Volume-XIV

STRABAG

JV of STRABAG Infrastructure & Safety Solutions GmbH

and STRABAG AG

Mumbai Trans Harbour Link Project, Package-4

Design, Supply, Installation, Testing and Commissioning of Intelligent Transport System (ITS), Toll Management System, Electrical works, Highway and Bridge streetlighting system, Construction of Toll Plazas and Administrative Buildings including Command Control Centre

Bid Documents

INDEX

003788

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

Technical Proposal

Site Organization
Method Statement
Mobilization Schedule
Construction Schedule
Preliminary/Bidding Design
Safety Plan
Environmental Management Plan
Health Plan
Quality Assurance Plan
Form SOG
Form SPA: Spare Parts
Form SUB

Technical Proposal

Site Organization

PROPOSED PROJECT ORGANOGRAM


```
                    OPERATIONS HEAD
                          |
                    PROJECT MANAGER
                          |
                  DEPUTY PROJECT MANAGER
```

PROCUREMENT MANAGER	COMMERCIAL MANAGER	CONTRACT MANAGER		QUALITY ASSURANCE MANAGER
PROCUREMENT OFFICER	BILLING OFFICER		SAFETY OFFICER	
			SHE STAFF	

DESIGN MANAGER — CIVIL DESIGN ENGINEER — ITMS & TMS DESIGN ENGINEER — MECHANICAL DESIGN ENGINEER — DESIGN SUPPORT TEAM

INDEPENDENT DESIGN CHECKER

ENVIORONMENT SPECIALIST

ADMINISTRATION OFFICER

PLANNING ENGINEER

CONSTRUCTION MANAGER CIVIL AND BUILDINGS — CONSTRUCTION TEAM

CONSTRUCTION MANAGER ELECRICAL WORKS — CONSTRUCTION TEAM

CONSTRUCTION MANAGER ITS & TMS — CONSTRUCTION TEAM

Note
1: ABOVE SHOWS ONLY PARTIAL LIST, MANPOWER SHALL BE DEPUTED AS PER CONTRACTUAL REQUIREMENT

1753

Technical Proposal

Site Organization

FORM PER 1

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Form PER -1: Proposed Personnel

1.	**Title of position:** Project Manager
	Name: Syed Aijaz Zaheer Rizvi
2.	**Title of position:** Deputy Project Manage
	Name: Rajiv Sati
3.	**Title of position:** Design Manager
	Name: Sanjay Gupta
4.	**Title of position:** Construction Manager – Intelligent Transport System (ITS) and Toll Management System
	Name: Gurpreet Singh Basra
5.	**Title of position:** Construction Manager – Electrical Works
	Name: Walter Hofbauer
6.	**Title of position:** Construction Manager – Civil and Buildings
	Name: Sandipan Sirsat
7.	**Title of position:** Planning Engineer
	Name: Aladin Halilagic
8.	**Title of position:** Safety (Accident Prevention) Officer
	Name: Edurd Grohe
9.	**Title of position:** Environment Specialist
	Name: D K Mishra

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10	**Title of position:** Contract Specialist
	Name: Manas Mandal
11	**Title of position:** Quality Assurance Manager
	Name: Vijay Kumar
12.	**Title of position:** Administration Officer
	Name: Arnab Chaudhari

Technical Proposal

Site Organization

FORM PER 2

Technical Proposal

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FORM PER 2 – Project Manager

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Form PER – 2: Resume of Proposed Personnel

Name of Bidder:

JV of STRABAG Infrastructure & Safety Solutions GmbH and STRABAG AG

Position:		
Project Manager		
Personnel information	**Name:** Syed Aijaz Zaheer Rizvi	**Date of birth:** 02-08-1970
	Final Education: B.E. (Mechanical)	
	Professional qualifications: B.E. (Mechanical)	
Present employment	**Name of employer:** STRABAG	
	Address of employer: Level 1, Tower B, Vatika Towers Main, Golf Course Road, Sector 54, Gurugram, Haryana, 122003	
	Telephone: 0124- 4722500	**Contact name and title:** Mr. Chandan Bhatwadekar (Senior Manager HR) Contact Number - +91-8128226333
	Fax:	**E-mail:**
	Job title: Vice President (Tunnel Division)	**Years with present employer** 17 May 2021

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From	To	Company / Project / Position / Outline of the Project/Relevant Technical and Management Experience
May.2021	Present	**Company:** STRABAG **Projects:** NCRTC (Delhi-Meerut Corridor), IRCON (Tunnel Project in J&K) **Position:** Vice President Project (Tunnel Division) **Outline of the Project:** Package 23- Design, Detail Engineering, Supply, Installation, Testing and Commissioning of ECS, TVS, Electrical, ECS -E and M BMS, TVS BMS and TVS SCADA OCC/BCC Systems of 4 Under Ground Stations including Ventilation Buildings on Delhi-GZB-MRT RRTS. **Relevant Technical and Management Experience:** • Handling Infrastructure Projects • Operation Head
2017	2021	**Company:** Parsons Corporation (SAPL) **Projects:** Riyadh Metro, Line 2. **Position:** In charge (R.E) **Outline of the Project:** 15 Nos. Metro Stations, Road works of 25 Kms Stretch. **Relevant Technical and Management Experience:** • 15 Nos. Metro Stations, Road works of 25 Kms Stretch • In charge of MEP Services.
2013	2017	**Company:** Isolux Ingenieria S.A **Projects:** DMRC Project, Phase III, Lot 4 consisting of 5 Underground Stations and Tunnel. **Position:** Senior General Manager **Outline of the Project:** MEP Works for DMRC Phase III, Lot 4. **Relevant Technical and Management Experience:** • MEP Works for DMRC Phase III, Lot 4. • Chief Project Manager.
2008	2013	**Company:** Blue Star Limited

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		Projects: DMRC Phase 2 Consisting of 7 Stations and associated tunnel works. MEP Works for Power plants (NTPC Jhajjar, Vindyachal, Jindal Tamnar, Lanco Amarkantak), Airports (Varanasi and Dehradun), Hospitals (ILBS, Vasantkunj) **Position:** DGM **Outline of the Project:** MEP works for Infrastructure projects (Metro Projects including Tunnels, Power Plants, Airports, Hospitals **Relevant Technical and Management Experience:** • In charge of MEP works for Infrastructure projects (Metro Projects including Tunnels, Power Plants, Airports, Hospitals) • Northern Region Construction Head.
2004	2008	**Company:** Sahara India Medical Institute Limited **Projects:** 554 Bedded Super specialty, Tertiary care Sahara Apollo Hospital in Lucknow **Position:** In Charge - Engineering Services (Astt. Sr. Manager) **Outline of the Project:** Engineering Services for Hospitals Project. **Relevant Technical and Management Experience:** • Engineering Services for Hospitals Project • In charge Engineering Services
JAN 2004	SEP 2004	**Company:** ETA Engineering Pvt. Ltd **Projects:** MEP Works for Wipro EC4 Project, Forum Mall, Bangalore. **Position:** Senior Project Engineer **Outline of the Project:** MEP Works **Relevant Technical and Management Experience:** • MEP Works • Project Engineer
NOV 2003	DEC 2003	**Company:** Hotel Sahara Star **Projects:** Hotel Sahara Star, Mumbai. **Position:** Project Engineer **Outline of the Project:** MEP Revamp Work. **Relevant Technical and Management Experience:** • MEP Revamp Work • Project Engineer

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1998	2003	**Company:** Air-Mech Engineers (P) Ltd
		Projects: MEP Works for HCL Raebareli, Recron Allahabad, Sahara Auditorium Lucknow, Sahara Mall Gurgaon, Lucknow Reservation Centre, Northern Railway.
		Position: Asstt. Project Manager
		Outline of the Project: MEP Works
		Relevant Technical and Management Experience: • MEP Works • Project Engineer
1995	1998	**Company:** Subros Limited
		Projects: Shift Engineer for compressor Assembly Section
		Position: Production Engineer
		Outline of the Project: Manufacturing of Auto A.C
		Relevant Technical and Management Experience: • Manufacturing of Auto A.C • Production Engineer

Technical Proposal

Site Organization

FORM PER 2 – Deputy Project Manager

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Form PER – 2: Resume of Proposed Personnel

Name of Bidder:		
JV of STRABAG Infrastructure & Safety Solutions GmbH and STRABAG AG		

Position: Deputy Project Manager		
Personnel information	**Name:** Rajeev Sati	**Date of birth:** 21-12-1973
	Final Education: B.E Mechanical -2002.	
	Professional qualifications: B.E Mechanical	
Present employment	**Name of employer:** STRABAG	
	Address of employer: Level 1, Tower B, Vatika Towers Main, Golf Course Road, Sector 54, Gurugram, Haryana, 122003	
	Telephone: 0124- 4722500	**Contact name and title:** Mr. Chandan Bhatwadekar (Senior Manager HR) Contact Number - +91-8128226333
	Fax:	**E-mail:**
	Job title: Chief Project Manager	**Years with present employer** 6 Months

1764

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From	To	Company / Project / Position / Outline of the Project/Relevant Technical and Management Experience
June-2021	Now	**Company:** STRABAG **Projects:** ➤ NCRTC RRTS Package – 23, Underground stations and associated Tunnels **Position:** Chief Project Manager **Outline of the Project:** ➤ 4, Underground stations and associated Tunnels. ➤ Design, Detail Engineering, Supply, Installation, BMS /Scada, OCC/BCC Testing and Commissioning of Environment Control System (ECS) & Tunnel Ventilation system (TVS). **Relevant Technical and Management Experience:** ➤ Monitoring the Site progress and planning to achieve targets. ➤ Implementation of safety and quality plan. ➤ Interfacing with client, Architects, and other agencies for site deliverables. ➤ Installation & Commissioning of the system. ➤ Performing acceptance testing of installed equipment with client. ➤ Handover of system to client and clearing punch list. ➤ Finalization of SEM & Block cut outs drawings ➤ Design reviews and provide inputs to design teams. ➤ Motivating the site teams to achieve progress. ➤ Subcontractor Management. ➤ Handover of the system to client and generating documentations for DLP. ➤ Guidance to the team of Engineers and designers for preparing all deliverables and review the design calculations, reports & drawings submissions of MEP ➤ Implementation of quality standards in General working and documents delivered ➤ Team Management ➤ Coordination with other stakeholders of the project ➤ Understanding the scope of the work. ➤ Project Planning. ➤ Project Execution ➤ Material Scheduling and its Tracking. ➤ Coordination for Document submission and work program. ➤ Preparation of working drawings and its submissions.

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		➢ Ensuring and monitoring Statutory compliance.
		➢ Handing Project Inventory.
		➢ Testing, commissioning of system and its documentations.
		➢ Handing over process and its documentation.
Dec-2002	July-2013	**Company:** ETA engineering Pvt Ltd. **Projects:** ➢ DMRC IT park Phase II ➢ DMRC Vishwa Vidyalaya Station Delhi ➢ Jaipur Metro underground Project Phase I **Position:** Deputy Project Manager **Outline of the Project:** ➢ ECS-TVS, E&M Work with Scada. ➢ ECS & Scada. ➢ ECS-TVS, E&M Work with Scada. **Relevant Technical and Management Experience:** ➢ Monitoring the Site progress and planning to achieve targets. ➢ Implementation of safety and quality plan. ➢ Interfacing with client, Architects, and other agencies for site deliverables. ➢ Installation & Commissioning of the system. ➢ Performing acceptance testing of installed equipment with client. ➢ Handover of system to client and clearing punch list. ➢ Finalization of SEM & Block cut outs drawings ➢ Design reviews and provide inputs to design teams. ➢ Motivating the site teams to achieve progress. ➢ Subcontractor Management. ➢ Handover of the system to client and generating documentations for DLP.
Feb-2001	Nov-2002	**Company:** Span engineers. **Projects:** ➢ Laboratory like Path Labs, Lal Path labs. ➢ Show rooms: Advani Oerlikon, Skoda silver stone Moti Bagh, Honda care, L Dees at Lajpat Nagar etc. ➢ Offices: Aditya Birla Connaught Place, Schneider electrical Pvt ltd., ➢ Shopping complex: Vishal Mart Karol Bagh, Mega Mart. **Position:** Project Engineer.

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		Outline of the Project: ➤ HVAC Projects for Commercial buildings and infrastructure. **Relevant Technical and Management Experience:** ➤ Roles and responsibility cover: ➤ Site Managements includes Unloading and shifting of equipment's. ➤ Erection and commission of equipment's ➤ Interfacing with architects and clients for drawing finalization and billing. ➤ Designing of Ducting layout to meet the client requirement. ➤ Timely Billing and collection.	
Sep-1999	Jan-2001	**Company:** Duna Matic Engineers Pvt Ltd. **Projects:** ➤ INDOMAG Steel Ltd ➤ Spectra mind e services Pvt ltd. ➤ EDCIL Noida ➤ Qutab Hotel &ESSAR phones **Position:** Project Engineer. **Outline of the Project:** ➤ HVAC Projects for Commercial buildings and infrastructure. **Relevant Technical and Management Experience:** ➤ Planning and Execution of site work. ➤ Monitoring the site progress and arranging labor accordingly. ➤ Interfacing with Architect and client. ➤ Commissioning of HVAC system and performing the Testing. ➤ Handover of the system to client and billing.	
June-1995	Aug-1999	**Company:** Blue Star Ltd as Service Engineers. **Projects:** Multi Projects **Position:** Project Engineer. **Outline of the Project:** ➤ Service engineer for HVAC system.	

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		Relevant Technical and Management Experience: ➢ Experience in Handling of servicing of Central Chiller system including preventive maintenance scheduling of equipment's for complete year. ➢ AMC renewal of existing clients and timely billing of same.

1769

Technical Proposal

Site Organization

FORM PER 2 – Design Manager

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Form PER – 2: Resume of Proposed Personnel

Date: 08th December 2021
Bidder's Legal Name: JV of STRABAG Infrastructure & Safety Solutions GmbH and STRABAG AG
Joint Venture Party Legal Name: STRABAG Infrastructure & Safety Solutions GmbH
IFB No.: MMRDA/ENG1/0002561
Page 1 of 8 pages

Name of Bidder:

JV of STRABAG Infrastructure & Safety Solutions GmbH and STRABAG AG

Position: Design Manager		
Personnel information	**Name:** Sanjay Gupta	**Date of birth:** 15-02-1969
	Final Education: MBA (PGP)	
	Professional qualifications: MBA (PGP) – Finance and Marketing from IILM Institute of Higher Education – Gurgaon - 2009 Bachelor of Engineering (B.E.) – Electronics from Pune University- 1992	
Present employment	**Name of employer:** STRABAG	
	Address of employer: Level 1, Tower B, Vatika Towers Main, Golf Course Road, Sector 54, Gurugram, Haryana, 122003	
	Telephone: 0124- 4722500	**Contact name and title:** Mr. Chandan Bhatwadekar (Senior Manager HR) Contact Number - +91-8128226333
	Fax:	**E-mail:**
	Job title: Head- Solution Design and Quality	**Years with present employer** Aug- 2021

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From	To	Company / Project / Position / Outline of the Project/Relevant Technical and Management Experience
Aug-2021	Now	**Company:** STRABAG **Projects:** Varanasi Smart City Project, Varanasi **Position:** Head- Solution Design and Quality **Outline of the Project:** **Relevant Technical and Management Experience:** ➤ Heading PAN India projects design, design validation of Electrical & Mechanical works, ITMS ➤ Review of electrical loads, cable sizing, voltage drop as per the standards ➤ Review of all E&M services working drawings ➤ Review of all combined services drawings ➤ Guiding the respective discipline design team ➤ Weekly review of all design deliverables for timely submission and approvals ➤ Monitoring and control ➤ Managing Complex IT, State Fiber Connectivity Projects with more than > 60 engineer ➤ Responsible for Business development for ICT Solution & System Integration across various industry verticals• ➤ Developing System Integration practice for complex projects having software and hardware solution• ➤ Third party OEM Solution Tie up including Power and Site Infra, Fiber Infra ➤ Guiding Team for Optimum Solutions Design and Validation ➤ Identifying and implementing technology trends that will be able to support the future cash flow to company due to dynamic technology changes. ➤ Develop capability building plan for delivery new technology solutions across all regions.
Feb-2020	Jul-2021	**Company:** RV Solutions Pvt Ltd. **Projects:** ➤ Completed Navy Communication project (VARUN) with in timeline and received appreciation from customer. ➤ Successfully completed POC with Honeywell for Saharanpur and Bareilly Smart City Won Faridabad smart City O&M Order ➤ Completed Navi Mumbai Airport Network Design including Data Center. ➤ Successfully executed State Fiber (Mahanet, T Fiber) and BEL SAT Project.

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			Position: Design Head- ICT **Outline of the Project:** ➢ Navi Mumbai Airport Network Design including Data Center. ➢ Successfully executed State Fiber (Mahanet, T Fiber) and BEL SAT Project. **Relevant Technical and Management Experience:** ➢ Review of electrical loads, cable sizing, voltage drop as per the standards ➢ Review of all E&M services working drawings ➢ Review of all combined services drawings ➢ Guiding the respective discipline design team ➢ Weekly review of all design deliverables for timely submission and approvals ➢ Leading team for Telecom, ICT, IOT, Enterprises Networking and Smart City solution design based on multiple OEM products and other ancillaries system components. ➢ Heading PAN India design delivery with effective governance ➢ Monitoring and control ➢ Managing Complex IT, State Fiber Connectivity Projects with more than > 60 engineer ➢ Responsible for design for MEP services, ICT Solution & System Integration across various industry verticals• ➢ Developing System Integration practice for complex projects having software and hardware solution• ➢ Guiding Team for Optimum Solutions Design and Validation ➢ Working with MSI Like L&T, Honeywell, BEL, Sterlite in addition to Telco's etc ➢ Identifying and implementing technology trends that will be able to support the future cash flow to company due to dynamic technology changes.
Oct-2014	Jan - 2020		**Company:** IL&FS Technologies Ltd. **Projects:** ➢ Got breakthrough in Transport domain by acquiring and successfully Go Live of Rapid Metro Integrated Communication Network with Command Control center in DC /DR ➢ Rapid Metro Project was successfully Go Live in March 2017 ➢ Central University Campus Wi-Fi project of BHU and Other Universities ➢ MPLS Core Network connecting all the department and integration with NKN ➢ Firewall with IPS. IDS and UTM functionalities ➢ Aggregation and Access Network to connect all LAB and Class room ➢ Outdoor and Indoor Wi Fi with WLAN controller

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		➢ Un Licensed Radio to connect building outside the campus ➢ Naya Raipur Smart City - Chief Solution Architect and Project End to End Solution design. ➢ Smart Governance consisting of 10 -Citizen Centric Module + ERP and 6-Organization Backend Software Application Module. **Position:** Practice Head for Smart ICT Infrastructure solution **Outline of the Project:** ➢ Naya Raipur Smart City End to End Solution design and Project management comprising. ➢ Rapid Metro Project was successfully Go Live in March 2017 consisting of following sub system **Relevant Technical and Management Experience:** ➢ Leading design Team for manage complete business cycle including and Integrated solution design, Proposal/ Bid management, Pricing. ➢ Creating Universal solution blueprint applicable across multiple Industry vertical integration of various layer such as Shared Street / Last Mile Infrastructure layer - Based on Sensors, Wi-Fi, FTTx, Integrated Network Infrastructure Layer – High Capacity 10G network (Packet+ TDM), Unified Voice Communication layer - Fixed. Mobile Voice, Asset tracking and building management Layer - for monitoring IT (Server, network) and Non-IT Infra, Command Control Center in DC/ DR Model ➢ Responsible for design deliverables as per the requirements.
Sept-2009	Sep-2014	**Company:** Huawei Telecommunication India Pvt Ltd. **Projects:** ➢ Established India BSSC competence center including manpower planning, technical skill development, benchmarking process, and implementation of network design. Today India BSSC is handling multi-technology projects for global operators ➢ End to End Solution design for Augere LTE MP CG Network for 15 Cities with 500 eNodeB , IP MW Backhaul , Packet core , IP Transport and OSS / BSS Solution . ➢ Technical Lead for TCIL Sierraleone West Africa IMS Project –(Modernization of Fixed Network to IMS based Broadband Network) ➢ Other Strategic Project - Gold Key LTE Ghana. Smartel 2G/ 3G Network Nepal, CG Telecom, BSNL Ph-VI, Egypt FTTX, Tunisia FTTX, Dialog IP Core etc ➢ Appointed as CTO for Bharti Myanmar project for Bidding 2G/ 3G/ LTE license in Myanmar Republic - 20 Mn Subscriber

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2G / 3G spread ove 14 state/region. Project Involved End to End Network design including 2G/ 3G RAN, Circuit Core, packet Core, HLR, OSS/ BSS, IN, MW backhaul, National DWDM Transport, IP Backbone, Site Solution etc. S

➢ RCOM Metro DWDM, VDF Access Transport, Bharti MW breakthrough swapping Incumbent vendor are major project undertaken by BSSC in 2013, 40G/ 100G Long haul and Regional DWDM project with VDF Idea and TATA 100 G in 2012.

Position: Design Head Solution Support Center (BSSC).

Outline of the Project:
➢ BSSC competence center including manpower planning, technical skill development, benchmarking process, and implementation of network design.

➢ RCOM Metro DWDM, VDF Access Transport, Bharti MW breakthrough swapping Incumbent vendor are major project undertaken by BSSC in 2013, 40G/ 100G Long haul and Regional DWDM project with VDF Idea and TATA 100 G in 2012.

Relevant Technical and Management Experience:

➢ Providing consultation to telecom operators on Network Construction, Traffic Planning, Technology deployment, Network Augmentation of Mobile and Fixed Network. End to End Transmission & OSP Network planning and design including FTTX, DWDM & ASON & NLD & MPLS Backbone & M/W Transmission backhaul

➢ Driving intricate network design of multiple technologies ensuring interworking of various network layers with end to end Protection , QOS , Resiliency ,Security at optimum cost of overall project . Design and planning of network augmentation, including Traffic engineering ,cost optimization, Technology Evaluation & product roadmap Planning, based on business case and budget constraints

➢ Business process management including bid operation, , LTC / isles compliance ,strategy formulation, pre and post bid communication, SOC , Technical Proposal , Eligibility , Product Qualification , HLD, ensuring customer satisfaction and optimum risk for company.

