognized as 'suspicious', 'wanted', or any other category tagged by the user. The system has integration framework with a city surveillance system. The vehicles can be searched on the basis of timestamp, number plate, colour or vehicle category.

Camera Name	Vehicle Image	LP Number	LP Image	Event	Confidence	Category	Record Time	Action (Valid/Invalid)
Exit Gate		MP02AV4813		ANPR	94.25	carLP	1/22/2021, 12:35:46 PM	✓ ✕
Exit Gate		MP04CF5741		ANPR	98.73	carLP	1/22/2021, 12:32:46 PM	✓ ✕
Exit Gate		MP30E1144		ANPR	91.69	carLP	1/22/2021, 12:31:46 PM	✓ ✕
Exit Gate		MP04CY5159		ANPR	97.93	carLP	1/21/2021, 9:25:07 PM	✓ ✕
Exit Gate		MP04QA7894		ANPR	83.43	motorcycleLP	1/21/2021, 9:24:45 PM	✓ ✕
Exit Gate		MP04CE0289		ANPR	94.70	carLP	1/21/2021, 9:24:18 PM	✓ ✕
Exit Gate		MPL04Q0880		ANPR License Plate Issue Triple Riding	98.18	motorcycleLP	1/21/2021, 9:05:33 PM	✓ ✕
Exit Gate		MP04CY5159		ANPR	97.93	carLP	1/21/2021, 9:05:11 PM	✓ ✕
Exit Gate		MPO4CE0289		ANPR	91.69	carLP	1/21/2021, 9:01:46 PM	✓ ✕

Event Popup

Reporting Interface: The interface allows control room operators to search and view archived events anytime. There can be various search criteria, e.g., date and time, event type, license plate number, or any combination of these parameters. The search results appear on screen and can be exported as an Excel or PDF file.

Alerts: The system can be configured to send messages to any third-party software/device whenever any event is detected. Additionally, the system itself can send emails/SMS to any recipient as notification against an event.

18

No Helmet Detection System:

No Helmet Detection System tracks in real time those two-wheeler riders who are violating traffic laws by 'NOT' wearing helmet while driving on road. No Helmet Detection System is intelligent enough to detect riders who fake to wear helmet by using caps, scarfs etc. to cover their head. The system is intelligent enough to train various types of standard helmets.

Triple Rider Detection System:

BEPL's Triple Riding Detection System detects in real time those persons who are riding triple seat on the two- wheelers. The ultra-powerful technology is not only capturing the number plate of the two-wheeler with ANPR but also can generate an alert with the evidence video. On detection of Triple Ride, the system generates events, store them and allow retrieval of such events on need basis for later analysis.

Once a violation is detected (driving without helmet and/or triple riding), evidentiary image is recorded with time, stamp and vehicle number. The detected event is sent to the Command-and-Control Room.

Red Light Violation System:

RLVD system is a module in ITMS component which is combined with ANPR through camera synchronization providing an evidence to the RLVD violation with number plate of the violator. RLVD camera are at the same location with the ANPR camera. Where Wide Angle RLVD camera provides the violation evidence through violation video clip as evidence footage, ANPR camera gives narrow view to identify the violator's vehicle number plate.
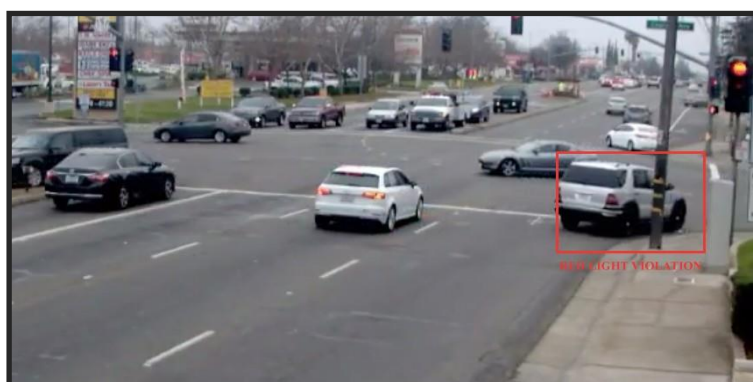
Vehicle Make and Model:

ITMS system has a module which is trained to identify the make and model of the vehicle. The system has been trained on more than 2,000 vehicles make and model which not only includes Indian car manufacturers but foreign OEMs and imported models too. The system is extensively trained to identify the Vehicle make and model and color to give more insights on critical scenario like stolen vehicle. It serves the purposes of zeroing down to the vehicle in crime scenarios.

Vehicle Categorization:

ITMS system has a provision of maintaining vehicle categories as "VIP", "Staff", "Wanted", "Suspicious", "Stolen", "Emergency Vehicle", etc. The categories are generally predefined and exists as per the earlier implementations but it also provides an option to add more categories as per the department's requirement. Whenever any specific category vehicle is spotted, an alert is thrown as per the severity of the category and can serve as a trigger for immediate action.

Centralized Management Module:

ITMS module provides a Master Server Architecture for the ITMS component. Since the system is implemented as monitoring at junctions and supervision at Smart Integrated Command and Control room (SICCR). The Local monitoring stations have Local Processing Units as local servers to capture, process and alert the immediate events whereas the SICCR expects a continuous live video feed, storage for all camera feeds for a certain duration (typically 30-90 days) and events so generated with evidence footage. The events and evidences related to them are scheduled to arrive at SICCR at a pre-configured schedule w.r.t. to the department's requirements and Traffic Control Plan.

Violation eChallan System:

ITMS system has an eChallan module which is capable of processing an eChallan for all the violations captured and approved by the department. The system is integrated to the Traffic Databases to obtain vehicle owners information to link the same with the violation they have done. Once the violation occurs, it is saved in the system for automated generation of an eChallan in the name of vehicle owner. Once it is prepared, it goes for a manual supervision by the department staff, which is an optional but important step to validate the dispatch of the challan. The eChallan format will have details like Unique Challan no., Vehicle Owner, Vehicle Number Plate, Type of Violation, Place of Violation, Date and Time of Violation, Challan fee and the evidence images for cross verification and validation if needed.

6. Training and Handover

The Training plan is customized to suit the needs of the user. Comprehensive training and training materials to equip and enable the various to use the proposed system effectively and efficiently will be conducted. The training shall be imparted on conceptual aspects of the Application Software including hands on training on the Application Software. The Project Management team will design relevant trainings to be given to all the personnel involved in the operations in batches.

Set-Up - The setup of environment for training like hardware, software, networking equipment, etc. will be arranged by the MSI. The course material including user documents and sample datasets (if required) will be supplied at the time of training.

Course Timing - Courses would be conducted on a full day basis and for a normal duration from 10 am to 5:00 pm or as per schedule mutually agreed with department, including lunch and other breaks. (The detailed Training program with full agenda shall be provided)

Venue - The training shall be conducted at premises chosen by the Department. Necessary training hall arrangements required, are to be made available by the department.

Attendance - BEPL will maintain a record of attendance and will submit the record at the end of training activity.

Language of Instruction - The classroom training will be provided in English (Local / Regional language arrangement shall be made available if required. The employer needs to arrange support for regional language translator).

The MSI is expected to nominate the SPOC for training purpose.