➢ Overall responsible for network expansion - solution design, network dimensioning, scenario analysis, network availability simulation and survivability analysis.

➢ Driving the technical specification Sr Management Interaction/ solution presentation on 2G / 3G / LTE Mobile

1775

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		Broadband Solution, Ultra Broadband Solution, and Convergent Transport / Backbone Solution.
Aug-2009	Aug-2010	**Company:** Network Solution Group. **Projects:** ➤ Achieved highest Sales for Network BU – 120% of Target (>300m$) with strategic breakthrough in Bharti for Metro Ethernet Network , 40 G Expressway . ➤ Established alliance with CMC / Betel to capture network business in Enterprise domain and successfully setup FTTx Open Access business model. Secured L1 position in PGCIL MPLS tender by beating competition like Juniper / Cisco/ ALU. **Position:** Dy. Director. **Outline of the Project:** ➤ Secured L1 position in PGCIL MPLS tender by beating competition like Juniper / Cisco/ ALU. ➤ Metro Ethernet Network, 40 G Expressway . **Relevant Technical and Management Experience:** ➤ Network Business Unit head responsible for Products (IP, Access, Optics & MW) sales and revenue targets, business operation annual market strategy , strategic customer penetration and market share improvement plan ,. Heading team of 40 network engineers across Gurgaon. Mumbai & Nepal. ➤ Solution marketing, competitive intelligence, aligning cost structure with market conditions and improving sales in all industry verticals. Promotion of Mobile Back-haul, Mobile Bearer, Ultra Broadband, DWDM / OTN Transport Converged IP backbone solution to telecom operator.
Aug-2000	Jul - 2009	**Company:** Alcatel Lucent India. **Projects:** ➤ Achieve a business growth for business unit from 50 Cr to 600 cr over a period of 9 year order book ➤ Secured two contract in one year with Bharti (MSAN 50Mn Euro, CEN- 12 Mn$). Won MTNL Broadband 1 M DSL Lines (30Mn$) manage technical rejection of competition .TTSL PAN India Fiber Optics System (FOTS) – 200Mn$ frame Contract for three years. Reliance Internet Backbone Network (3Mn$) ➤ Handle NIB 2.2 and MTNL broadband Project &Succeed to get SLT ADSL Expansion in 2005

MMRDA

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		➢ Succeed to Sign ADSL TOT with ITI - 2006 & Technical qualification in BSNL Multiplay Tender
		
		➢ Successfully won and executed TTSL TDM Switch Contract – 10 Mn $. Introduce Litespan 1540 in BSNL switching tenders. Negotiated NT C Wireline contract (10Mn$)
		
		Position: General Manager
		
		Outline of the Project:
		➢ manage technical rejection of competition.TTSL PAN India Fiber Optics System (FOTS) – 200Mn$ frame Contract for three years.
		Relevant Technical and Management Experience:
		  ➢ Wireline Business Group Head responsible for Solution and Marketing for wireline Products (IP ,Access , Optics & MW) . Managing resources, budget, P&L for India RU.
		  ➢ Group Leader for Access Network Division for Alcatel Lucent South Asia region to design and dimension end to end broadband solution involving various equipment such as DSLAM , MSAN FTTX , LAN switch , router , BBRAS , PMS ,OSS/ BSS, etc.
		  ➢ Solution Sales for NGN and TDM network by positioning the various product in different layer i.e. Core, Edge, Access. Fixed Line switch dimensioning- TAX, Local cum Tandem Exchange, RSU, RLU).

May-1994	July-2000	**Company:** Benning SMC Power Systems Pvt Ltd & S.M. Creative Electronics **Projects:** **Position:** Design Manager **Outline of the Project:** ➢ Sales and Marketing in the Western Region of country for various telecom products like Line Concentrator, Digital Pair Gain System, HDSL, ISDN – NT. SMPS Power system, test Instruments, OMC (E-10B) Spares. **Relevant Technical and Management Experience:** ➢ Overall responsible for design in the Western Region of country for various telecom products like Line Concentrator, Digital Pair Gain System, HDSL, ISDN – NT. SMPS Power system, test Instruments, OMC (E-10B) Spares.
Jan-1993	Apr-1994	**Company:** Sahastratronic Controls (P) Ltd., Nasik. **Projects:**

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		Position: Marketing & Customer support
		
		Outline of the Project:
		    ➢ Marketing / Customer support to DOT for telecom products like Hotline, 2W / 4W relays, Inverters, CNA System, Bill Reminder System.
		
		Relevant Technical and Management Experience:
		
		    ➢ Marketing / Customer support to DOT for telecom products like Hotline, 2W / 4W relays, Inverters, CNA System, Bill Reminder System.

1778

Technical Proposal

Site Organization

FORM PER 2 – Construction Manager – Intelligent Transport System (ITMS)

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Form PER – 2: Resume of Proposed Personnel

Date: 08th December 2021
Bidder's Legal Name: JV of STRABAG Infrastructure & Safety Solutions GmbH and STRABAG AG
Joint Venture Party Legal Name: STRABAG Infrastructure & Safety Solutions GmbH
IFB No.: **MMRDA/ENG1/0002561**
Page 1 of 3 pages

Name of Bidder:
JV of STRABAG Infrastructure & Safety Solutions GmbH and STRABAG AG

Position:		
Construction Manager – Intelligent Transport System (ITS) and Toll Management System		
Personnel information	**Name:** Gurpreet Singh Basra	**Date of birth:** 16th July 1970
	Final Education: B.E. (Electronics and Communication)	
	Professional qualifications: -	
Present employment	**Name of employer:** EFKON India Private Limited	
	Address of employer: 1115, 11th Floor, Rupa Solitaire, Building No. A-1, Sector 1, Millennium Business Park, Mahape, Navi Mumbai 400710	
	Telephone: +91 22 42949498	**Contact name and title:** Rajat Mishra (CEO)
	Fax: +91 22 42949333	**E-mail:** g.basra@efkonindia.com
	Job title: Sr. Vice President	**Years with present employer** 11 years

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From	To	Company / Project / Position / Outline of the Project/Relevant Technical and Management Experience
Apr 2015	Till date	**Efkon India Pvt. Ltd** • Project: ORR TMS / Position: Project Manager TMS • Project: ORR HTMS / Position: Project Manager HTMS • Project: Delhi Noida Direct Expressway Up gradation / Position: Project Manager TMS
Nov 2009	Mar 2015	**Telegra India (Telegra d.o.o, Croatia)** • Project: Ahmedabad Maliya / Position: Project Manager TMS • Project: Halol Samalaji / Position: Project Manager TMS • Project: Rajkot Vadinar / Position: Project Manager TMS • Project: NAM Expressway / Position: Project Manager TMS • Project: Pimpal Gaon Nasik / Position: Project Manager TMS • Project: Chennai Tada / Position: Project Manager TMS • Project: Beawar Palli Pindwarah / Position: Project Manager TMS • Project: Devanhalli Hassan / Position: Project Manager TMS • Project: Ahmedabad Maliya / Position: Project Manager HTMS • Project: Halol Samalaji / Position: Project Manager HTMS • Project: Rajkot Vadinar / Position: Project Manager HTMS • Project: Krishnagiri walajahpet / Position: Project Manager HTMS • Project: NAM Expressway / Position: Project Manager HTMS • Project: Pimpal Gaon Nasik / Position: Project Manager HTMS • Project: Beawar Palli Pindwarah / Position: Project Manager HTMS • Project: Hazirabagh Ranchi Expressway / Position: Project Manager HTMS
Dec 2005	Oct 2009	**Scientechnic (Easa Saleh Al Gurg Group Company), Dubai (U.A.E)** • Project: Falcon Project R 669/1 / Position: Project Manager Out Station Equipments

1781

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		HTMS • Project: Modernization Urban Traffic Systems/ Position: Project Manager ITS
May 2001	Nov 2005	**Efkon India (Efkon AG, Austria)** • Project: Multi Lane free flow Toll Audit system (NHAI) / Position: Project Manager TMS • Project: Jaipur Kishangarh Expressway / Position: Project Manager TMS • Project: Jaipur Kishangarh Expressway / Position: Project Manager HTMS
Nov 2000	April 2001	**Compsis (Brazil)** • Project: Delhi Noida Expressway / Position: Project Manager TMS
Mar 1997	Oct 2000	**Philips India Ltd. Business Electronic Division** • Project: Hubli Dharwarh Expressway / Position: Project Manager TMS

Technical Proposal

Site Organization

FORM PER 2 – Construction Manager – Electrical Works

STRABAG

Form PER – 2: Resume of Proposed Personnel

Date: 08ᵗʰ December 2021
Bidder's Legal Name: JV of STRABAG Infrastructure & Safety Solutions GmbH and STRABAG AG
Joint Venture Party Legal Name: STRABAG Infrastructure & Safety Solutions GmbH
IFB No.: MMRDA/ENG1/0002561
Page 1 of 3 pages

Name of Bidder:
JV of STRABAG Infrastructure & Safety Solutions GmbH and STRABAG AG

Position:		
Construction Manager – Electrical Works		
Personnel information	**Name:** Walter Hofbauer	**Date of birth:** 23-02-1957
	Final Education: B.Sc. Electrical Engineering	
	Professional qualifications: B.Sc. Electrical Engineering	
Present employment	**Name of employer:** STRABAG	
	Address of employer: Level 1, Tower B, Vatika Towers Main, Golf Course Road, Sector 54, Gurugram, Haryana, 122003	
	Telephone: 0124- 4722500	**Contact name and title:** Mr. Chandan Bhatwadekar (Senior Manager HR) Contact Number - +91-8128226333
	Fax:	**E-mail:**
	Job title: Chief Project Manager	**Years with present employer** 17 years

STRABAG

From	To	Company / Project / Position / Outline of the Project/Relevant Technical and Management Experience
2013	Present	**Company: EFKON** **Position: Chief Project Manager** **Projects & Relevant Technical and Management Experience:** • 2019 Roll Out Manager Auto PASS/Electronic Fee Collection (EFC) System. • 2019 Project management Belgium/FRSE Vehicle Redesign. • 2013 - 2019 TETI Traffic (Pty)/South Africa Implementation of nationwide ITS project for South African Road Authority (SANRAL), Project Coordinator leading project operations. • Project contains Variable message signs (VMS) with lane management, CCTV, Fiber Optic Link, Central Control Room, Emergency Call/ Response System, Weather Sensor Systems, Traffic information system via web and SMS, ATCC (Automated Traffic Counting and Classification), DBOM project (Design Build Operations Maintenance) including operations of the emergence response vehicles.
2012	2013	**Company: EFKON GmbH / Austria** **Projects:** Rohtang Tunnel/ India. Preparation City Solution System/ Kazakhstan. **Position: Special Projects and Tender Manager** **Relevant Technical and Management Experience:** • Electrical & Control Systems/ Rohtang Tunnel/ India. • Preparation City Solution System/ Kazakhstan.
2010	2011	**Company: KAPSCH TRAFICCOM / Austria** **Projects:** • Poland Truck Toll System, Sub-Project Management. • Truck Tolling Enforcement System Poland - Rollout for 102 cars manual enforcement.
2007	2009	**Company: BERNHARD INGENIEURE / Austria** **Projects & Position:** • Employers Representative (ASFINAG, Austrian Motorways co.) for Construction Supervision 51/Vienna and Tunnel Linz

1785

STRABAG

		Austria. • Project Management Design and Construction Supervision of Variable Message Signs, Salzburg Austria. • Security administrator for aviation safety- Tunnel Project Old Airport Road Riyadh/Saudi Arabia. • Project Management Design Tunnel Control Center Nord, Liezen Austria

2002	2007	**Company: EFKON AG / Austria**
		
		 Projects & Position:
		
		 • Project management of several internal and external projects.
		 • Truck Tolling System Germany, General Project Manager / Key Account Manager
		     o development prototypes for automatic enforcement
		     o 275 cars for manual enforcement
		     o 75 mobile and 210 stationaries Infrared DSRC beacons 850.000 On board modules.
		 • Project management-MLFF Test station Tunnel A9 Austria.
		 • Project management-EFKON AG Test circuit Gratkorn Austria.
		 • Project management-Test station enforcement ASSS Germany.
		 • Project management - Dangerous goods transports (A22).
		 • Project management - Demo Taxi-Payment-Project South Africa.
		 • Project management GPS-On Board Unit next generation.

1994	2002	**Company: Salomon Automation GmbH / Austria** **Position: Project Manager** **Relevant Technical and Management Experience:** Numerous projects as • Project Manager Logistics Automation Systems • Project Manager of fully automatic logistics systems, all EU, USA • Project Manager "GPS-Track& Trace"-Systems

Technical Proposal

Site Organization

FORM PER 2 – Construction Manager – Civil & Buildings

STRABAG

Form PER – 2: Resume of Proposed Personnel

Date: 08th December 2021
Bidder's Legal Name: JV of STRABAG Infrastructure & Safety Solutions GmbH and STRABAG AG
Joint Venture Party Legal Name: STRABAG Infrastructure & Safety Solutions GmbH
IFB No.: MMRDA/ENG1/0002561
Page 1 of 4 pages

Name of Bidder:

JV of STRABAG Infrastructure & Safety Solutions GmbH and STRABAG AG

Position: Construction Manager Civil and Buildings

Personnel information	Name: Sandipan Sirsat	Date of birth: 11-12-1971
	Final Education: B.E. (Civil)	
	➤ B.E. Civil B.E. Civil in Oct -1995 Amravati University,	
Present employment	Name of employer: STRABAG	
	Address of employer: Level 1, Tower B, Vatika Towers Main, Golf Course Road, Sector 54, Gurugram, Haryana, 122003	
	Telephone: 0124- 4722500	Contact name and title: Mr. Chandan Bhatwadekar (Senior Manager HR) Contact Number - +91-8128226333
	Fax:	E-mail:
	Job title: Senior Manager.	Years with present employer Nov.2021

STRABAG

From	To	Company / Project / Position / Outline of the Project/Relevant Technical and Management Experience
Nov-2021	Now	**Company:** STRABAG **Projects:** ➤ **NCRTC RRTS Package – 23,** Underground stations and associated Tunnels **Position:** Senior Resident Engineer. **Outline of the Project:** ➤ 4, Underground stations and associated Tunnels. ➤ Design, Detail Engineering, Supply, Installation, BMS /Scada, OCC/BCC Testing and Commissioning of Environment Control System (ECS) & Tunnel Ventilation system (TVS). **Relevant Technical and Management Experience:** ➤ Monitoring the Site progress and planning to achieve targets. ➤ Implementation of safety and quality plan. ➤ Interfacing with client, Architects, and other agencies for site deliverables. ➤ Installation & Commissioning of the system. ➤ Performing acceptance testing of installed equipment with client. ➤ Handover of system to client and clearing punch list. ➤ Finalization of SEM & Block cut outs drawings ➤ Design reviews and provide inputs to design teams. ➤ Motivating the site teams to achieve progress. ➤ Subcontractor Management. ➤ Handover of the system to client and generating documentations for DLP.
Oct-2015	Oct -2021	**Company:** M/s Techno Consultant. **Position:** Resident Engineer **Outline of the Project:** ➤ In charge for getting work done from contractor as per specification of ➤ Contract. Communicate to client and Contractor. Give decision to ➤ contractor as per Tender Specification. To communicate to his staff for billing and quality assurance.

STRABAG

		Relevant Technical and Management Experience: ➤ In charge for getting work done from contractor as per specification of ➤ Contract. Communicate to client and Contractor. Give decision to ➤ contractor as per Tender Specification. To communicate to his staff for billing and quality assurance.
Oct-2012	Sep-2015	**Company:** M/s Pentacle Consultants(I)Pvt. Ltd. **Projects:** Project consists of road length 27.80 km with bridges (2+2lane). **Position:** Resident Engineer **Outline of the Project:** Project consists of road length 27.80 km with bridges **(2+2 lane).** **Relevant Technical and Management Experience:** ➤ Overall traffic survey, topographic surveys, finalization of alignment, geometric design. Project consists of ➤ Road length 27.80 km with bridges (2+2 lane). Analyzing of different ➤ Options of realignments and bypasses, making presentation to the stake-holders for getting their approvals based on the critical analysis of each option. Also responsible for existing pavement and new / widening construction. Preparation Check lists, Technical Schedules. Day to day supervision& PMC for road construction including bridges.
Jun 2006	Aug 2012	**Company:** M/s Irrigation Department. G.O.M. **Projects:** construction of retaining wall road Beautification, touch pile, meter panel. MMRDA **Position:** Deputy engineer **Outline of the Project:** ➤ Project for construction of retaining wall road Beautification, touch pile, meter panel. **Relevant Technical and Management Experience:** ➤ Project for construction of retaining wall road Beautification, touch pile, meter panel.

1790

STRABAG

Jan-2001	May-2006	**Company:** M/s Irrigation Department. G.O.M. **Projects:** ➢ construction At Thane as vigilance officer in Irrigation Department Mumbai. **Position:** Deputy engineer **Outline of the Project:** ➢ At Thane as vigilance officer in Irrigation Department. **Relevant Technical and Management Experience:** ➢ At Thane as vigilance officer in Irrigation Department.
1997	2000	**Company:** M/s Irrigation Department. G.O.M. shahapur. **Projects:** ➢ Bhatsa canal construction canal, pipeline, Roads.Co-ordination With Client. **Position:** Sectional Engineer. **Outline of the Project:** ➢ Bhatsa canal construction canal, pipeline, Roads.Co-ordination With Client. **Relevant Technical and Management Experience:** ➢ Bhatsa canal construction canal, pipeline, Roads.Co-ordination With Client.
1995	1996	**Company:** M/s Irrigation Department. G.O.M. shahapur. **Projects:** ➢ Bhatsa canal construction canal, pipeline, Roads.Co-ordination With Client. **Position:** Sectional Engineer. **Outline of the Project:** ➢ Bhatsa canal construction canal, pipeline, Roads.Co-ordination With Client. **Relevant Technical and Management Experience:** ➢ Bhatsa canal construction canal, pipeline, Roads.Co-ordination With Client.

Technical Proposal

Site Organization

FORM PER 2 – Planning   Manager

STRABAG

Form PER – 2: Resume of Proposed Personnel

Date: 08th December 2021
Bidder's Legal Name: JV of STRABAG Infrastructure & Safety Solutions GmbH and STRABAG AG
Joint Venture Party Legal Name: STRABAG Infrastructure & Safety Solutions GmbH
IFB No.: MMRDA/ENG1/0002561
Page 1 of 3 pages

Name of Bidder:
JV of STRABAG Infrastructure & Safety Solutions GmbH and STRABAG AG

Position: Planning Engineer

Personnel information	Name: Aladin Halilagic		Date of birth: 26-02-1982
	Final Education: Electrical Engineering		
	Professional qualifications: Electrical Engineering		
Present employment	Name of employer: STRABAG		
	Address of employer: Level 1, Tower B, Vatika Towers Main, Golf Course Road, Sector 54, Gurugram, Haryana, 122003		
	Telephone: 0124- 4722500		Contact name and title: Mr. Chandan Bhatwadekar (Senior Manager HR) Contact Number - +91-8128226333
	Fax:		E-mail:
	Job title: Planning Scheduling Manager		Years with present employer 4 Years

1793

STRABAG

From	To	Company / Project / Position / Outline of the Project/Relevant Technical and Management Experience
2017	Present	**Company:** STRABAG **Projects:** • Marieholmstunnel 2-tube tunnel with 3 lanes. • Tunnel length: 497 m, new electrical equipment. • Project Planning & Scheduling. **Position:** Planning Scheduling Manager **Relevant Technical and Management Experience:** • Marieholmstunnel 2-tube tunnel with 3 lanes. • Tunnel length: 497 m, new electrical equipment. • Project Planning & Scheduling.
2012	2017	**Company:** Hopferwieser Consult ZT GmbH **Projects:** • A9 Pyhrn highway • Tunnel Hungerbichl and Kienberg • Lowari Tunnel, Pakistan • Tunnelchain Klaus **Position:** Project Manager **Outline of the Project:** • A9 Pyhrn highway, 2-tube tunnels • Lowari Tunnel, Pakistan Modified road tunnel and North access road tunnel • Tunnelchain Klaus- 2 X 2166 mts, 2 X 462 mts, 2 X 2894 mts, 2 X 752 mts **Relevant Technical and Management Experience:** • Development of functional basics for the tender for the operational tunnel equipment as a functional construction contract including energy efficiency and application in a pilot project A49 tunnel Frankenhein. • Site supervision construction of cross-cut equipment • Planning of the detailed and tender project of the E&M facilities.
2006	2012	**Company:** Secondary technical school of electrotechnics, Bihac Bosnia and Herzegovina. **Projects:** Practical Lessons and trainings

1794

STRABAG

		Position: Professor
		Relevant Technical and Management Experience:
		• Practical lessons and trainings.

Technical Proposal

Site Organization

FORM PER 2 – Safety (Accident Prevention) Manager

STRABAG

Form PER – 2: Resume of Proposed Personnel

Date: 08th December 2021
Bidder's Legal Name: JV of STRABAG Infrastructure & Safety Solutions GmbH and STRABAG AG
Joint Venture Party Legal Name: STRABAG Infrastructure & Safety Solutions GmbH
IFB No.: **MMRDA/ENG1/0002561**
Page 1 of 2 pages

Name of Bidder:
JV of STRABAG Infrastructure & Safety Solutions GmbH and STRABAG AG

Position:
Safety (Accident Prevention) Officer

Personnel information	Name: Eduard Grohe	Date of birth: 11-10-1957
	Final Education: Civil Engineer	
	Professional qualifications: • Dipl. Civil studies at the University of Agricultural Sciences • EOQ Certification for Quality Management • EOQ Certification for Occupational Health and Safety Manager • SCC Certification • Energy Representative- Energy Management Systems-Certification • Quality and Environment Certification	
Present employment	**Name of employer:** STRABAG	
	Address of employer: Level 1, Tower B, Vatika Towers Main, Golf Course Road, Sector 54, Gurugram, Haryana, 122003	
	Telephone: 0124- 4722500	**Contact name and title:** Mr. Chandan Bhatwadekar (Senior Manager HR) Contact Number - +91-8128226333
	Fax:	**E-mail:**
	Job title: Safety (Accident Prevention) Officer	**Years with present employer** 25 Years

STRABAG

From	To	Company / Project / Position / Outline of the Project/Relevant Technical and Management Experience
1996	Present	**Company:** STRABAG **Position:** Divisional representative for Quality, Safety and Environmental Management, Internal Auditor. **Projects:** • Perschling tunnel chain • Leibenfeld exploration tunnel • Hungerburgbahn • IBK-Skanska / Prague • Krapina tunnel chain • H8 Jenbach / Austria • TS Klingenberg / Germany • ARGE Fritzens and vomp / Austria • Niagara tunnel and projects in Canada • Motorway project M6 / Hungary • Motorway project in Poland • Metro Budapest / Hungary • Power plant in the gorge / South Tyrol • Brenner Base Tunnel exploratory tunnel • Alto Maipo / Chile project • Arge Koralmtunne KAT2 / Austria • Project ARGE Stollen T uxbach / Zillertal in Austria • Project Akalla / Sweden • Project Mekorot 5th Line / Israel • Project Rohtang / India • ARGE Tulfes project -Pfons / Brenner base tunnel in Austria • Leibenfeld / Deutschlandsberg exploration tunnel • Niklasdorf tunnel
1993	1995	**Company:** Wibeba **Position:** Site Manager
1990	1993	**Company:** New reform building **Position:** Site Manager

Technical Proposal

Site Organization

FORM PER 2 – Environment Specialist

STRABAG

Form PER – 2: Resume of Proposed Personnel

Date: 08ᵗʰ December 2021
Bidder's Legal Name: JV of STRABAG Infrastructure & Safety Solutions GmbH and STRABAG AG
Joint Venture Party Legal Name: STRABAG Infrastructure & Safety Solutions GmbH
IFB No.: **MMRDA/ENG1/0002561**
Page 1 of 9 pages

Name of Bidder:
JV of STRABAG Infrastructure & Safety Solutions GmbH and STRABAG AG

Position: Environment Specialist		
Personnel information	**Name:** D.K. Mishra	**Date of birth:** 12-08-1970
	Final Education: Post Graduate Diploma in Industrial Safety	
	Professional qualifications: ➢ Post Graduate Diploma in Industrial Safety from Board of Technical Education Delhi in 2007. ➢ Lifetime member ship of National Safety Council Mumbai. ➢ Workshop training by National Safety Council Mumbai. ➢ First Aid course from St. John Ambulance New Delhi. ➢ Internal auditor training on ISO 14001:2015 and OHSAS 45001:2015 from Quality Growth Services Pvt Ltd.	
Present employment	**Name of employer:** STRABAG	
	Address of employer: Level 1, Tower B, Vatika Towers Main, Golf Course Road, Sector 54, Gurugram, Haryana, 122003	
	Telephone: 0124- 4722500	**Contact name and title:** Mr. Chandan Bhatwadekar (Senior Manager HR) Contact Number - +91-8128226333
	Fax:	**E-mail:**
	Job title: Chief SHE Manager	**Years with present employer** Nov. 2021

STRABAG

From	To	Company / Project / Position / Outline of the Project/Relevant Technical and Management Experience
Nov-2021	Now	**Company:** STRABAG **Projects: NCRTC RRTS Package – 23,** Underground stations and associated Tunnels **Position:** Chief SHE Manager **Outline of the Project:** ➤ 4, Underground stations and associated Tunnels. ➤ Design, Detail Engineering, Supply, Installation, BMS /Scada, OCC/BCC Testing and Commissioning of Environment Control System (ECS) & Tunnel Ventilation system (TVS). **Relevant Technical and Management Experience:** ➤ Identify project specific requirements of statutory bodies. ➤ Formulate and implements plans to comply with statutory bodies. ➤ Organize meetings and presentations to disseminate statutory requirements. ➤ Prepare, control and implement the Project S&OH plan and advice on S&OH matters at all stages of the project. ➤ To monitor the safety standard of electrical installations and report to any sub-standard performances to the safety manager. ➤ Reviewing risk assessments and method statements to ensure that work is undertaken with the avoidance and control of risk in accordance with the legislative requirements ➤ Planning/preparation to identify all potential electrical safety hazards when observing work undertaken on or in the vicinity of energized electrical equipment ➤ Specific controls to be implemented as per an electrical safety regulation, electrical safety code of practice or electrical safety standards ➤ Workplace consultation with workers as to electrical hazards, electrical safety procedures etc. ➤ Workplace health and safety training for employees and workers addressing electrical safety
Jul-2021	Oct-2021	**Company:** Shanghai Tunnel Engineering P. Ltd., **Projects:** ➤ Design and Construction of Tunnels by TBM from near New Ashok Nagar DN Ramp to Sahibabad UP Ramp and One Under Ground Station at Anand Vihar by Cut & Cover

STRABAG

		Method [Including Architectural Finishing and Design, supply, installation, testing and commissioning of Electrical and Mechanical Systems including Fire detection & suppression Systems and Hydraulic systems] on Delhi – Ghaziabad – Meerut RRTS Corridor of NCRTC.
		➢ National Capital region transport Corporation (NCRTC)

Position: Chief SHE Manager

Outline of the Project:
- ➢ Design and construction of Tunnel.
- ➢ Architectural Finishing and Design, supply, installation, testing and commissioning of Electrical and Mechanical Systems including Fire detection & suppression Systems and Hydraulic systems] .

Relevant Technical and Management Experience:

- ➢ Advice Joint Venture Management on the measures to be taken in the interest of Safety, Occupational health and Environment for persons employed therein.
- ➢ Identify project specific requirements of statutory bodies.
- ➢ Formulate and implements plans to comply with statutory bodies.
- ➢ Organize meetings and presentations to disseminate statutory requirements.
- ➢ Prepare, control and implement the Project S&OH plan and advice on S&OH matters at all stages of the project.
- ➢ To monitor the safety standard of electrical installations and report to any sub-standard performances to the safety manager.
- ➢ Reviewing risk assessments and method statements to ensure that work is undertaken with the avoidance and control of risk in accordance with the legislative requirements
- ➢ Planning/preparation to identify all potential electrical safety hazards when observing work undertaken on or in the vicinity of energized electrical equipment
- ➢ Specific controls to be implemented as per an electrical safety regulation, electrical safety code of practice or electrical safety standards
- ➢ Workplace consultation with workers as to electrical hazards, electrical safety procedures etc.
- ➢ Workplace health and safety training for employees and workers addressing electrical safety

Mar-2021	Jun-2021	**Company:** Afcons Infrastructure Limited.,
		Projects:
		➢ Construction of Elevated Viaduct, Ramp & Under Ground RCC Box (Cut & Cover, Box Pushing) Including Related Works

STRABAG

| | | for 3.520 Km Length From CH.25891.527 To CH. 29410.989 at Allied Detection, Metro between Existing Pier CP-760 (Near City Centre-II) To Merging Point With Metro Railway Biman Bandar Station Yard Including Two Stations (Rabindra Tirtha & VIP Road) With All Works (Architectural, Electrical,Mechanical,Heating, Ventilation, Air Conditioning, Fire Fire Suppression System & Public Health Engineering Works) In Newgaria-Bimanbandar Corridor Of Kolkata Metro Railway Line, West Bengal.
➢ RAIL VIKASH NIGAM LIMITED (RVNL)

Position: Chief Manager HSE

Outline of the Project:

➢ Construction of Elevated Viaduct, Ramp & Under Ground RCC Box (Cut & Cover, Box Pushing).
➢ (Architectural, Electrical, Mechanical, Heating, Ventilation, Air Conditioning, Fire Fire Suppression System & Public Health Engineering Works).

Relevant Technical and Management Experience:

➢ Act, as the SHE is auditing focal point & liaison with Auditor. Audits are included in the overall audit schedule.
➢ Review SHE performance statistics and initiates actions for improvement.
➢ Set S&OH targets and planning to enhance S&OH performance.
➢ Act as secretary of the Safety Committee established at project and assist the Chairman in directing the functions of the Site Safety Committee.
➢ Inspect the site personally or direct his Sr. /Jr. Managers to Inspect the site on his behalf to determine whether there is any Machinery, plant, Equipment's appliances, or any type of manual labour being used in the site which is of such nature that is liable to cause risk or badly injury to any person working or employed in the site.
➢ Manage and control the situation arising during an emergency. Continuously review the emergency procedure and update accordingly. |
| Jul-2019 | Feb-2021 | **Company:** KEC – CCECC JV.,

Projects:
➢ National Capital Region Transport Corporation (NCRTC).

Position: Chief Project -Manager SHE

Outline of the Project: |

STRABAG

		- Construction of elevated viaduct from start of elevated ramp near Sahibabad RRTS Station up to end of Ghaziabad RRTS Station, including all special spans and two Numbers of elevated RRTS stations viz, - Sahibabad & Ghaziabad {excluding Architectural finishing & roof structure of stations} of Delhi- Meerut Regional Rapid Transit System (RRTS) Corridor. - National Capital Region Transport Corporation (NCRTC). **Relevant Technical and Management Experience:** - Advice Joint Venture Management on the measures to be taken in the interest of Safety, Occupational health and Environment for persons employed therein. - Identify project specific requirements of statutory bodies. - Formulate and implements plans to comply with statutory bodies. - Organize meetings and presentations to disseminate statutory requirements. - Prepare, control and implement the Project S&OH plan and advice on S&OH matters at all stages of the project. - Act as secretary of the Safety Committee established at project and assist the Chairman in directing the functions of the Site Safety Committee. - Inspect the site personally or direct his Sr. /Jr. Managers to Inspect the site on his behalf to determine whether there is any Machinery, plant, Equipment's appliances or any type of manual labor being used in the site which is of such nature that is liable to cause risk or badly injury to any person working or employed in the site. - Manage and Control the situation arising during an emergency. Continuously review the emergency procedure and update accordingly.
Mar-2018	Jun-2019	**Company:** GYT-TPL JV (Tata Project Ltd)., **Projects:** - Part Design and Construction of Elevated via duct, 8 Elevated stations viz. Shahid Nagar, Raj Bag, Rajendra Nagar, Shyam Park, Mohan Nagar, Arthala, Hindan River & New Bus Adda including Architectural Finishing works of station from Chainage 3323.582m 12920.678m of line-1 Extension (Dilshad Garden to New Bus Adda Ghaziabad) of Phase III Delhi MRTS. (Delhi Metro Rail Corporation) **Position:** Chief Manager - SHE **Outline of the Project:** 8 Elevated stations viz. Shahid Nagar, Raj Bag, Rajendra Nagar, Shyam Park, Mohan Nagar, Arthala, Hindan River & New Bus Adda includind Architectual Finishing.

STRABAG

		➢ line-1 Extension (Dilshad Garden to New Bus Adda Ghaziabad) of Phase III Delhi MRTS. **Relevant Technical and Management Experience:** ➢ Identify project specific requirements of statutory bodies. ➢ Formulate and implements plans to comply with statutory bodies. ➢ Organize meetings and presentations to disseminate statutory requirements. ➢ Prepare, control and implement the Project S&OH plan and advice on S&OH matters at all stages of the project. ➢ Act as secretary of the Safety Committee established at project and assist the Chairman in directing the functions of the Site Safety Committee. ➢ Inspect the site personally or direct his Sr. /Jr. Managers to Inspect the site on his behalf to determine whether there is any Machinery, plant, Equipment's appliances or any type of manual labor being used in the site which is of such nature that is liable to cause risk or badly injury to any person working or employed in the site. ➢ Manage and Control the situation arising during an emergency. Continuously review the emergency procedure and update accordingly.
Jan-2015	Feb-2018	**Company:** ISOLUX INGENIERIA SA & Sterling and Wilson Limited Consortium **Projects:** ➢ Delhi Metro Rail Corporation Phase III, Project CE10&CE11, Lot-4; - Design verification, detail engineering, supply, installation, testing and commissioning of Environment Control System (ECS) and Tunnel Ventilation System (TVS) of Underground Stations IGDA, Palam, Dasharathpuri, Dabri Mor & Janakpuri. ➢ Delhi Metro Rail Corporation **Position:** Chief Manager - SHE **Outline of the Project:** ➢ Phase III, Project CE10&CE11, Lot-4; - Design verification, detail engineering, supply, installation, testing and commissioning of Environment Control System (ECS) and Tunnel Ventilation System (TVS) of Underground Stations **Relevant Technical and Management** ➢ Identify project specific requirements of statutory bodies. ➢ Formulate and implements plans to comply with statutory bodies.

1805

STRABAG

		➢ Organize meetings and presentations to disseminate statutory requirements. ➢ Prepare, control and implement the Project S&OH plan and advice on S&OH matters at all stages of the project. ➢ Act as secretary of the Safety Committee established at project and assist the Chairman in directing the functions of the Site Safety Committee. ➢ Inspect the site personally ➢ Manage and Control the situation arising during an emergency. Continuously review the emergency procedure and update accordingly.
Oct-2011	Dec - 2014	**Company: PRATIBHA INDUSTRIES LIMITED.** **Projects:** ➢ Interceptor Sewer for Abatement of Pollution in Yamuna River with Micro Tunneling System. **Position: Sr. Manager HSE** **Outline of the Project:** ➢ Abatement of Pollution in Yamuna River with Micro Tunneling System. ➢ Mock Drill on fire safety. **Relevant Technical and Management** ➢ Identify & implement the improvement in plant equipment and the process to improve the safety, Health & Environment in the plant. ➢ Promoting Safety and Health practices at various construction sites. ➢ To render advice on matters related to reporting and investigation of industrial accidents and diseases. ➢ To investigate selected accident and dangerous occurrence and to suggest remedy to the site management. ➢ To maintain such records, as the necessary relating to accidents, dangerous occurrence and industrial diseases. ➢ To conduct safety audits and organizing safety committee meetings and implementing its recommendations. ➢ Implement Work permit system in the plant as well as construction sites. ➢ Organizing/ conducting training programs and other safety promotional activities.
May-2010	Sept-2011	**Company: STRABAG-AFCON JV.** **Projects:** ➢ Rohtang Pass Highway Tunnel Project-H. P **Position: Safety Manager**

STRABAG

		Outline of the Project: ➢ Tunnel Project with 9km road tunnel. **Relevant Technical and Management** ➢ EHS statutory requirements & their compliances ➢ Prepare & develop EHS related documents viz., HIRA, Safety Manual, GRA, OCP, IER, JSA etc. ➢ Promote a safety culture within the organization and with contractors. ➢ Carry out safety audits during the design and construction phases; ➢ Designing and expanding training and development programs based on both the organization's and the individual's needs apart from induction programs ➢ Scheduling trainings referring to training calendar and job role matrix ➢ Providing appropriate safety and health, accident prevention, and investigation training for managers and supervisors. ➢ Conducting operation & safety trainings and development programs followed by evaluating & reviewing progress of trainees ➢ Evaluation/assessment of pre and post training
Jan-2007	Apr-2010	**Company:** METRO TUNNELING GROUP. **Projects:** ➢ Delhi Metro Rail Corporation Phase II, BC-16 **Position:** Safety Manager **Outline of the Project:** ➢ Identify & implement the improvement in plant equipment and the process to improve the safety, Health & Environment in the plant. ➢ Implement Work permit system in the plant as well as construction sites. **Relevant Technical and Management** ➢ Identify & implement the improvement in plant equipment and the process to improve the safety, Health & Environment in the plant. ➢ Promoting Safety and Health practices at ➢ other safety promotional activities for the various categories of employees. ➢ Conduct training, Mock Drill on fire safety. ➢ Liaison with the authorities of Clients, Consultants and Local bodies in the matter of Safety and Accident prevention.

STRABAG

Sept-1997	Dec - 2006	Company: GANNON DUKKERLY & CO LTD LIMITED
		Projects: ➢ Gautami Power plant. IDA Peddapuram (A.P.) **Position:** Safety Officer **Outline of the Project:** ➢ working as a Safety officer in 469 MW Gautami Power plant.IDA Peddapuram (A.P.). **Relevant Technical and Management** ➢ Identify & implement the improvement in plant equipment and the process to improve the safety, Health & Environment in the plant. ➢ Promoting Safety and Health practices at various construction sites. ➢ To render advice on matters related to reporting and investigation of industrial accidents and diseases. ➢ To investigate selected accident and dangerous occurrence and to suggest remedy to the site management. ➢ To maintain such records, as the necessary relating to accidents, dangerous occurrence, and industrial diseases. ➢ To conduct safety audits and organizing safety committee meetings and implementing its recommendations. ➢ Implement Work permit system in the plant as well as construction sites. ➢ Organizing/ conducting training programs and other safety promotional activities for the various categories of employees. ➢ Conduct training, Mock Drill on fire safety. ➢ Liaison with the authorities of Clients, Consultants and Local bodies in the matter of Safety and Accident prevention.

1808

Technical Proposal

Site Organization

FORM PER 2 – Contract Specialist

STRABAG

Form PER – 2: Resume of Proposed Personnel

Date: 08th December 2021
Bidder's Legal Name: JV of STRABAG Infrastructure & Safety Solutions GmbH and STRABAG AG
Joint Venture Party Legal Name: STRABAG Infrastructure & Safety Solutions GmbH
IFB No.: MMRDA/ENG1/0002561
Page 1 of 4 pages

Name of Bidder:		
JV of STRABAG Infrastructure & Safety Solutions GmbH and STRABAG AG		

Position: Contract Specialist

Personnel information	Name: Manas Mandal	Date of birth: 4-10-1977
	Final Education: M.Com.	
	➢ M.Com.	
Present employment	Name of employer: STRABAG	
	Address of employer: Level 1, Tower B, Vatika Towers Main, Golf Course Road, Sector 54, Gurugram, Haryana, 122003	
	Telephone: 0124- 4722500	Contact name and title: Mr. Chandan Bhatwadekar (Senior Manager HR) Contact Number - +91-8128226333
	Fax:	E-mail: [insert contact e-mail address]
	Job title: Senior Manager Contract	Years with present employer 4 Months

STRABAG

From	To	Company / Project / Position / Outline of the Project/Relevant Technical and Management Experience
Aug-2021	Now	**Company:** STRABAG **Projects:** ➤ **NCRTC RRTS Package – 23,** Underground stations and associated Tunnels **Position:** Contract Specialist **Outline of the Project:** ➤ 4, Underground stations and associated Tunnels. ➤ Design, Detail Engineering, Supply, Installation, BMS /Scada, OCC/BCC Testing and Commissioning of Environment Control System (ECS) & Tunnel Ventilation system (TVS). **Relevant Technical and Management Experience:** ➤ Vendor payments (domestic & foreign), this includes payments for purchase of Capital assets, purchase of project consumable items, IT services availed, Property Lease payments and payment to sub contractors. ➤ Employee benefits related payments & reporting on EBC payments, which includes, joining expenses reimbursement, final settlement, perquisites as per HR Policies. ➤ Site expenses Report booking on fortnightly basis, voucher scrutiny, maintaining MIS of various payments done at site and also, preparing reconciliation statement of site Bank account & cash balance on monthly basis. ➤ Site audit and submission of report to management. o Booking & raising Debit/credit advices for expenses incurred on behalf of/by various group companies. ➤ Prepared statement of Provision for expenses and reconciled same for quarterly balance sheet. ➤ GL Scrutiny & vendor balance scrutiny on quarterly basis. ➤ Prepared statement of deposit /advance /prepaid expenses incurred. Prepared Analytical variance report of Balance sheet and Profit & Loss account for statutory auditors. o Variance report of balance sheet and P&L A/c for senior management.
Apr-2017	July-2021	**Company:** M/s IOT AEC / AEPL **Position:** Chief Manager Contract

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		Relevant Technical and Management Experience: ➢ Checking of various recovery in line with the Contract provisions Statutory compliance in time as per contract ➢ Scrutiny of enquiry / tender documents for any job for civil & structural Mechanical [both tank & piping /equipment] etc like comparative statement, negotiation, taxation compliance etc. ➢ Checking of sub-contract clause in line with our tender documents and time to time implementation.
June-2015	Mar-2017	**Company:** M/s Fujairah, Dubai at IOT Anwesha FZE **Position:** Finance & Commercial Head **Relevant Technical and Management Experience:** ➢ Attend the statutory, commercial audit and complied ➢ Preparation of POC (Percentage of Completion) Sheet on monthly basis, for revenue recognition. ➢ Various MIS pertaining to project cost booking and project progress. o Preparation of weekly project cash flow status. ➢ Monthly submission of Budget Vs Actual report of each project to Operation Head. ➢ Tracking project Receivable and preparation of reconciliation sheet. o AP & AR Ledger scrutiny. ➢ Tracking project Advances and timely settlement. ➢ Preparation of Debit Note & Recovery Statement ➢ Planning Fund Allocation for Contractor and Vendor Payment ➢ Co-ordinate for taxation and assessment with consultant
Apr-2004	May-2015	**Company:** M/s IOT AEC / AEPL **Position:** Finance Executive to Chief Manager Contract **Relevant Technical and Management Experience:** ➢ Checking of various recovery in line with the Contract provisions Statutory compliance in time as per contract ➢ Scrutiny of enquiry / tender documents for any job for civil & structural Mechanical [both tank & piping /equipment] etc like comparative statement, negotiation, taxation compliance etc.
Jan-2001	Mar-2004	**Company:** M/s Petron Civil Engg Pvt Ltd

1812

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		Position: Account Officer
		Relevant Technical and Management Experience:
		- Booking of Purchase order in system for all MRN related purchase at Sankarda works. - Passed and processed bills of all type of vendors. - Prepared Statement of drawing power of Fund from bank and fund utilization details on monthly basis. - Done Stock valuation and prepared stock statement for submission along with fund drawing power statement. - Sales booking and monthly reconciliation of customer account. - Assisted in finalization of accounts, which included preparation of provision statement, GL scrutiny, vendor balance confirmation, valuation of stock statement, etc. - Assisted in IT Return filling and Tax Audit report. - Done working of TDS payment and return filling. - Booked site expense report after scrutiny. o Maintain time sheet of manpower and log sheet of vehicle

Technical Proposal

Site Organization

FORM PER 2 – Quality Assurance Manager

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Form PER – 2: Resume of Proposed Personnel

Date: 08th December 2021
Bidder's Legal Name: JV of STRABAG Infrastructure & Safety Solutions GmbH and STRABAG AG
Joint Venture Party Legal Name: STRABAG Infrastructure & Safety Solutions GmbH
IFB No.: MMRDA/ENG1/0002561
Page 1 of 6 pages

Name of Bidder:
JV of STRABAG Infrastructure & Safety Solutions GmbH and STRABAG AG

Position: Quality Assurance Manager		
Personnel information	**Name:** Vijay Kumar	**Date of birth:** 25-08-1976
	Final Education: B. Tech. (Mechanical) 2003	

	Professional qualifications:
	➢ B. Tech. (Mechanical) 2003
	   M D U Rohtak with Honor
	➢ Post Diploma (Mechanical) 1997
	   Y. M. C. A. Institute of Engineering, Faridabad with specialization in Ref. & Air Conditioning.	