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Server Sizing (ANPR + Traffic Analytics) – 45 ANPR Cameras, LPU Processing

S No	Systems / Cameras	Junctions/Intersections
1	ANPR Software Licenses	30
2	RLVD Software Licenses	15
3	Local Processing Units for RLVD & ANPR	5
4	eChallan System	1

Storage Calculation						
Cameras	Frames (FPS)	Hours of Play	Storage Duration (Days)	Resolution	Video Quality	Total Storage (TB)
45	25 FRS	24	30	1920*1080 (2 MP)	Low	14.60
					Medium	20.51
					High	40.90
			60		Low	29.20
					Medium	41.02
					High	81.80
			90		Low	43.81
					Medium	61.52
					High	122.70

Sr.	Sever Description	Qty.	Virtual/ Physical	CPU	vCores	v/Memory (GB)	OS Portion size	HDD	Total v/Cores	Total v/Memor y	Total HDD	Network Cards (1/2/3)	Any other Requirements / Remarks / Comments
1	ITMS Master Server	1	Physical		20	32	200 GB	2 TB	20	32 GB	2 TB	1 Gig	MySQL
2	ANPR LPU Server	5	Physical	Intel Xeon Gold Series2.6 or better	4	8	200 GB	2TB	20	40 GB	10 TB	1 Gig	CentOS/Ubuntu 18.04/ 128 GB SSD per LPU server
3	ANPR DB Server	1	Physical		20	32	200 GB	2 TB	20	32 GB	2 TB	1 Gig	CentOS/Ubuntu 18.04/
4	eChallan Server	1	Physical		4	8	200 GB	500 GB	4	8 GB	500 GB	1 Gig	CentOS/Ubuntu 18.04/

Note: The Above sizing is for DC only with no HA consideration. Each application component is active component and shall require the exact replica of the hardware for HA and/or DR requirement.

7. Client Confidentiality

Client confidentiality is of utmost importance to BEPL and stringent practices and measures are in place to keep the confidentiality of client's data;

At the same time, BEPL follows a Chinese wall policy to ensure that your identity and data are absolutely confidential even from other consultants from BEPL'S technical team and accessed only from the onsite consultant and the project manager.

7. Client Confidentiality

Quotation Ref No. : DHN/ BEP/ ATCS/ 20-21   Date : 9th Feb, 2021

Kind Attn : Shri Chandan Kumar, IAS/ Addnl. DM Dhanbad

Dear Sir

We are pleased to submit the below offer for your requirement.

Sl.No	Description	Amount
1	ATCS	₹ 18,454,541
2	PA system	₹ 5,325,227
3	ITES	₹ 18,908,677
4	Data centre with server storage	₹ 6,801,500
A	Capex (A)	₹ 49,489,946
	Total	₹ 49,489,946
	GST @18%	₹ 8,908,190
	Grand Total	₹ 58,398,136

Sl.No	Description	Opex Year-1	Opex Year-2	Opex Year-3	Opex Year-4	Opex Year-5
1	ATCS	₹ 1,220,768	₹ 1,424,229	₹ 1,424,229	₹ 1,627,691	₹ 1,627,691
2	PA system	₹ 335,489	₹ 391,404	₹ 391,404	₹ 447,319	₹ 447,319
3	ITES	₹ 1,178,957	₹ 1,375,449	₹ 1,375,449	₹ 1,571,942	₹ 1,571,942
4	Data centre with server storage	₹ 408,090	₹ 476,105	₹ 476,105	₹ 544,120	₹ 544,120
B	OPEX Total	₹ 3,143,304	₹ 3,667,188	₹ 3,667,188	₹ 4,191,072	₹ 4,191,072
	Total for 5 years	₹ 18,859,823				
	GST @18%	₹ 3,394,768				
	Grand Total	₹ 22,254,591				

Payment Terms
20% Advance on Mobilization
60% on delivery
20% on I&C

Payment Terms
Equal instalment in quarterly basis.

Terms & Conditions
Power supply and network connectivity shall be in customer scope.
ROW/RI charges and permissions shall be in customer scope.
All permissions related with different departments to work on
junctions shall be in customer scope.
Space for installation of DC components shall be in customer scope.

Assumptions
Video wall for viewing cameras and violations along with printer,
workstations and other consumables shall be in customer scope.

Please feel free to call for any further information required.

Regards
Puneet