Present employment	**Name of employer:** STRABAG	
	Address of employer: Level 1, Tower B, Vatika Towers Main, Golf Course Road, Sector 54, Gurugram, Haryana, 122003	
	Telephone: 0124- 4722500	**Contact name and title:** Mr. Chandan Bhatwadekar (Senior Manager HR) Contact Number - +91-8128226333
	Fax:	**E-mail:**
	Job title: MEP Quality Control and Assurance	**Years with present employer** Nov. 2021

1815

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From	To	Company / Project / Position / Outline of the Project/Relevant Technical and Management Experience
Nov-2021	Now	**Company:** STRABAG **Projects:** NCRTC RRTS Package – 23, Underground stations and associated Tunnels, MEP. **Position:** MEP Quality Control and Assurance **Outline of the Project:** ➢ 4, Underground stations and associated Tunnels. ➢ Design, Detail Engineering, Supply, Installation, BMS /Scada, OCC/BCC Testing and Commissioning of Environment Control System (ECS) & Tunnel Ventilation system (TVS). **Relevant Technical and Management Experience:** ➢ Working as Quality Assurance Manager and overall responsibility for the timely delivery of the project quality plan, Project management plan, design plan, procurement plan, manufacturing, installation, testing and commissioning plan for Environmental Control System, Tunnel ventilation system, Electrical System and Building Management System. ➢ Planning for weekly inspection for the site installation activities performed by project site team. ➢ Review of quality assurance plan proposed by vendor in line with approved material datasheet by employer and raising factory inspection call. ➢ Raising inspection request to customer after verifying the material delivered at store. ➢ Closure of NCR (if any) ➢ Guiding the Quality team ensuring proper quality check at each stage of project life cycle.
Aug-2013	Oct-2021	**Company:** Voltas Ltd., Delhi as Senior Manager **Projects:** Delhi Metro Rail Corporation (DMRC) **Position:** Head Quality Control and Assurance **Outline of the Project:** ➢ Working as Quality Assurance Manager and overall responsibility for the timely delivery of the project quality plan, Project management plan, design plan, procurement plan, manufacturing, installation, testing and commissioning

1816

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		plan for Environmental Control System, Tunnel ventilation system, Electrical System and Building Management System. ➢ Planning for weekly inspection for the site installation activities performed by project site team. ➢ Review of quality assurance plan proposed by vendor in line with approved material datasheet by employer and raising factory inspection call. ➢ Raising inspection request to customer after verifying the material delivered at store. ➢ Closure of NCR (if any) ➢ Guiding the Quality team ensuring proper quality check at each stage of project life cycle. **Projects:** Kolkata Metro rail Corporation (KMRCL) **Position:** Head Quality Control and Assurance **Outline of the Project:** ➢ Working as Quality Assurance Manager and overall responsibility for the timely delivery of the project quality plan, Project management plan, design plan, procurement plan, manufacturing, installation, testing and commissioning plan for Environmental Control System, Tunnel ventilation system, Electrical System and Building Management System. ➢ Planning for weekly inspection for the site installation activities performed by project site team. ➢ Review of quality assurance plan proposed by vendor in line with approved material datasheet by employer and raising factory inspection call. ➢ Raising inspection request to customer after verifying the material delivered at store. ➢ Closure of NCR (if any) ➢ Guiding the Quality team ensuring proper quality check at each stage of project life cycle.
Dec-2008	Jul- 2013	**Company:** ETA Engineering Pvt. Ltd., **Projects:** ➢ Jaipur Underground Metro Station & Tunnels . ➢ Hospital- ILBS New Delhi Multistory(-2+G +6) Delhi Metro R Corp **Position:** Design & Quality Assurance Manager **Outline of the Project:** ➢ Testing & Commissioning of Environmental control system, verification performance acceptance as per the design data of the system. ➢ Getting approvals on shop drawing from Client and DDC.

1817

STRABAG

		Relevant Technical and Management Experience: ➢ Engineering Manager for the Detailed Design & Engineering of HVAC, TVS, Fire Fighting and Plumbing, BMS SCADA & Water Treatment System for Underground Metro Station. ➢ Review of the GAD layouts w.r.t. ECS, TVS Rooms for equipments, future maintenance etc. ➢ Review of Design reports of Tunnel SES, CFD, Tunnel fans capacity and Booster fans Niches. ➢ Review of Tunnel alignment drawings, CSD drawings. ➢ Review of the Fans Total pressure calculations, Fan selections, heat load calculations, pump head calculations, AHU / FCU selections and approvals. ➢ Review of Electrical SLDs, panel designing and cable sizing. ➢ Review of SEM cutouts in RCC walls and floors. ➢ Review of Wall opening Drawings. ➢ Finalization of BMS, SCADA architecture, control philosophy. ➢ Finalization of Mode Tables – Master modes, station modes etc. ➢ Planning for weekly inspection for the site installation activities performed by project site team. ➢ Review of quality assurance plan proposed by vendor in line with approved material datasheet by employer and raising factory inspection call. ➢ Raising inspection request to customer after verifying the material delivered at store.
Nov-2005	Nov-2008	**Company:** M/S Blue Star Ltd. **Projects:** ➢ HVAC works of Chiller Replacement at IFCI Tower (-2 + G + 21) New Delhi ➢ HVAC Works at GAIL India Ltd. (-1 + G + 6) New Delhi: ➢ HVAC Works at BEL Sahibabad: **Position:** Dy, Project Manager **Outline of the Project:** ➢ Ventilation and air conditioning work. **Relevant Technical and Management Experience:** ➢ Overall, in charge for the design verifications, technical approval from consultants, Invoicing and payment collections, Project Monitoring, testing commissioning and handing over.
Oct-2004	Oct-2005	**Company:** M/S Honeywell Automation India Limited, **Projects:** ➢ MEP works at Hotel OM Sons Holiday Inn Moradabad.

MMRDA

1818

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		Position: Project Manager **Outline of the Project:** ➢ HVAC design verifications, ➢ MEP works. **Relevant Technical and Management Experience:** ➢ Overall, in charge for the HVAC design verifications, technical approval from consultants, Invoicing and payment collections, Project Monitoring, Testing.
July-2002	Sept -2004	**Company:** M/S Blue Star Ltd. **Projects:** ➢ HVAC works of AHU Replacement at Indian air lines (-2 + G + 6) New Delhi. ➢ HVAC Works of Chiller replacement at Videocon towers (-1 + G +13) New Delhi. **Position:** Engineer, **Outline of the Project:** ➢ HVAC works. **Relevant Technical and Management Experience:** ➢ Overall, in charge for the design verifications, Heat loads, pump head calculations, Fans pressure loss calculation, preparation of working drawings, technical approval from consultants, Invoicing and payment collections, Project Monitoring, testing commissioning and handing over.
Aug-1997	June-2002	**Company:** Emirates Trading Agency LLC – Dubai, **Projects:** ➢ MEP works at Dubai Convention Centre (-2 + G + 10) consisting of 14 nos. air-cooled Carrier chillers. ➢ MEP works at Dubai Convention Centre (-2 + G + 10) consisting of 14 nos. air-cooled Carrier chillers with total TR 2874 ➢ MEP refurbishment works at Al Ghurair Retail Shopping & Residential Complex (G + 8) consisting of 5 nos. air-cooled & 1 no. Water-cooled Trane chillers ➢ MEP works at Emirates tower Hotel Project (-2 + G + 52) and Chiller yard consisting of 18 nos. air-cooled McQuay chillers ➢ HVAC works for the Gas Turbine power Station "H" Al Aweer. **Position:** HVAC Engineer, **Outline of the Project:** ➢ HVAC works. ➢ MEP Work.

1819

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Relevant Technical and Management

- ➢ Project Planning, Works program submission to client, status updates of the physical work progress etc.
- ➢ Responsible for the HAVC works for the Apartment building, Weekly site work scheduling and progress monitoring, Measurements and Invoicing, Variations and extra works claims, Material quantity take off and planning and ordering.
- ➢ Monitoring of the HVAC works at Plant rooms piping, ducting, equipments installations etc.
- ➢ Testing and commissioning of the HVAC System / Equipments.
- ➢ Performance Validation of the installed HVAC system / equipments i.e. Chiller, chiller Pumps, AHUs, ventilation fans w.r.t. Design data and conditions.

1820

Technical Proposal

Site Organization

FORM PER 2 – Administration Officer

STRABAG

Form PER – 2: Resume of Proposed Personnel

Name of Bidder:
JV of STRABAG Infrastructure & Safety Solutions GmbH and STRABAG AG

Position: Administration Officer		
Personnel information	**Name:** Arnab Chaudhary	**Date of birth:** 23-05-1981
	Final Education: MBA	
	Professional qualifications: M.B.A. (Distance learning) from ICFAI University. Acquired Diploma and Advanced Diploma in Management from ICFAI University M. Com. with Human Resource Management from Banaras Hindu University in 2004	
Present employment	**Name of employer:** STRABAG	
	Address of employer: Level 1, Tower B, Vatika Towers Main, Golf Course Road, Sector 54, Gurugram, Haryana, 122003	
	Telephone: 0124- 4722500	**Contact name and title:** Mr. Chandan Bhatwadekar (Senior Manager HR) Contact Number - +91-8128226333
	Fax:	**E-mail:**
	Job title: Senior Manager Admin	**Years with present employer** 2Years 4Month

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From	To	Company / Project / Position / Outline of the Project/Relevant Technical and Management Experience
July-2019	Now	**Company:** STRABAG **Position:** Senior Manager Admin **Relevant Technical and Management Experience:** ➤ Provide administrative and clerical support to departments or individuals. ➤ Coordinates office management activities. ➤ Operate office equipment, such as photocopy machine and scanner. ➤ Maintain hard copy and electronic filing system. ➤ Taking care of Vehicle Insurance (renewal, quotation etc.) ➤ Manage spreadsheets and other official records ➤ Greet and receive visitor. ➤ Handle information requests. ➤ Inter departmental coordination ➤ Maintain an adequate inventory of office supplies ➤ Maintain other necessary invoices and taking care of subscriptions. ➤ Planning and preparation of meetings, conferences and conference calls, Video Conferences ➤ Receive, direct and relay telephone messages of CEO ➤ Manage travel and schedule. ➤ Maintain Attendance & Outdoor records. ➤ Coordinate with accounts for payments. ➤ Coordinate interviews & Meeting at office ➤ Festival & Birthday Celebration at office ➤ HR Generalist, Recruitment, Employee Database (DBMS), MIS - HRMS, Statutory Compliance, Performance Appraisal, Employees Policy, Employee Handbook, Human Resource Budgeting & Accounting and Financial reporting.
Mar-2019	June-2019	**Company:** SOTRAFER S.A.R.L. Lubumbashi, DRC (Congo) **Position:** Senior Manager Admin **Relevant Technical and Management Experience:** ➤ Provide administrative and clerical support to departments or individuals. ➤ Coordinates office management activities. ➤ Operate office equipment, such as photocopy machine and scanner. ➤ Maintain hard copy and electronic filing system. ➤ Taking care of Vehicle Insurance (renewal, quotation etc.) ➤ Manage spreadsheets and other official records ➤ Greet and receive visitor.

		➤ Handle information requests. ➤ Inter departmental coordination ➤ Maintain an adequate inventory of office supplies ➤ Maintain other necessary invoices and taking care of subscriptions. ➤ Planning and preparation of meetings, conferences and conference calls, Video Conferences ➤ Receive, direct and relay telephone messages of CEO ➤ Manage travel and schedule. ➤ Maintain Attendance & Outdoor records. ➤ Coordinate with accounts for payments. ➤ Coordinate interviews & Meeting at office ➤ Festival & Birthday Celebration at office ➤ Successfully done recruitment of Employee's and workers for overseas projects in Oman, Abu Dhabi & Kuwait. ➤ Active team member for Employee and workers benefits disbursement and eligibility checker. ➤ Implemented Biometric Attendance System and was part of Implementation of HRMS Adrenalin
July-2015	Feb-2019	**Company:** Anwesha Engineering & Projects Limited **Position:** Senior Manager HR & Admin **Relevant Technical and Management Experience:** ➤ Successfully done admin works for overseas projects in Oman, Abu Dhabi & Kuwait. ➤ Continually practicing and completed on monthly / due basis the statutory Compliance work related to EPF, ESIC, BOCW, Contract Labor (R & A) Acts', EW/ WC. ➤ Active team member for Employee and workers benefits disbursement and eligibility checker.
May-2015	June-2015	**Company:** Adani Institute for Education & Research **Position:** Manager Admin **Relevant Technical and Management Experience:** ➤ Inter departmental coordination ➤ Maintain an adequate inventory of office supplies ➤ Maintain other necessary invoices and taking care of subscriptions. ➤ Planning and preparation of meetings, conferences and conference calls, Video Conferences ➤ Receive, direct and relay telephone messages of CEO ➤ Manage travel and schedule. ➤ Maintain Attendance & Outdoor records. ➤ Coordinate with accounts for payments. ➤ Coordinate interviews & Meeting at office ➤ Festival & Birthday Celebration at office

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		➢ Payroll, Statutory compliance process formulation and implementation with respect to employee, recruitment and HR process implementation it's 4 NEW verticals as practiced in APSEZ (Parent Organization), as stated below:
Aug-2013	Apr-2015	**Company:** IOT Anwesha Engineering & Construction Ltd., Vadodara, Gujarat **Position:** Asst. Manager Admin **Relevant Technical and Management Experience:** ➢ Employee Database, Payroll processing and compensation budgeting ➢ Statutory Compliance (Mainly EPF, ESIC, BOCW, Contract Labor (R & A) Acts', EW/ WC and et all). ➢ Employee benefits managing and inducting employee engagement programs. ➢ Provide administrative and clerical support to departments or individuals. ➢ Coordinates office management activities. ➢ Operate office equipment, such as photocopy machine and scanner. ➢ Maintain hard copy and electronic filing system. ➢ Taking care of Vehicle Insurance (renewal, quotation etc.) ➢ Manage spreadsheets and other official records ➢ Greet and receive visitor. ➢ Handle information requests. ➢ Inter departmental coordination ➢ Maintain an adequate inventory of office supplies ➢ Maintain other necessary invoices and taking care of subscriptions.
Sep-2011	July-2013	**Company:** ION Exchange Infrastructure Ltd., Kolkata **Position:** Senior Executive Admin **Relevant Technical and Management Experience:** ➢ Responsible for the regular updating and maintaining of database, Managing monthly payroll processing. ➢ Statutory Compliance (Mainly EPF, ESIC, Employee's compensation, contract Labour (R and A) Acts.) ➢ Responsible for set off confirmation's dues / contract renewals. ➢ Managing and processing Sub Contractor bills under the administration of Kolkata office.
Aug-2008	Aug-2011	**Company:** STUP Consultants Pvt. Ltd., Kolkata **Position:** Executive Admin

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		Relevant Technical and Management Experience:
		- Relevant Technical and Management Experience: Managing and supervising the MIS HR report (Appointments/ Exit / Confirmation, Payroll). - Statutory compliance processing, processing EPF, ESI and Tax planning formalities required for employees. - Responsible for organizing of summer vocational training for graduate engineer trainees.
June-2004	July-2008	**Company:** Simplex Infrastructures Limited, Delhi & Kolkata **Position:** Senior Officer Grade-II (Admin) **Relevant Technical and Management Experience:** - Maintaining a centralized MIS database for new employees across the 5 zones (Delhi, Mumbai, Chennai, Kolkata and Overseas). - Provide administrative and clerical support to departments or individuals. - Coordinates office management activities. - Operate office equipment, such as photocopy machine and scanner. - Maintain hard copy and electronic filing system. - Taking care of Vehicle Insurance (renewal, quotation etc.) - Manage spreadsheets and other official records - Greet and receive visitor. - Handle information requests. - Inter departmental coordination

1826

Technical Proposal

Method Statement

Technical Proposal

Method Statement

Traffic Management System

STRABAG

EFKON

Technical Proposal

of

ITS Part-2: Highway Traffic Management System (HTMS)

for

Mumbai Metropolitan Region Development Authority (MMRDA)

at

Mumbai Trans Harbour Link (MTHL) Project

Document name: MMRDA-MTHL/ITS Part-2 HTMS/TP/001/V1/R0

STRABAG	TECHNICAL PROPOSAL – HIGHWAY TRAFFIC MANAGEMENT SYSTEM	एम एम आर डी ए MMRDA

Table of Contents

	TECHNICAL PROPOSAL – HIGHWAY TRAFFIC MANAGEMENT SYSTEM	एम एम आर डी ए MMRDA
STRABAG		

	TECHNICAL PROPOSAL – HIGHWAY TRAFFIC MANAGEMENT SYSTEM	एम एम आर डी ए MMRDA
STRABAG		

STRABAG	TECHNICAL PROPOSAL – HIGHWAY TRAFFIC MANAGEMENT SYSTEM	एम एम आर डी ए MMRDA

List of Table

	TECHNICAL PROPOSAL – HIGHWAY TRAFFIC MANAGEMENT SYSTEM	एम एम आर डी ए MMRDA
STRABAG		

Abbreviations

Abbreviation	Description
ATCC	Automatic Traffic Counter cum Classifier
CCTV	Closed Circuit Television
FOI	Fiber Optic Interface
FPS	Frames Per Second
GUI	Graphical User Interface
HTMS	Highway Traffic Management System
ITS	Intelligent Transport Systems
LAN	Local Area Network
MET	Meteorological Data Systems
NMS	Network Management System
OFC	Optic Fiber Cable
PTZ	Pan, Tilt, Zoom
RSU	Road Side Unit
TMCC/ CCC	Traffic Management Control Centre
UPS	Uninterruptible Power Supply
VASS	Vehicle Actuated Speed System
VMS	Variable Message Signs

| **STRABAG** | **TECHNICAL PROPOSAL –**
HIGHWAY TRAFFIC
MANAGEMENT SYSTEM | एम एम आर डी ए
MMRDA |

1   About EFKON India

1.1   Introduction

EFKON India Private Limited (EIPL) is a fully owned subsidiary of STRABAG SE, headquartered in Vienna, Austria. EFKON India is a Global leader in providing end-to-end solutions for Smart cities, Smart Tunnels, Intelligent Revenue Collection System (Toll Management & Parking Management), Advanced Traffic Management System (including Intelligent Lighting System), and Intelligent Transport Management System (ATCS, RLVD, ANPR, Speed Enforcement, Emergency Communication, ATCC, etc.). These systems are widely used by various government agencies, cities, concessionaires, and transport corporations, and logistics companies for the improvement of their Business Processes. Having been established in the Indian market since 2001, EFKON India is the pioneer to bring innovative solutions for the Intelligent Transportation Systems (ITS) industry in India. Leveraging high-level domain expertise and support from worldwide group companies, EFKON India aims to deliver turnkey solutions, customized system integration, and lifecycle services programs for the entire value chain. We have significant know-how on all major technologies for building smarter, safer, and more efficient solutions.

1.2   EIPL Portfolio

- **ITMS Solutions**
  - Adaptive Traffic Control System (ATCS)
  - Red Light Violation Detection (RLVD)
  - Speed Violation Detection (SVD)
  - Video incident detection (VID)
  - Automatic Number Plate Recognition (ANPR)
  - E - CHALLAN
  - Video Automatic Vehicle Counter & Classifier (ATCC-V)
  - IR Automatic Vehicle Counter & Classifier (ATCC-S)
  - Traffic Accident Recording System (TARS)
  - Variable Message Sign Board (VMS)
  - Emergency Call Box (ECB)
  - Integrated Command & Control Centre (ICCC)
- **Intelligent Revenue Collection System**
  - Toll Management System (Manual Toll, Electronic Toll, Hybrid Toll)
  - Parking Management System
- **Intelligent Transport Management System**

- o Vehicle Tracking & Logistics Support System
- o In-Bus Surveillance System
- o Automated Fare Collection System
- o **Intelligent Tunnel Management System**
- o Supervisory Control & Data Acquisition (SCADA)
- o Tunnel Ventilation System
- o HVAC System
- o Fire & Plumbing
- o Surveillance

EFKON India has 500+ staff & full-fledged innovation lead R&D center in India for development and IT services support person team of professionals that allows the organization to be nimble and responsive to its client needs. Decisions are made quickly the entire operation is optimized for low cost with high value-added benefits for our customers.

Efkon as a group is experienced in implementing high volume, secure, flexible, scalable, enterprise-wide technology solutions for large clients. This has enabled us to deliver the most advanced technical solutions to solve the ITS industry's problems. Our technical team has experience in enterprise solutions for Toll Road Management, Smart Highways, Smart Cities, Customer Relationship Management (CRM), Software Development Life Cycle (SDLC) Management, Business Process Management (BPM), Quality, Engineering, and IT Services.

STRABAG	TECHNICAL PROPOSAL – HIGHWAY TRAFFIC MANAGEMENT SYSTEM	एम एम आर डी ए MMRDA

2   Overview

- The MTHL (Mumbai Trans Harbour Link) connects Sewri on the Mumbai side with Chirle on the Navi Mumbai side in Maharashtra State, India.

- The proposed solution covers the "Design, Manufacture and Factory Test, Shipping to Site, Installation, Testing and Commissioning of The Highway Traffic Management System (HTMS) for the Mumbai Trans Harbour Link (MTHL), Mumbai, India".

- The proposed HTMS system is a part of "**Package 4**- Design, Supply, Installation, Testing and Commissioning of Intelligent Transport System (ITS), Highway Traffic Management System (HTMS), Electrical works, Highway Illumination System, Construction of Toll Plazas and Administrative Buildings including Command Control Centre." of the MTHL project.
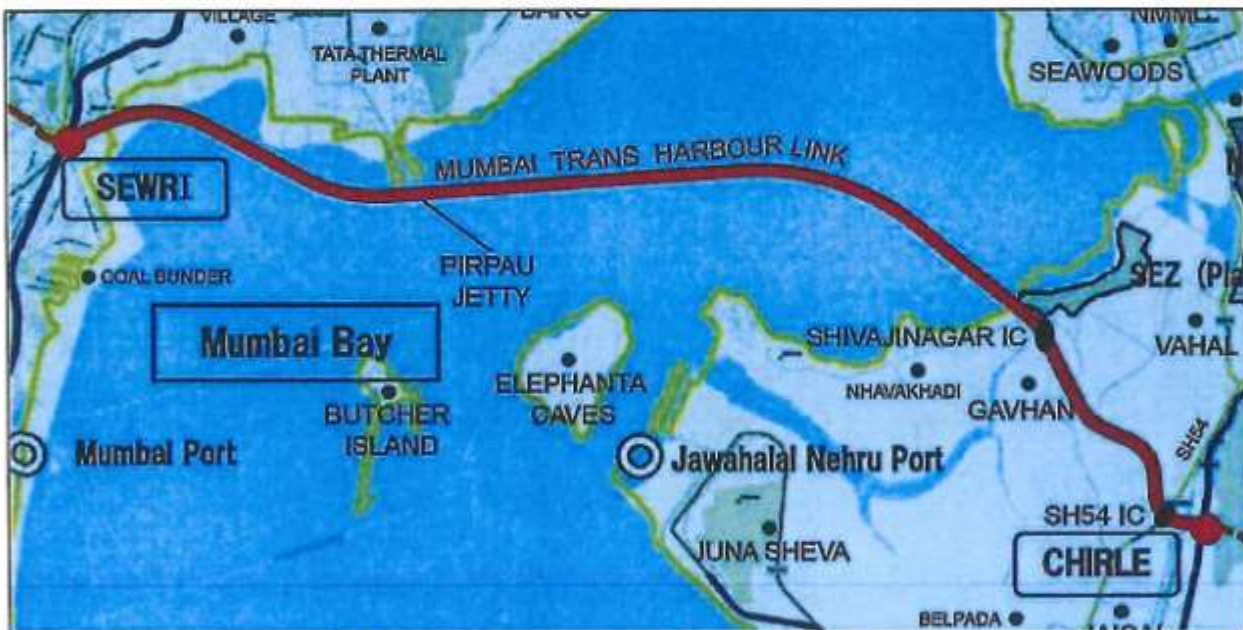
Figure 2:1 – Indicative Image of Mumbai Trans Harbour Link

- The traffic management system comprises the command control center system, various roadside equipment, data communication system connecting them, and mobile radio communication system.

- The HTMS solution in this document is for traffic management and enhanced road safety at the project and it is aimed at:

  a) Smooth and uninterrupted traffic flow

  b) Enhanced road safety

  c) Information and guidance to road users

  d) Emergency assistance round the clock

e) Alerts for abnormal road and weather conditions

f) Reduced journey time and inconvenience

g) Database creation for analyzing road crashes, and

h) Maintain database on traffic volume and other traffic flow parameters, and lane distribution of vehicles – particularly, commercial vehicles – for pavement distress modeling.

- The HTMS is helpful to prevent and actively fight congestion by intelligently influencing traffic on the road and demonstrating responsibility through a proactive approach to traffic improvement on the national highways.

- The principle of the installation of HTMS is to enhance the quality of safety by applying vision-based technologies to deliver convenience and comfort of mobility. The HTMS thereby provides the basis for traffic strategies and information distribution.

- The HTMS monitors & visualizes the traffic conditions on the road in real-time. The HTMS installation along the road will be useful to provide value-added traffic information services to the public and improve road safety through incident detection & response management.

2.1 Project Details

o The MMRDA will execute this HTMS project for the Mumbai Trans Harbour Link in the state of Maharashtra, India for traffic management and road safety enhancement.

o The center system will be a central monitoring and control system for the traffic that traverses the Mumbai Trans Harbour Link (MTHL) in Mumbai, India.

o The roadside equipment will include an automatic traffic counter cum classifier, closed-circuit television camera, meteorological observation equipment, emergency call box, and variable message sign. The system will also monitor the operating condition of the equipment. In addition, the system will be equipped with an emergency call system to assist motorists who are in need.

o The data communication system will connect roadside equipment with the command control center. In addition, it will provide data communication service for toll management systems by connecting the toll management center system with the toll plaza system and other applications within MTHL.

The HTMS systems will be installed along the MTHL road according to their objectives & functionalities as per Table 2:1.

Table 2:1– Proposed Equipment Quantity as per ITS Part-2

Sr. No.	HTMS System	Function/Objective
1)	Traffic Management Control Centre	The center system will consist of servers, workstations, peripheral equipment, video wall, and data communication equipment. The system

	STRABAG	TECHNICAL PROPOSAL – HIGHWAY TRAFFIC MANAGEMENT SYSTEM	एम एम आर डी ए MMRDA

Sr. No.	HTMS System	Function/Objective
	system/ HTMS Control Room	will gather traffic and road condition data from roadside equipment, process them into useful road, traffic, and weather condition information and disseminate the information to the road users through variable message signs and the Internet.
2)	Emergency Call Box (ECB)	It will provide a communication tool between the MTHL users & TCCC to make emergency calls (in case of accidents, breakdowns, other incidents) to obtain required assistance
3)	Closed Circuit Television (CCTV) for traffic	It will be used to capture live video of covered zones of road. It will monitor the traffic operation along the entire stretch of MTHL.
4)	Closed Circuit Television (CCTV) for security	It will be used to capture live video of covered zones of road. It will monitor the security condition under the bridge.
5)	Video Incident Detection System(VIDS)	It will be used to detect the incidences like stalled traffic, wrong direction, fallen object, fire, smoke, etc all along the MTHL and generate respective alarms at the Control Center.
6)	Automatic Traffic Counters-cum-classifier (ATCC)	It will measure traffic volume by vehicle class at each section of MTHL between interchanges.
7)	Meteorological Data System (MET)	It will detect rainfall, measure precipitation, wind velocity, and wind direction. The output result detected by the MET system will inform the MTHL users of the adverse driving condition through VMS.
8)	Variable message sign (VMS)	It will be used to provide traffic, road, weather condition, and other information to MTHL users with fixed and portable VMS.
9)	Vehicle Actuated Speed Warning System (VASS)	It will be used to provide a warning to the MTHL users with the information of the speed of the user and the warning if necessary.
10)	Data Communication System	The system will provide data communication service along the MTHL for toll management system, traffic management system, security surveillance system, and other applications.
11)	Mobile Radio Communication	It will be used for three communication between the staff of MTHL & the staff will include all maintenance and rescue teams of MTHL.

Sr. No.	HTMS System	Function/Objective
	System	
12)	Optic Fiber Cable System	It will be used for data communication equipment connectivity with the TCCC.

2.2 Equipment Quantity as per ITS Part-2

The quantity proposed in this solution is as per the requirement mentioned in ITS Part-2.

Table 2:2 – Proposed Equipment Quantity as per ITS Part-2

Sr. No.	HTMS System	Location	Quantity	UOM
1)	Traffic Management Control Centre system/ HTMS Control Room	It will be located at the main toll plaza administration and command control center	1	No.
2)	Emergency Call Box (ECB)	At each truck layby of the project. laybys are planned 3 on each side of traffic direction on MHTL.	6	Nos.
3)	Closed Circuit Television (CCTV) for traffic	Every 333 m on both sides of the entire stretch ofMTHL	130	Nos.
4)	Closed Circuit Television (CCTV) for security	Every 1 km on both sides under the bridge	36	Nos.
5)	Video Incident Detection System (VIDS)	Every 333 m on both sides of the entire stretch ofMTHL	130	Nos.
6)	Automatic Traffic Counters-cum- classifier (ATCC)	One unit for each direction at locations betweentwo interchanges. Eastbound: 1+660 (on VMS), 18+330 (on VMS) Westbound: 16+000 (on VMS), 19+580 (on VMS)	4	Nos.
7)	Meteorological Data System (MET)	At each truck layby of the project on RHS.	3	Nos.
8)	Variable message sign (VMS)	The VMS will be installed on the gantry over the main carriageway of MTHL at six (6) locations KM 1+660 (bridge), KM 18+330 (bridge),	6	Nos.

	TECHNICAL PROPOSAL – HIGHWAY TRAFFIC MANAGEMENT SYSTEM		एम एम आर डी ए MMRDA

Sr. No.	HTMS System	Location	Quantity	UOM
		KM16+000 (bridge), KM19+580 (earth) The remaining 2 locations will be on the bridge between Km 5 to Km 15.		
9)	Vehicle Actuated Speed Warning System (VASS)	VASS will be installed on the VMS gantry as one per location. Hence, the location of the VASS will be the same as VMS locations.	6	Nos.
10)	Mobile Radio Communication System	The mobile radio communication system will consist of a base station at the Command Control Centre, vehicle mobile stations, and handheld mobile stations. A repeater station will be provided to cover the entire project stretch.	1	Nos.

2.3 Purpose of this Document

This document elaborates the functional and technical specifications of various HTMS equipment and systems to ensure the achievement of desired safety, reliability, availability, and environmental requirements.

2.4 Assumptions

1) ECB guide sign dimension will be similar to board for helpline number (Mentioned in corrigendum). It will be installed near to ECB location (One per ECB).

2) The proposed ECB is powered on Solar. The solar system of ECB will provide 24 hours power backup. Six quantity of ECB is considered as mentioned in "1.2 Division 5A ITS Part-2 -27.08.21".

3) According to the received tender drawings, the CCTV for traffic & VIDS camera will be installed on the same pole. Hence, we have considered & proposed 130 locations & poles as mentioned in "1.2 Division 5A ITS Part-2 -27.08.21".

4) According to the received tender drawings, the ATCC cameras will be installed on the VMS gantry.

5) The VASS system will be installed at six locations (The location of VASS is not provided in tender drawings). We have considered these Six locations on the VMS gantry. Hence the VASS system display will be installed on the same gantry (below the position of the VMS board). Hence no separate mounting structure and other infra is proposed.

6) The Power & OFC cable will be laid through the girder of the bridge on the cable trays.

7) The Outdoor cabinets (SS 304) / RSU shall be provided at each location inside the girder.

STRABAG

**TECHNICAL PROPOSAL –
HIGHWAY TRAFFIC
MANAGEMENT SYSTEM**

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8) Proposed Camera for VIDS functions in the given temperature range asked in the RFP, without any external heater. Proposed Camera supports -40 to 65 degrees Celsius range. Power consumption of proposed camera is 24VAC/60 watt.

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3 System Description

3.1 EFKON HTMS Design Concept

1) EFKON India's proposed Advance Traffic Management System Solution provides an effective and secure road management system for collecting and delivering data concerning road status, accidents, congestions as well as adherence to the law of enforcement by vehicles plying on the expressway.
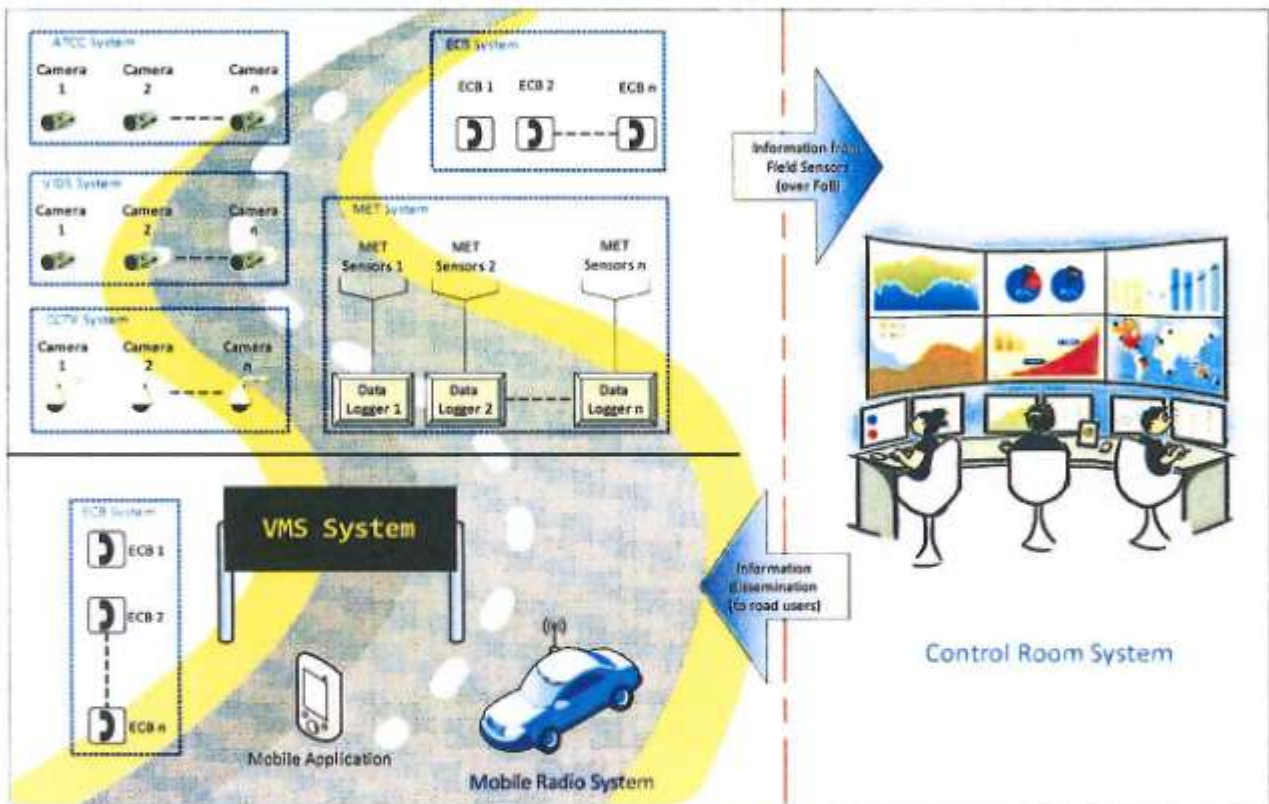
Figure 3:1 – HTMS Concept

3.2 HTMS Components
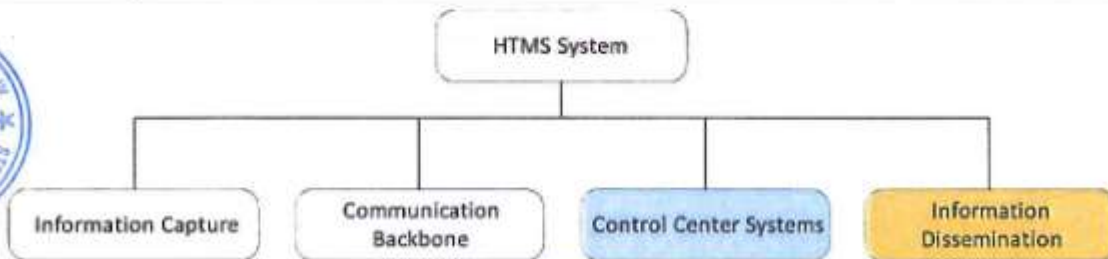
Figure 3:2 – HTMS Components

A Highway Traffic Management System (HTMS) is built upon 4 primary components:

1) Information capture:

   a) Video streams and images from CCTV cameras including expressway CCTV cameras for traffic surveillance, CCTV cameras for security, and VIDS cameras

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b) Calls received via Emergency Call Box telephones / Calls received on helpline numbers / Calls receive through Mobile radio (wireless sets)

c) Weather information from MET stations located on the stretch

d) Information from Video Incident Detection Systems that can detect pre-programmed traffic-related incidents on the stretch

2) **Communication Backbone:**

a) Fiber optics (Hardware) and relevant interfaces

b) The network management function will be provided to the system to continuously monitor the conditions of the layer 2 switch and layer 3 switches using a simple network management protocol. In case a malfunction occurs, the network management system will issue an alarm to the network management workstation.

3) **Control Room Systems (Hardware / Software):**

a) The control room systems take device inputs and output actions and communication to the road user either automatically or through manual operator intervention

b) Internet (Public Portal)

4) **Information Dissemination to Road Users:**

a) The VMS boards are mounted on the gantries along the MTHL that can be accessed from the control room via a fiber-optic backbone

b) The road, traffic, and weather condition information gathered and processed in the command control center will be provided in text or graphic format to the road users through VMS and Internet. The information will be concise and easy to understand. The structure of the message will be standardized based on the pre-defined nomenclature.

c) Internet server will provide road, traffic, and weather condition information, and other information related to the operation of MTHL through the Internet. A firewall will protect the Internet server against a possible attack.

d) Dedicated Mobile based Applications for Android and iOS will be developed. This application will have various user levels such as System administrator, system user, road user, etc.

1) The typical operation of the HTMS system is shown in Figure 3:3.
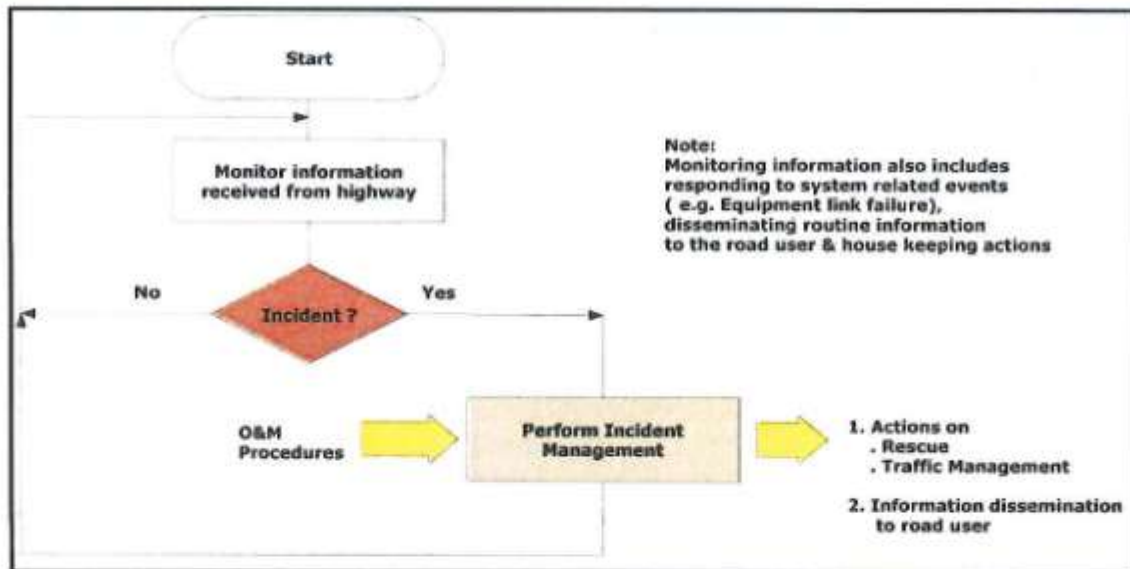
Figure 3:3 – HTMS Operation

2) The system allows operational personnel of the HTMS to take appropriate decisions (and subsequent actions) to ensure an optimal response. This is in the form of 'electronic' system-generated checklists that need to be followed by the operator while managing an incident. The procedures are in turn derived from optimal processes that are developed to meet operational goals.

3.3 Data Communication & Gathering from Roadside Equipment

1) The system will communicate with the roadside equipment through a fiber optic cable network using a TCP/IP-based data communication system. The communication system will have a redundant dual ring configuration and an interruption of the communication in one ring will not cause the disconnection of the communication link.

2) The system will gather the traffic and meteorological data from the automatic vehicle counter cum classifier and meteorological observation station. It will also receive the video feed data captured using CCTV cameras.

3) The types of data, data format, and collection interval will be configured as per the requirement for the respective component subsystems and equipment.

3.4 Monitoring of Roadside Equipment

1) All roadside equipment comprising the system will be constantly monitored for their normal operation. Depending on the type of equipment monitored, the monitoring mechanism will be initiated either by the center system or roadside equipment at a fixed interval or as an event arises.

2) The system operator can initiate the test of roadside equipment and confirm the normal operation.

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3.5 Database Management

1) The server will store all events within a system in an industry-standard SQL database. The system will have one centralized database for all the subsystems of the complete traffic management system.

2) The type and quantity of data to be stored in the database are configurable. Each data and event will be stored with the necessary data timestamp to enable the search and retrieval of the data based on the time of occurrence.

3) Following data and events will be stored:

   a) Login and logout of operators onto the system.

   b) All system-related events like changes to the system configuration, shutting down and starting of all software services and applications, failure of hardware or software components

   c) Data collected from automatic vehicle counter-cum-classifier, and meteorological sensors

   d) Incidences collected through VIDS

   e) Messages and information displayed on the variable message sign

   f) Change of equipment operating mode (switching between automatic, manual, and local mode of operation) and parameters

   g) Emergency call statistics

   h) All malfunctions and failures of the automatic vehicle counter-cum-classifier, CCTV cameras, VIDS, meteorological sensors, emergency call box, variable message sign, layer 2 switch, layer 3 switches, and media converter

   i) Loss of communication link

   j) All malfunctions and failures of the power supply system including the low voltage of the battery, if any

   k) All alarm events triggered by weather conditions, traffic flow parameters, and automatic traffic counter-cum-classifier

   l) Operator's responses to alarm events

3.6 Voice Communication

1) The system will be provided with a voice communication function with an emergency call box, mobile phone, and fixed-line telephone.

2) The mobile workstation will be provided for communication with mobile phones and fixed-line telephones.

3.7 Human-Machine Interface

1) Three kinds of display devices will be provided as a human-machine interface, video wall, CCTV display monitor, and workstation display monitor.

2) The CCTV display monitor will have a multiple screen display function in which the display area will be divided into smaller screen areas and each of them can display images from different sources.

3) The video wall will be capable of displaying an image from a CCTV system and any workstation.

3.8 Automated Traffic Monitoring and Alarm

1) The traffic management system has the functionality to monitor data gathered by the sub-systems. Upon detected scenario, the system will generate an alarm automatically or the operator can create alarms based on the monitored data and recommend actions.

2) If an incident is detected by the VIDS system or adverse weather condition is detected by the meteorological observation system, these systems will send an alarm to the VMS system. The VMS system will then create a warning message indicating the location, type of incident, and required action. The created message will be sent to the VMS workstation for confirmation along with the contents of the message and the location of VMS for which message is recommended. Upon confirmation of the recommendations, the message will be displayed on the specified VMS.

3) If an abnormal traffic flow parameter is observed at a lane or a section by the automatic traffic counter-cum-classifier, an alarm will be issued and displayed on the ITS workstation for the operator's attention and appropriate action.

3.9 System Clock

1) The traffic management system will have a real-time clock server (Time server) that will be used for time monitoring, data transfer, device control, reports, and printouts. The clock server will have an automatic adjustment function using GPS and the clock will remain accurate within one second all the time.

2) The real-time clock will have an internal battery and will maintain the correct time for at least 48 hours. All sub-systems, equipment, and devices comprising the system will synchronize with the real-time clock.

3.10 Operation Log

1) All operations by the system operator through the workstation including login and logout will be recorded as an operation log with the operator's ID and time.

2) All malfunctions of the equipment comprising the system will be recorded with the time of occurrence, time of recovery, and type of error.

3.11 Fault management

1) The traffic management system will have a fault management system to record and manage all faults and errors reported by the sub-systems. The issues will be associated with subsystems such as ECB

meteorological station, ATCC, VMS, CCTV, network, workstation, system server, time server, Internet server, database, video wall, and operating system.

2) The system will be flexible enough to add more sub-system names. Each entry in the fault management system will also have a status: new, attended, awaiting parts, temporary fixed and recovered, and corresponding severity level: critical, high, medium, and low.

3) The login to the fault monitoring system will be integrated with the system login. A new issue will be automatically assigned a "New" status and an alarm will be automatically issued to the maintenance staff. The system will record the timestamp of the status change and severity change.

4) The system will be able to provide a snapshot of all current unresolved issues at any given time. The system will also produce a monthly report of all the issues identified during the month, time taken to fix, time taken to close. The system will also be able to produce fault reports categorized based on the associated sub-system.

3.12 Report Production

1) The system can produce various kinds of reports.

2) The list of some reports is as follows:
   a) Emergency call statistics
   b) Traffic flow parameters
   c) Incident Reports
   d) Weather conditions
   e) Variable message sign operation
   f) Equipment malfunction and recovery
   g) Fault resolution statistics

3) All reports will be produced automatically according to the schedule and stored in the storage device as the print-out images. For the report periodically produced, a utility program will be provided to set or cancel the automatic print-out on the printer for each report.

3.13 System Capacity

1) The proposed traffic management system is designed to have the system capacity sufficient to operate and monitor the roadside equipment concurrently with other tasks such as the operator's manual operation without noticeable delay.

CPU Utilization

1) The CPU utilization is maintained well below 50% by applying best practices of design and development to improve performance and scalability. Key areas where the reviews and tests are carried out are the following:

a) Coupling and Cohesion

b) Communication (Across remote machines, Queuing, etc)

c) Concurrency (Symmetric multithreading)

d) Caching, state management

e) Resource management (Resource sharing, DISK I/O, Memory I/O, Hardware interfacing, etc)

f) Best practices of the language and architecture in use

g) Multithreading with optimizing usage to reduce unnecessary context switching

2) Environmental Factors that are taken into consideration

a) Network Configuration

b) Network Security

c) Authentication across network

d) Firewalls (Allowed ports etc.)

Tool Name	File Name	Function
Trace Capture, Processing, and Command-Line Analysis tool	Xperf.exe	Captures traces, post-processes them for use on any machine, and supports command-line (action-based) trace analysis.
Visual Trace Analysis tool	Xperfview.exe	Presents trace content in the form of interactive graphs and summary tables.
Windows performance monitoring tool	Perform.exe	CPU, Memory utilization visibility of each application and service.

1) To test the CPU utilization following tests need to be carried out:

a) For simulation advanced test scripts and tools are incorporated which randomly generate lane transactions and can be configured to generate various toll transactions as per the size and volume required to stress test the server.

b) XPERFVIEW would be executed simultaneously to trace the CPU usage.

c) The number of virtual lanes would be gradually increased to full load with all lanes active at one time generating normal and discrepant transactions as per the estimated load.

d) Data transfer agents would be launched on all virtual lanes.

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4.1   Introduction

1) The Central Processing System is composed of many component systems to manage the HTMS project. All HTMS components will perform their functions to achieve the overall objective of the project for efficient, safe, and smooth traffic on the MTHL road.

2) For this, a Centralized server system is proposed to manage various systems of the HTMS project efficiently. It provides a user-friendly graphical user interface for the operator and records all events and incidents.

3) The Central processing system is divided into the following sections:

   a) Command & Control Center

   b) HTMS network architecture

   c) Core central processing software including HTMS software, NMS, FMS, Video Management & Analytics software, VMS module, VIDS module, etc.

4.2   System Components

The Command Control Centre system will consist of the following component:

1) Command control center server

2) Time server

3) Intelligent transportation system (ITS) workstation

4) Closed Circuit Television (CCTV) server

5) Emergency Call Box (ECB) workstation

6) Variable Message Sign (VMS) workstation

7) Mobile radio workstation

8) Network management workstation

9) External storage device

10) Videowall

11) CCTV display monitor

12) Printers

13) Internet server

14) Firewall

15) Data communication equipment

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4.3 System Architecture
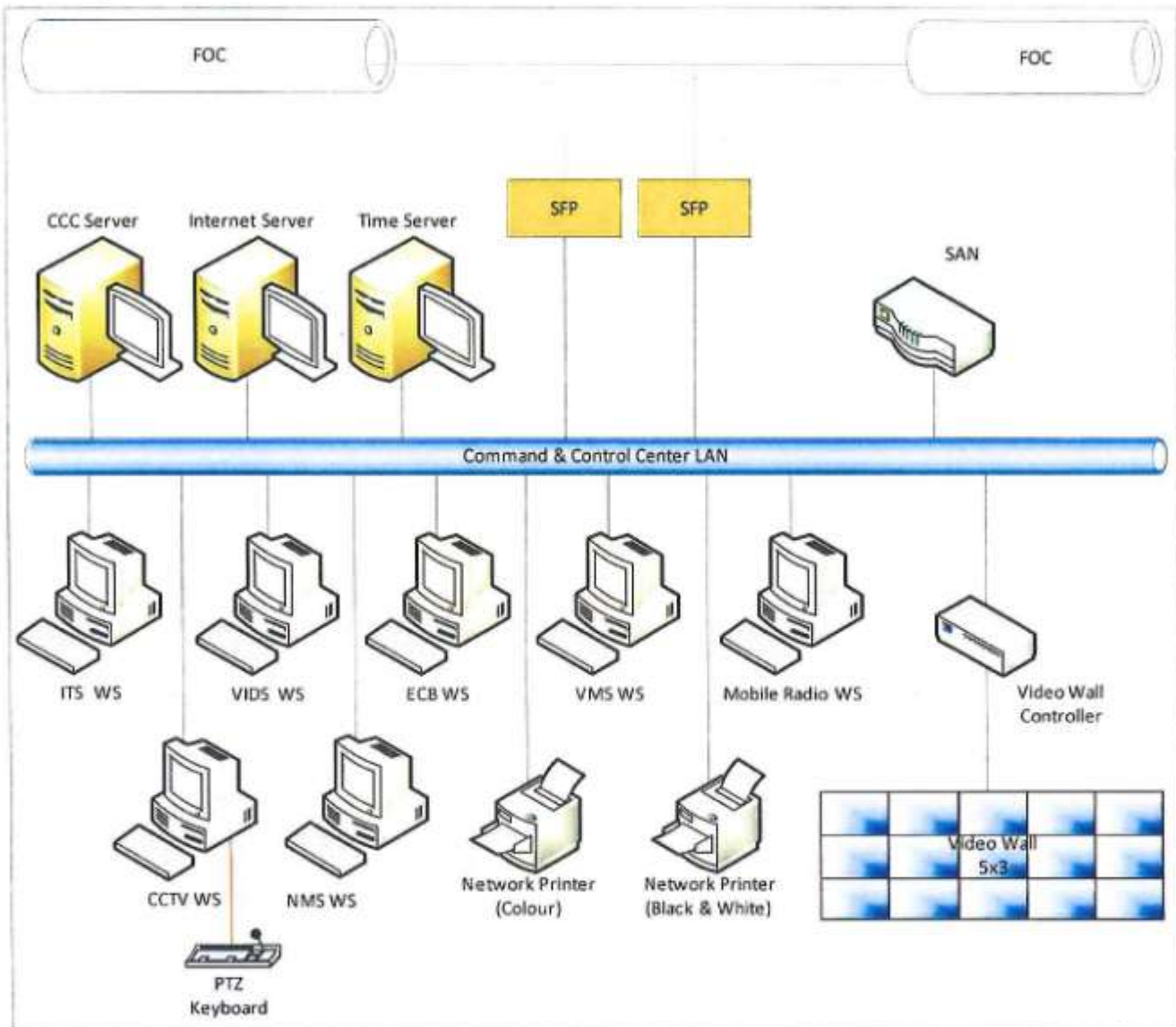
Figure 4:1 – Indicative CCC components

4.4 System Function

1) The command control center is the most crucial part of the project which accommodates and operates the entire HTMS system. It will be set up in the HTMS room located at the Main Toll Plaza building at Gavan.

2) Following functions will be integrated into the traffic management system:

   a) Data gathering from roadside equipment.

   b) Monitoring and control of roadside equipment

   c) Data communication with roadside equipment

   d) Database management

e) Voice communication with emergency call boxes, mobile phones, and fixed-line telephones

f) Network management and control

g) Dissemination of information through variable message sign and Internet

h) Human-machine interface

i) Automatic traffic monitoring and alarm via VIDS

j) System clock

k) Operation log

l) Fault management

m) Report production

3) All the central equipment including server, network, video wall, data communication system, voice communication system, and associated equipment will be accommodated in the same MTP administration building.

4.4.1 Command Control Center (CCC) Server

1) The traffic management system server system consists of a single server.

2) The Traffic Management Centre will receive all the data from the field. The Centralized server system will be installed at CCC to process the data gathered from the field equipment.

3) The server will support multi-task, multi-operations functions to execute multiple functions of the system simultaneously. For this, different priority levels are assigned to each software module.

4) We have taken care of applications implemented as a part of the traffic management system. The server has spare memory capacity and processing power which are available for future enhancement or implementation of new applications. As per the calculation provided in Section 3.13, the current proposed applications are designed to not consume more than 50% of CPU utilization as per the RFP Requirement.

4.4.2 Time Server

1) A time server will be provided in the command control center system to synchronize all servers and workstations operating in the traffic management system with the standard time obtained from GPS (global positioning system) satellite.

2) Time server will communicate with the servers and workstations through Network Time Protocol (NTP) to adjust the real-time clock of servers and workstations. All servers and workstations will be provided with simple network time protocol (SNTP) or network time protocol (NTP) software running under a variant of the UNIX, Windows operation systems.

3) A GPS antenna will be provided together with the time server to receive the GPS satellite signal. The antenna will be installed at the proper location of good reception at the traffic management Centre building.

4) The time server will be provided with a built-in crystal oscillator to maintain the accurate time when time information is not available from GPS satellites for the minimum duration of 24 hours.

4.4.3 Internet Server System

1) Internet server system consisting of an Internet application server & firewall.

2) The basic information to be provided to the road users through the Internet will include the following:

   a) Events and incidents on the MTHL such as accidents, construction work, lane control, closure, inclement weather, and other events that hamper the normal operation of the MTHL.

   b) Video stream from the selected CCTV camera.

3) Two types of Internet sites will be prepared, one for access from a personal computer and another for access by mobile phone. The site for personal computers will show the event and incident information in a graphic manner indicating the incident location on the schematic map of the MTHL while the site for mobile phones will provide the information in text and simplified graphics.

4) Video images captured using the CCTV camera will be converted to the video streaming signal of the resolution suitable for the distribution through the Internet.

4.4.4 HTMS Workstations

1) The traffic management system will consist of several workstations to perform the function of each HTMS sub-system. Each workstation will have its functions and perform the tasks assigned to it under normal conditions. In the event of unavailability of a workstation due to malfunction or maintenance, the operator can use any other workstations as a substitution to perform the same functions. Access privilege control will be applied in the same manner when the workstation is being replaced.

2) The assignment of the functions to each workstation will be as per Table 4:1.

Sr. No.	Workstation	Main functions
1)	ECB Workstation	• To receive calls from emergency call box installed along the MTHL. • Location of the calling emergency call box identified and displayed automatically on the monitor • To transfer the received call to another emergency call receiving

Sr. No.	Workstation	Main functions
		telephone.
		• All calls will be automatically logged and recorded.
2)	CCTV Workstation	• Observation of traffic condition and operation of the CCTV camera • To select and control the CCTV camera and manage the recorded video.
3)	VIDS Workstation	• To monitor all incidences as reported by the VIDS roadside equipment. • To acknowledge the incidences and initiation of the response.
4)	ITS Workstation	• Monitoring and control of the reception and processing of traffic and meteorological data • Input and editing of incident data • Event information management that could affect the traffic on the MTHL
5)	VMS Workstation	• Creation and editing of messages to be displayed • Control and monitoring of variable message sign
6)	Mobile Phone Workstation	• Provided with a phone book to register, edit and delete mobile and fixed-line telephone numbers of the maintenance organization, maintenance staff, vehicle towing service, ambulance, traffic police, and other frequently contacted agencies. • Display of the calling or called party on the monitor display • Call history of both outgoing and incoming calls
7)	Mobile Radio Workstation	• Monitoring of MRCS system
8)	Network Management Workstation	• Monitoring and management of the network

Table 4:1 – Types & Functions of Workstations

4.4.5 Storage Device

1) All operational data of roadside equipment including failure log information will be stored in the storage device connected to the command control center server. The data will be easily searchable with a combination of keys that will include day, time, and item (name of roadside equipment, numbers of roadside equipment, or kilo post).

2) The disk capacity of the storage device is calculated by considering the need to store the operating system, the application software, other software packages necessary for the operation of the system, and the data generated by the system.

3) **Calculations of the hard disk capacity:**

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a) Sensors are deployed at various locations to collect data from the field. This data is then processed with the help of various algorithms to generate desired outputs and achieve the objectives of the project. Whether we need to store the collected raw data or processed data, storage devices are required. These storage devices enable safe and secure storage of data by deploying various modern technologies and protection mechanisms.

b) For this project, a microprocessor-based Server Area Networked or simply SAN type storage is selected considering its connection proficiency with servers & speed of data operations. As per the requirements of the project, logical storage of 30 TB will be provided as primary storage & 150 TB storage will be provided as secondary storage. The solution will be modular in design and will be in rack-mountable form factor. For primary storage, SAS SSD's will be used whereas secondary storage will comprise SATA disks. Primary storage will be configured with RAID 5 for data loss prevention by hard disk failure.

c) As a regular practice, the storage system will be connected to the server farm with the help of a SAN switch using optical fiber patch cords for optimal performance. Controllers used will be configured in active-active configuration so that a single logical unit can be shared across all servers. These controllers will be able to scale up to support double the required capacity i.e., a total of 60 TB for primary & 300 TB for secondary storage by simply adding/populating more hard disks.

d) Following calculations are performed to ensure that the allocated storage capacity is sufficient to house all project data for the periods mentioned under various systems.

Video Feed Storage Calculations:

Sr.	Type of Camera	Resolution	Compression	Frame rate (FPS)	Hours	Days	Space / Camera (GB)	Qty.	Total Space Required (GB)
1.	CCTV - Traffic surveillance	Full HD (1920 X 1080)	H265 - medium quality	0.01667	24	365	3.6	130	468
2.	CCTV - security surveillance under bridge	Full HD (1920 X 1080)	H265 - medium quality	0.01667	24	365	3.6	36	129.6
3.	VIDS	Full HD (1920 X 1080)	H265 - medium quality	1.00000	24	7	4.2	130	546

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Sr.	Type of Camera	Resolution	Compression	Frame rate (FPS)	Hours	Days	Space / Camera (GB)	Qty.	Total Space Required (GB)
4.	ATCC	Full HD (1920 X 1080)	H265 - medium quality	1.00000	24	365	217	4	868
								Total:	**1.9644 TB**

Table 4:2 – Storage requirement for Video Feed

Logs and Metadata Storage calculations:

Sr.	System	Locations	No. Of Sensors	Frequency of Data in min	Total Size (MB)	Per Day (MB)	For 5 Years (MB)
1.	ATCC	4	1	5	22.000	6329.000	11550425
2.	MET	3	1	5	17.000	4747.000	8663275
3.	VMS	6	1	5	33.000	9493.000	17324725
4.	VASS	6	1	5	33.000	9493.000	17324725
5.	ECB	6	1	1	0.5607604	162.000	295650
6.	ECB raw data	6	1	1	0.0001144	1.000	1825
						Total:	**52.60TB**

Table 4:3 – Storage requirement for HTMS data for 5 years

From the above calculations, it is clear that the total required storage space for the project is approximately **55TB**. So considered and provided storage space will be sufficient to store all required project data for the required duration.

4.4.6   *Access Control and Operation*

The privileges are assigned to different level staff using the combination of functions. The person with the highest access level can modify the access rights.

4.4.7   *Video wall*

1)   A video wall will be provided in the command control center to display images, a schematic map of MTHL, and a video feed from CCTV & VIDS cameras.

2) The schematic map of the MTHL screen will show various kinds of static and dynamic information of the MTHL including the location of roadside equipment and its status for the system operator to understand the current condition and to take necessary action.

3) Video feed from the CCTV & VIDS cameras will display on the video wall.

Figure 4:2 – Indicative image of Videowall

4.4.7.1 Video wall layout

- The video wall will be configured in a 3X5 matrix as in three (3) rows and five (5) columns. The video wall supports two display modes, i.e., integrated mode and isolated mode. In integrated mode, the video image from a single source will be shown on multiple monitors, while in isolated mode, each unit will display video images from different sources independently.

- The malfunction of a monitor unit will not prevent the normal operation of other monitor units and another part of the CCTV camera system.

- The video wall will be mounted on the self-standing structure and video monitors will be surrounded by a panel paint in mat black of suitable dimensions around them for a better view of the screen. A digital clock showing the date and time provided by the time server will be placed at the suitable location of the panel.

4.4.7.2 Display Items

- It is possible to selectively show the static and dynamic information on the video wall for easy understanding of the condition.

- The video wall will be capable of displaying the following image and data:

Item	Contents
Route map	• Schematic map of MTHL, interchanges, and access roads • Name of interchange, kilo-post, Jurisdiction of the fire department and police

Item	Contents
Equipment locationand status	• Location of variable message sign and their condition (message / no message and normal / error) • Location of CCTV camera Location of VIDS cameras ATCC location details • Location of emergency call box and calling emergency call box • Location of meteorological station and status
Road, traffic, and weather condition	• Service level at the location of traffic counter cum classifier • Incident (accident, congestion, stalled vehicle, fallen object, construction work) • Weather condition (rain, wind velocity, wind direction, precipitation, visibility) • Regulation (lane closure, section closure, speed limit)
CCTV video feed	• Video feed from the CCTV camera selected • Video feed from the VIDS selected
Workstation monitordisplay	• Monitor display of workstation selected
Date and Time	• Current system date and time

Table 4:4 – Display items on Videowall

4.4.8   Printers

The high-speed colour & blank and white operation printers will be provided into the central control center. These printers will be connected to the LAN of the traffic management system. These printers support A3/A4 paper sizes.

4.5 Console Desk and Chair

1) The console desk will be of ergonomic design and neatly accommodate the workstations and cables connected to it to provide an efficient and pleasant working environment.

2) Please refer to Figure 4:3, tentative schematic drawing of the console.
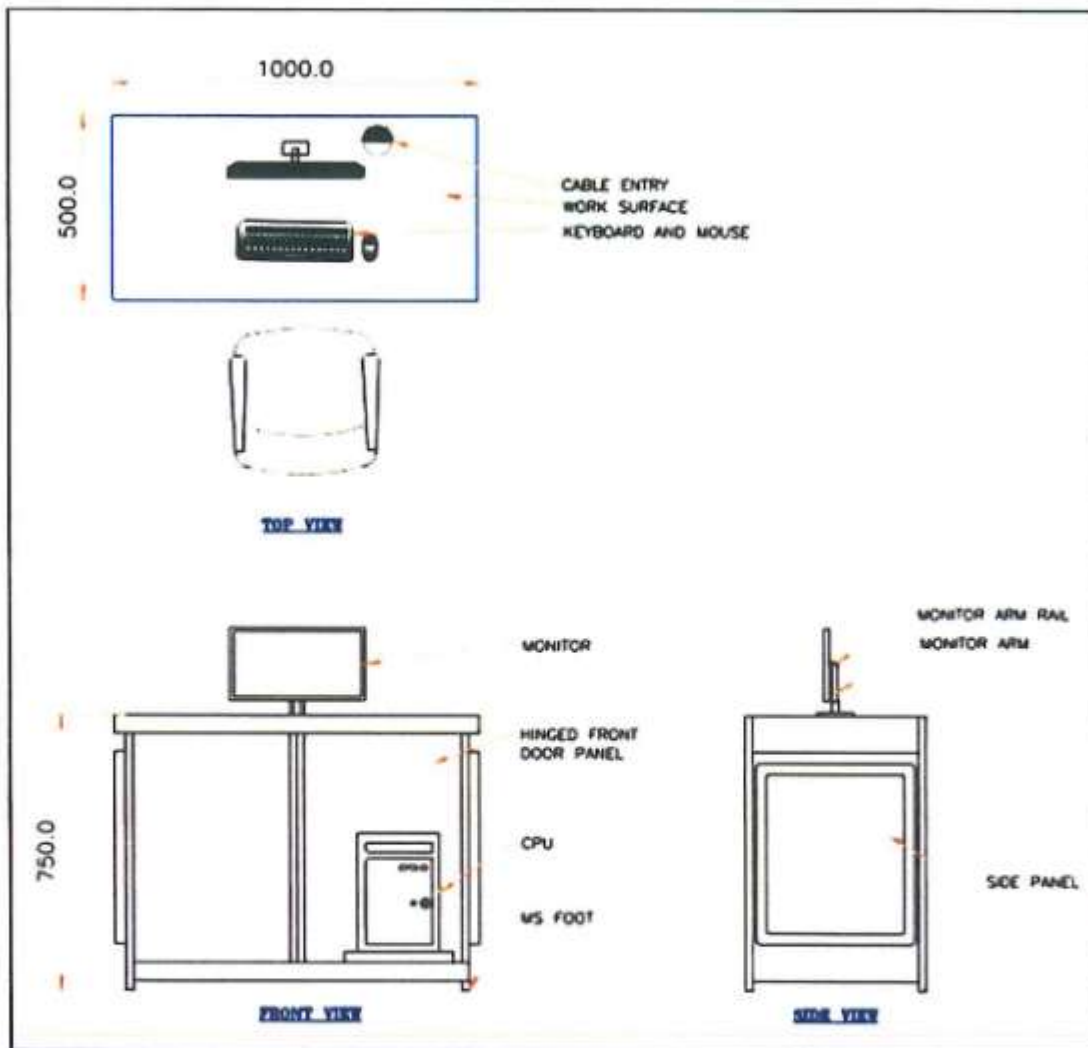
Figure 4:3 – Tentative Schematic of Console

4.6 Layout Plan of the Operation Room
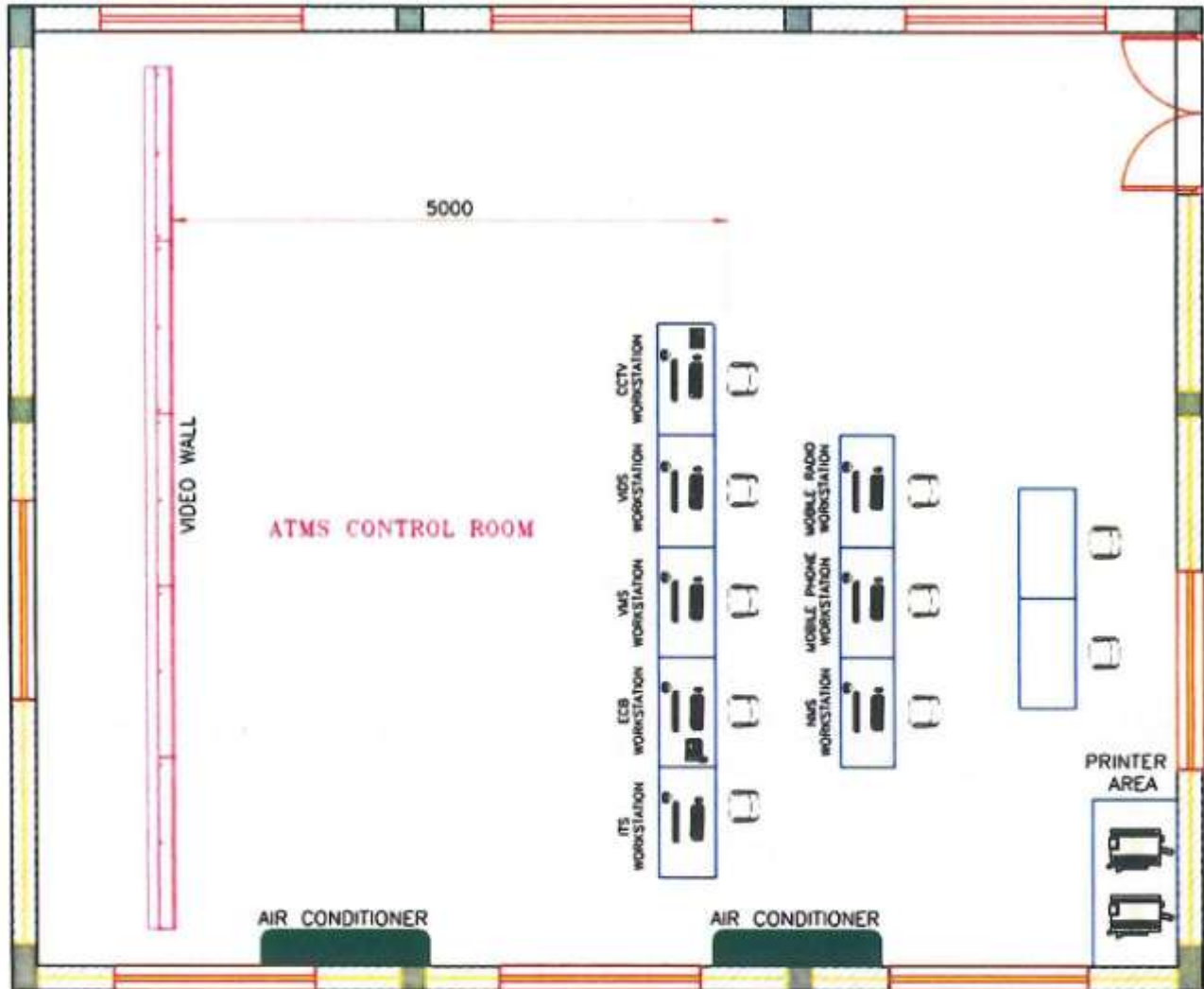
Figure 4:4 – Indicative Layout Plan of the Operation Room

4.7 CCC Software Module Description

1) The Traffic Management Center has a facility from where all the activities of the HTMS can be controlled. The Traffic Management Center will primarily comprise the indoor portion of support systems.

2) The HTMS control room operator can keep watch on the MTHL road activities using various cameras installed on the stretch viz. traffic surveillance cameras, security cameras, incident detection cameras, etc. The operator can provide road and traffic condition information to the commuters using variable message signboards.

3) The central server system will be implemented to manage & control all sub-systems efficiently & seamlessly. For this, a user-friendly graphical user interface for the operator is provided as well as records of all events and incidents related to the expressway will be stored in the database.

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4) The central server system constantly monitors the operation of component systems and their subsystems. It is possible to define/ modify the system configuration and add/remove any device connected to one of the component systems. It is also possible to change any system parameters defined and stored in the database. The user privileges are managed as a preventive measure against inadequate change to the system parameters. Using this, access to the system configuration function is restricted to the authorized personnel. The configuration and parameters of the system are backed up to allow recovery.

5) The system will provide detailed reports related to the System Operations (including the actions of various stakeholders during Incident Management) and maintenance. The system will also provide a method to log and report road incidents. Data used for logging and reporting will be picked up automatically from the roadside and other sensors to the maximum extent possible. Further, the system provides a facility for generating user-formatted reports to bring together the occurrence of highway incidents, values of various sensors, and the operational status of various equipment on a common timeline/scale.

6) Traffic Management System Software will include:

   a) Command & control center software

   b) Utility software

   c) Maintenance activity tracking and logging software

2) The HTMS software is based on modern architecture to optimally execute on the CCC server to ensure that:

   a) The system response times are instantaneous to support effective traffic management (i.e. Traffic monitoring and incident/accident management) actions on the HTMS workstation.

   b) Effective integration with the CCTV system, VIDS system, VMS system, and other relevant HTMS equipment will be carried out seamlessly with no disruption of / disturbance to the traffic management function (i.e. Traffic monitoring and incident management).

   c) All information (Data, video, and audio streams) collected from various sources will be archived in the CCC server for quick retrieval by authorized personnel. However, the performance of the HTMS software in terms of response times will not be affected during such a retrieval process.

3) The HTMS software is a modular system comprising of the following modules:

   a) Data acquisition module for acquiring data & video streams from field equipment

   b) Traffic monitoring module

   c) Incident & event management module

   d) Report generation module

   e) System administration module

4.7.1   *EFKON Solution Framework Technology Components*

1) Microsoft ASP.NET MVC pattern

2) IIS as a web server

3) Web API, WCF, Windows services at the application layer

4) J2EE struts1.0, TomCat Server

5) My SQL Enterprise

4.7.2   *HTMS Solution Architecture*
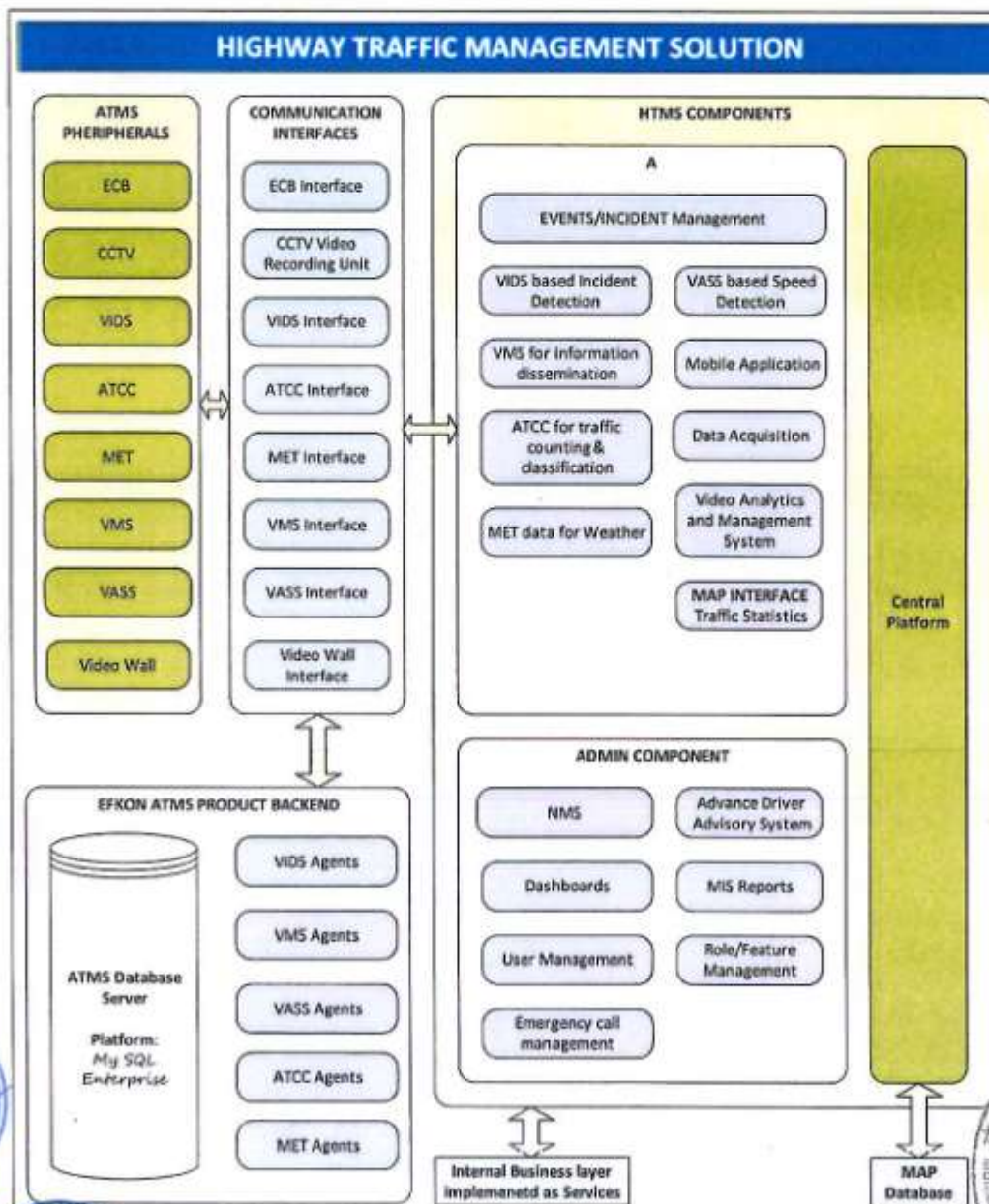
Figure 4:5 – HTMS Solution Architecture

1) The component architecture depicts the following key grouping:

   a) Communication interfaces are classes that allow specific hardware APIs and SDK to be consumed and exposed further as a generic message using the communication services.

   b) Communication services manage all the field-side equipment communication as part of data acquisition services using the specific communication interfaces.

   c) Web-based solution.

2) The application in observation mode allows the following key features:

   a) Layers for all equipment as part of monitoring and controlling

   b) All layers can be individually turned on and off

   c) Traffic and congestion statistics

   d) Health status of all equipment

   e) View currently set configuration parameters

   f) View incoming raw data from various subsystems

   g) Allows to select specific components and zoom or view videos for analysis

   h) Allows to view past events and incidents reported

3) Further, the operator can quickly control the following features as part of incident/ control mode:

   a) Manage the erroneous data from any subsystem

   b) Manage the events and incidents

   c) Manage the operational configurations

   d) Analyze the reports and health status

4) Admin component has the following key features:

   a) Complete user management

   b) Role management

   c) Configuration network management system

   d) Configuration of the system and operational parameters

   e) Dashboard and reports

   f) Configuration of alerts and notifications

   g) Analysis of activity and error logs

5) Key business intelligence reports and performance charts

4.7.3   *Software Solution and Technical Architecture*

4.7.3.1   *Solution Scalability and Reliability*

   1) The solution scalability and reliability are achieved and assured by adopting the following key guidelines:

a) An architecture that can be scaled up and scaled out as per the requirement.

b) **Database partitioning** is considered at design time considering the I/O load as the program grows will allow easy scaling in terms of I/O performance

c) **Coupling and cohesion**: Layered architecture allows loose coupling.

d) **Communication**: Necessary and limited calls across layers assuring a less chatty network.

e) **Concurrency**: Increase use of asynchronous and non-blocking calls assuring better performance, reliability, and scalability in terms of scaling.

f) **Resource Management:** Optimum design assuring necessary instantiation and use of shared pools with the proper release of the resource once the work is completed. This ensures better reliability as resources are kept free for service.

g) **Caching:** Caching synchronization will be maintained with optimized design for future scaling and reliable service to end-users.

h) **Data structures and algorithms**: Tested algorithms for file parsers, reconciliation, database processing, and caching with loads of data. This allows good performance and easy scaling using additional services running in parallel.

2) Figure 4:6 depicts the layered architecture where the UI, business layer, and data access layer are completely separated.

3) The business services are created to meet the specific business requirements and common services are kept to cater to the generic requirements across the application landscape.

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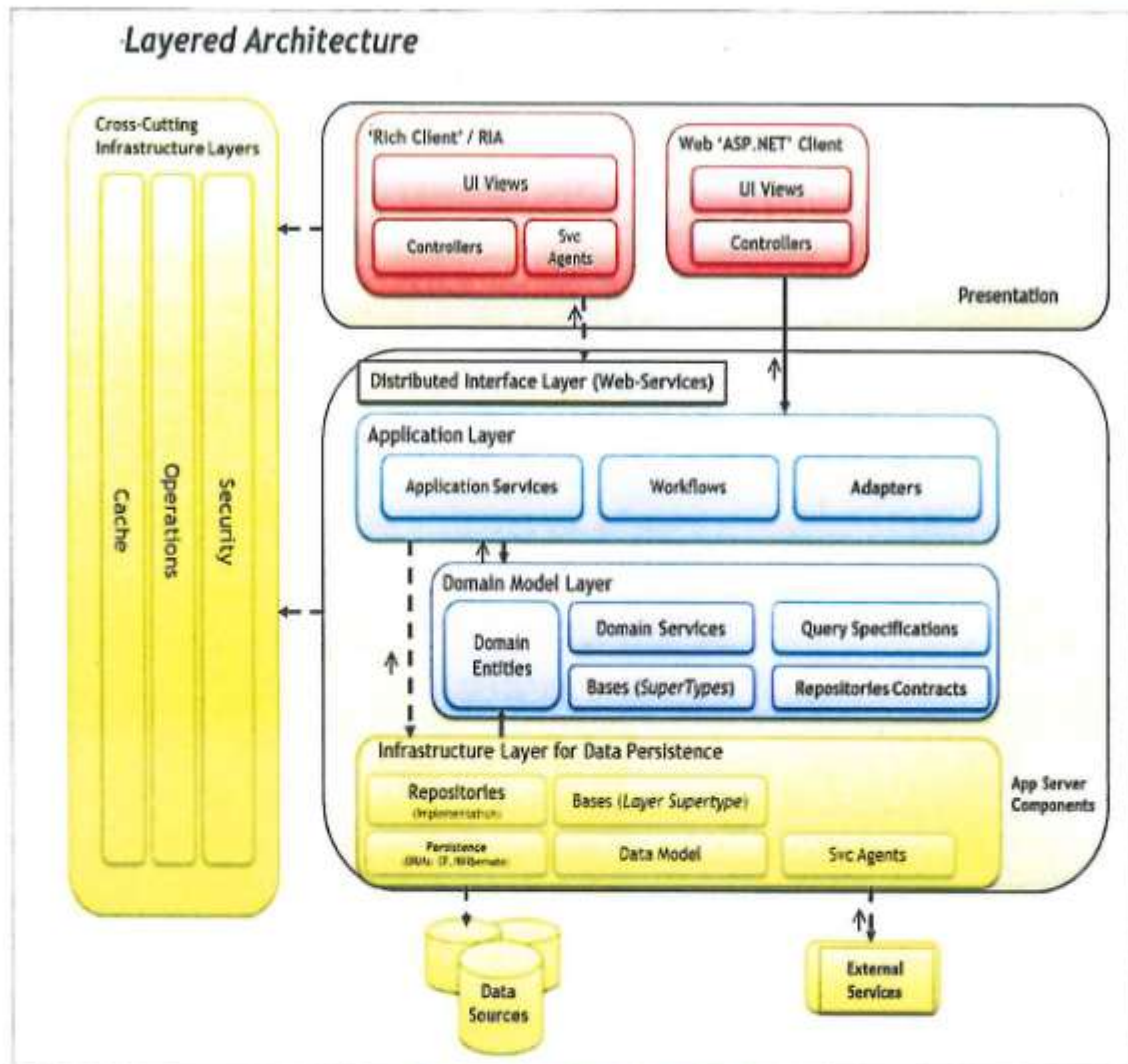
Figure 4:6 – Core Architecture

4.7.3.2   Web Application Layer

The Web application layer cluster will be configured to use either application level or physical load balancer to handle the scalability. It also supports the windows load balancing solution.

4.7.3.3   Session Management

Following key features are available:

- Stores session state as a single blog or as an individual item

- Supports concurrent access to the same set of session states for multiple readers and a single writer

- High throughput for scalable session management

4.7.3.4   *Application Server Layer*

1) The middle tier will be configured as part of business service layers. The service layers will be deployed either as web services or native windows services based on the interface type required with other applications.

2) For web services, native solutions will be used for clustering, whereas for background services, virtual clustering will be adopted.

3) The HTMS solution has the following key business services:

Key Business Services	Description
MAPS	EFKON GIS service for providing data using the set of inputs and doing the reverse geocoding to get the true location
ESVAS	EFKON validation service
ESCORE	EFKON core business service for generic operations
ESPRIV	EFKON privilege management service
ESGM	EFKON General options management service
ESIM	EFKON incident management service
ESNMS	EFKON notification service (This manages both auto mailing and SMS)
ESBULK	The service manages all bulk file pre-processing and validations before saving them for background processing

Key Background Managers	Description
EABULK	EFKON Bulk Posting Agent that allows the processing of events and incidents that can be posted in bulk using an EFKON Defined template
EACLEAN	Manages all the scheduled file-level and database level housekeeping
EAMAP	Manages any post-processing of probe data for reverse geocoding and manages all bulk processing
EAGM	EFKON general Manager agent manages the following: • Scheduled diagnostics • Auto acknowledgment of events and incidents if configured • Any file transfer load can be attached

4.7.3.5   *Operational Modes*

1) The system allows authorized users to perform operations by enabling them to work on different modes. Accordingly, suitable processes will be executed.

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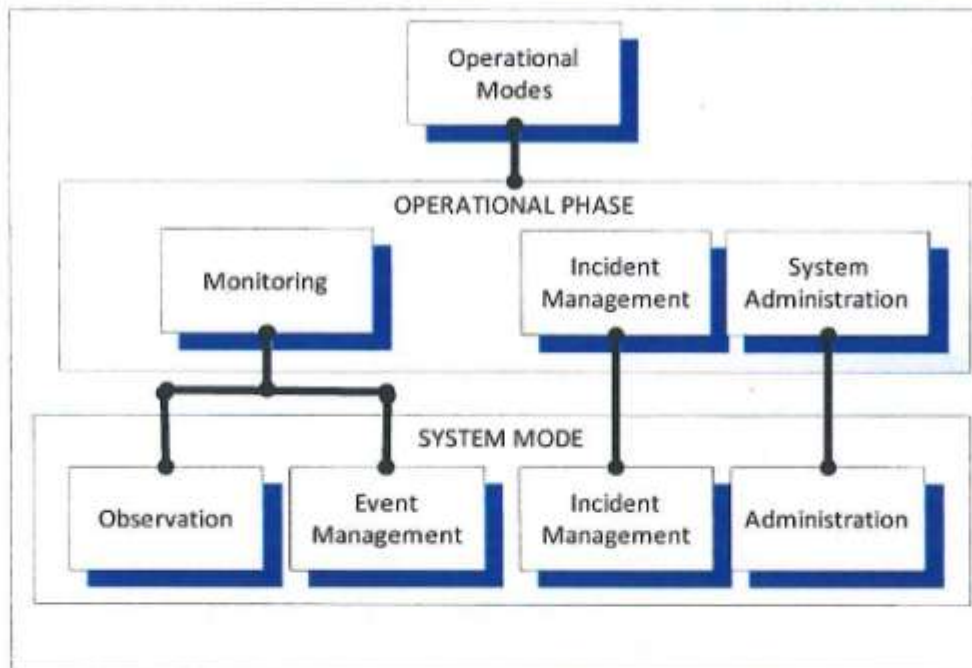
Figure 4:7 – Operational System Hierarchy

2) As shown in Figure 4:7, the operational modes of the system are configured in the operational phase.

3) The operations are performed in the following three phases:

   a) Monitoring

   b) Incident Management

   c) System Administration

4) In the system mode, the system can perform in:

   a) Observation Mode/ Expressway traffic monitoring

   b) Event Management Mode

   c) Incident Management Mode

   d) Administration Mode

5) There is a direct relationship between the Operational phase and the System mode.

4.7.4 Monitoring Module

1) The module supports effective traffic monitoring including the display of the road on the video wall & HTMS workstations. It also displays Graphic User interfaces and locations of all HTMS field devices on a map interface with the display of the current information (e.g., CCTV video Images, VMS messages) relevant to the field device on the selection of the device with a mouse.

2) The module displays the events acquired by the system (Traffic-related, and system-related) on a window at the bottom of the graphic display. The system provides a feature for the user to acknowledge such events and the subsequent display of the same.

3) In addition to the above, the module also displays the related event (e.g., a road-side emergency helpline call, VIDS event) on the map using suitable icons.

4.7.4.1 Observation Mode

1) Observation Mode is the default mode on the traffic manager console. The default View of Observation Mode will display the following:

   a) Map area with equipment HTMS field assets)

   b) Data acquisition window (Data Acquisition Module is integrated for acquiring data & video streams from field equipment)

      i) It can be configured to show other information like traffic summary data, incident summary data

      ii) The data acquisition enables the acquiring of data from the various field equipment in the form of data strings, video streams, and audio streams (e.g., Data string from VID system, VASS System, Video Streams from CCTV Camera, VIDS Camera, Audio Streams related to conversations on the helpline emergency Telephone, via emergency call box

      iii) The module allows the user to configure the acquisition conditions as follows:

         (1) At regular intervals of time with the interval being user

         (2) On the occurrence of Traffic-related events in the field (e.g., data from the VID system, instances of calls from Emergency helpline numbers and emergency call boxes)

         (3) On-demand (e.g., Video stream from a Camera)

         (4) On the occurrence of the system-related events like equipment failure & restoration, user login/logout.

      iv) The above-acquired information will be stored in the CCC server using an established database package.

2) The screen is suitably organized to show data from different equipment on the field. The display type is both textual information (Data Acquisition Values) and visual information (E.g., CCTV). Each video can be zoomed in or zoomed out depending on operational requirements.

3) The map contains the following layers on MAP at a particular zoom level:

   a) Emergency Call Box (ECB)

   b) CCTV camera for traffic (CCTV T)

003914

c) CCTV camera for security (CCTV-S)

d) Video Incident Detection System (VIDS)

e) Automatic Traffic Counters-cum-classifier (ATCC)

f) Meteorological Data System (MET)

g) Variable Message Sign (VMS)

h) Vehicle Actuated Speed Warning System (VASS)

4) The user can view detailed information by clicking on any one of the sub-systems in observation mode. The live streams coming from different cameras can be dragged and resized in operational mode.

5) The application supports a layered display of desired equipment, and all equipment can be seen on a single display.
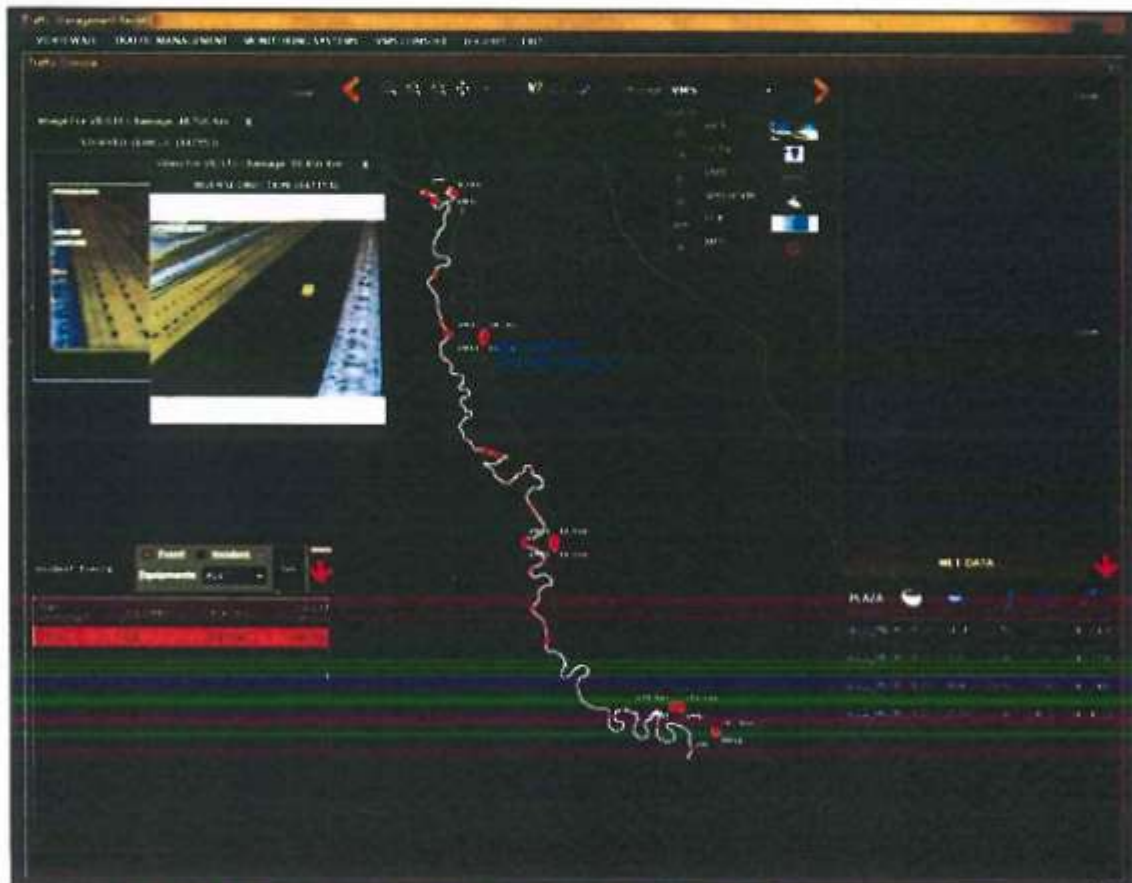
Figure 4:8 – Indicative Screen of Observation Mode with Selected Video Feeds

6) The WYSIWIG interactions for on-field equipment to the Traffic Manager console are explained below:

a) Common information like equipment ID, description, status, chainage, latitude, and longitude are displayed.

b) For VMS, it renders the exact display as currently appears on the actual VMS on the field. This can also be dragged and resized.

c) When the application is in Observation mode, it is possible to generate incidents and events manually or automatically.

d) On the occurrence of an incident, the system switches itself to either Incident Management Mode or Event Management Mode.

e) This facilitates the operator to focus on the prioritized activity. The activities performed during both Incident Management and Event Management are logged by the system. Such activity logs are viewable in reports.

4.7.4.2　　　　Event Management Mode

1) Event Management allows the operator to perform the necessary actions to close the incident.

Figure 4:9 – EFKON Incident & Event Manager

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2) Using the gathered information, the system allows users to input and register the traffic data/events with location information in the specified management unit.

3) It includes event generation, processing, closure, and escalation (if required) based on the traffic situation.

4.7.4.2.1   *Event Generation*

1) An event gets generated when one of the rules created for event generation is violated.

Figure 4:10 – Indicative Screen of Event Management Mode

2) <u>Automatic event generation:</u>

a) Using the traffic data measured by appropriate field systems in real-time, and live video data from VIDS, the system can detect traffic jam situations automatically by using a user-specified velocity parameter (e.g., Judged as a traffic jam in case of traffic velocity less than 20km).

b) Using the live video data monitored by VIDS in real-time, the system detects an abnormal situation (e.g., car incident) automatically.

c) Using the live video data from VIDS, CCTV, ATCC, and MET data analysis, the system detects traffic violations (e.g., slow-moving traffic, wrong direction driving, traffic congestion, fallen object on the road, etc.) automatically.

d) An event gets generated automatically by the system. There will be a notification at the bottom of the screen. The user can choose to work on any of the events by clicking on the event notification. The application switches itself to Event Management Mode once the user will click on a specific event. This is also denoted with a small single-line display of the event.

3) Manual event registration

After confirming events by the following method, the operator can register events manually:

a) Incident reported by using the emergency call box

b) Incident reported by using helpline number

c) Incident reported by using MRCS

d) Incident found in-cameras viz., CCTV for traffic, CCTV for security, VIDS camera, etc.

4) Priority management of event (Seriousness and Distance)

Based on the pre-defined seriousness of events and the distance between event location and VMS on which this information is displayed, the system has a function to prioritize information to be displayed automatically.

5) The events related to equipment failure/communication link failure (also known as equipment-related alarms) are detected by the Network Management System (performing in the background) and communicated to the CCC server.

6) The system remains in Event Management Mode if the user is working on any specific event. The user can close the single line display at any point in time and the application switches back to Observation mode. If the event is not yet closed, it simply gets reflected in the Event Window with its status.

4.7.4.2.2   Event Processing

1) In Event Management Mode, users can work on individual events and close the same. Some events can be pre-configured to perform specific actions that will be done automatically by the system. In such a case, the event's checklists will be automatically executed leading to event closure. If the event is not pre-configured for automatic processing, the user will have to individually execute the tasks as provided by the checklist for that specific event. There will be an additional feature to choose all events at once and acknowledge them for closure.

2) Event entry and release: The system has the function to associate the location (Up/Down lane), the event type, and the event detection time with the CCTV camera which detects the event. It provides an event management method to register and release traffic events. (E.g.,

003918

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Register and Release events by pull-down operation, specifying the type of event and the number of cameras which detected the event.)

3) Supporting function: In general, the events (e.g., car incidents) are supposed to be released by the operator manually. But to prevent neglecting the release of events, the system has a notification function to ask confirmation of operator for events that keep ongoing after a specified period. (E.g., Alarm is raised for the event which keeps ongoing more than 30 min).

4) Figure 4:11 shows a typical Event Master.

Figure 4:11 – Indicative Screen of Event Master

4.7.5 Incident / Accident Management Module

1) It supports incident/accident management by:

a) Allowing the operator to locate and mark (with a mouse) an accident/incident on the map and initiate the Incident management actions.

b) Displaying a contextual online checklist for the operator to follow in sequence. On the clicking of each item, the checklist will be automatically activated related to the HTMS equipment to aid in the management viz.,

i) seamless audio connection for the operator, via the integrated audio communication unit

ii) automatic pan, tilt, and zoom of the nearby camera to view the accident

iii) Display VMS-wise message edit screen (by interfacing with the VMS module) to create and dispatch messages to VMS boards.

c) Providing a user-programmable facility, for the automatic generation of VMS messages depending on incidents.

2) The Incident management window will show a grid view of each incident along with its status

4.7.5.1   *Incident Management*

Incident Management allows the traffic manager to perform the necessary steps to address and close the Incident. It involves incident generation, processing, closure, and escalation (on a need basis).

4.7.5.2   *Incident Generation*

1) An incident gets generated either automatically or manually. Some of the example incidents are:

     a) Heavy traffic congestion or low visibility

     b) Road user when calls the toll-free helpline number and reports the incident then it is treated as a manual incident.

     c) Further, any event can be converted to an incident as required.

2) When an incident is detected by the system, a popup appears on the traffic manager's console. An entry is added into the incident window with the details of the incident and its status. The user can choose to work on any of the incidents by selecting one of them from the incident window. The application switches itself to incident management mode once the user decides to work on a specific incident.

3) At the same time at the traffic manager console; a notification is displayed at the bottom of the screen.

4) The system remains in Incident Management Mode if the user is working on any specific incident. The user can close the single line display at any point in time and the application switches back to Observation mode. If the incident is not yet closed, it simply gets reflected in the Incident window with its status.

4.7.5.2.1   *Incident Processing*

1) When the application is in Incident Management Mode, the user can work on individual incidents and close the same. Every incident must undergo a verification process. This guides the user in determining whether the incident is valid or invalid.

2) Some incidents can be pre-configured to the over-ride verification process, indicating that they are always valid. The user must individually execute the tasks as provided by the checklist for that specific incident.

3) Once all the checklist action statuses of an incident are closed, the incident also gets marked as "Closed". The different state by which an incident transits during its life cycle is depicted in Figure 4:12.
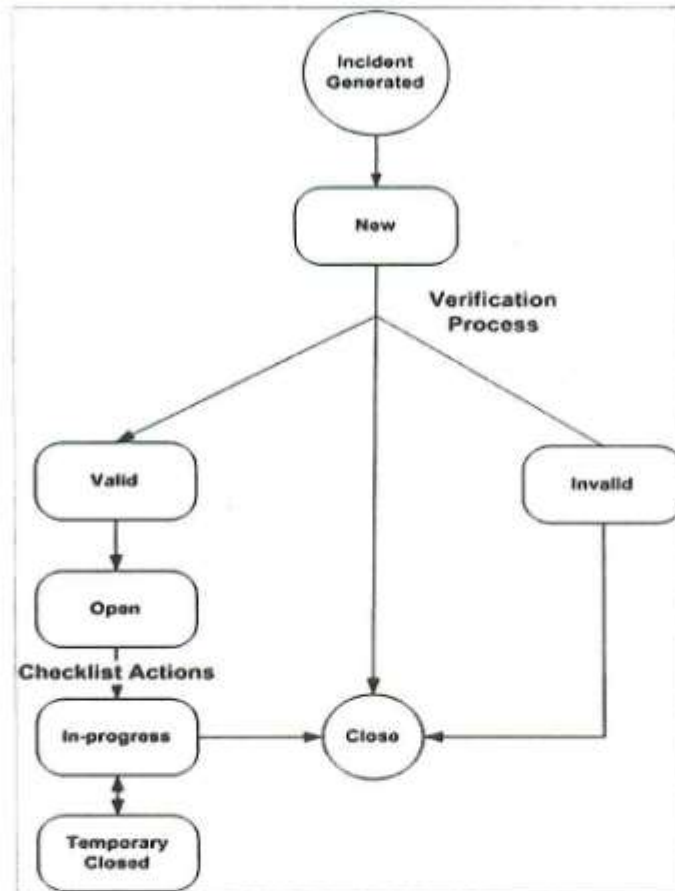
Figure 4:12 – Incident State Flow

4.7.5.2.2   *Incident Configuration Management*

1) Users can change the out-of-the-box configuration to meet the business objectives of the organization.

2) Incident can be customized into:

a) Groups

b) Categories

c) Notifications

d) Fields / Forms

e) Lists

f) Record Management

g) Process and Rules

h) Incident templates

4.7.6   *Report Generation Module*

1) The report module will generate periodic as well as on-demand statistical reports using data received from cameras & sensors for traffic planning and management Accurate forecasting. There is a provision to generate reports to aid planning and strategizing enforcement.

2) The module provides a range of reports on-demand including those,

   a) related to the acquired data

   b) VMS messages edited and sent

   c) Equipment availability,

   d) System-related events including those related to

      i) System malfunction and restoration

      ii) User login – logout

      iii) Incidents detected by VIDS

3) The module provides detailed performance reports on all aspects ranging from detection of incidents, through the field operations team actions, HTMS operators, and other HTMS control center operator actions.

4) The output of the HTMS system in conjunction with the operation that goes on behind the scenes is best captured in reports. The system produces a list of reports that can be effectively used for monitoring, control, and optimization of the systems and processes.

5) Brief about some reports are as follows:

   a) **Equipment Report:** Lists all the different equipment installed on the field along with their status. Equipment type is the main criteria for this report.

   b) **VMS Messages Report:** Lists all the messages that are sent to VMS, along with the message type, priority level, message source, and time stamp. The date is the criteria.

   c) **Incident Report:** This shows a list of incidents that have been generated for the criteria of date, Equipment, Status. It lists information like equipment ID, Incident ID, description, time-stamp, Status, Verification-Overridden: User-handling the incident, Escalation Status, Response time if closed. The report is grouped on Equipment ID and sorted on time-stamp.

   d) **Incident Activity Report:** Shows the activities performed on an incident for the given criteria of a combination of Equipment/Incident ID. It lists information like Incident ID, description, User, List of verifications, Checklist item, Action, Checklist status, status. The report is grouped on Incident ID, description, Incident Status.

   e) **Event Report:** This shows a list of events that have been generated for the given criteria of date, equipment, and status. It lists information like Equipment ID, Event ID, description, timestamp,

003922

status, Manual/Automatic, User, Event Status, Escalation Status, Response time if closed. The report is grouped on Equipment ID and sorted on time-stamp.

f) **Event Activity Report:** Shows the activities performed on an event for the given criteria of Equipment/Event ID combination. It lists information like Event ID, description, User, action-item, action-status, and action-time-stamp.

g) **Incident Escalation Report:** Shows the escalation levels that have happened for incidents based on the criteria of date, the user. It lists information like Equipment, Incident ID, description, Incident Reported On, Incident Escalated on, Escalation handled by, and Incident Status. The report is grouped on user and sorted on time-stamp.

h) **Event Escalation Report:** Shows the escalation levels that have happened for events based on the criteria of date, the user. It lists information like Equipment, Event ID, description, Event Reported On, Event Escalated on, Event handled by, Event status.

i) **Equipment Downtime Report:** This shows the time during which equipment was down and the reason for the given criteria of date and equipment. It lists information like Error code, error description, equipment, downtime, uptime, and fault duration.

j) **The trend of Accident Handling Time:** Shows the list of a specific incident that has been handled over a given duration (3 months) and estimates how better or worse the handling time will be for the next given duration (3 months). It lists information like equipment, Incident description, the average time taken for closure, maximum time taken for closure, minimum taken time for closure, the expected average time that will be taken in the future.

4.7.7 System Administration Module

As per pre-defined privileges, the Administrator can log in to the system. This mode allows the user to access the following activities:

1) **Master Data Management:** The master data of the application gets maintained. The activities include adding and editing existing data. All operations are logged for further auditing purposes.

2) **Technical Maintenance:** The application provides an Observation mode kind of an interface to the user from where one can check on the behavior of the different equipment as traceable on the map. Apart from the information given in the Observation mode, additional information relevant to a maintenance engineer is made available in this interface.

3) **MIS Reports:** The user can generate various reports under the assigned privilege.

4) **Audio/ Video Playback:** For authorized users as per configured privileges, it is possible to playback the videos stored on the video recording storage. The user will be able to browse through the file structure; choose the relevant file for the equipment/date needed and play the recorded video.

4.7.7.1   *Master Data Management*

The Master Data Management module provides some important functionality like Equipment Maintenance, Map data maintenance, Control Data Maintenance, and User Maintenance among other master data maintenance.

4.7.7.2   *Equipment Master*

The Equipment Master Maintenance allows maintaining individual equipment information. The following table shows the list of equipment and the maintenance activities that can be performed:

Equipment	Add	Modify	Status
CCTV Traffic	Allows to add a new CCTV Traffic	Allows to change the existing information	Status checks using SNMP/IP etc.
CCTV Surveillance	Allows to add a new CCTV Surveillance camera	Allows to change the existing information	Status checks using SNMP/IP etc.
VIDS Camera	Allows to add a VIDS camera	Allows to change the existing information	Status Checks using SNMP/IP etc.
VMS	Allows to add a VMS board	Allows to change the existing information	Status Checks using SNMP/IP etc.
ATCC	Allows to add an ATCC sensor	Allows to change the existing information	Status Checks using SNMP/IP etc.
MET	Allows to add a MET	Allows to change the existing information	Status Checks using SNMP/IP etc.
ECB	Allows to add an ECB	Allows to change the existing information	Status Checks using SNMP/IP etc.
VASS	Allows to add a VASS	Allows to change the existing information	Status Checks using SNMP/IP etc.

Table 4:5 – List of Equipment and Maintenance Activities

4.7.7.3   *Control Data Master*

1) Control data are mainly incidents, events, event generation rules, verification lists, checklists, and actions. Users with maintenance mode privileges configure this data. The Traffic Manager utilizes this data while performing Incident and Event Management.

2) Further business rules can be configured from the control data master with defined control limits and thresholds for an automatic incident generation.

3) A sample screen by which rules can be configured in the system is as shown in Figure

Figure 4:13 – Indicative Screen of Rules Generation Window

4.7.7.4 User Master

1) User management creates system users and assigns them roles with the help of FAP (Function Access Profile) and DAP (Data Access Profile).

2) The roles envisaged are Traffic Manager, Operators, Incident Owner, Incident Analyst, Incident Coordinator, and Manager.

3) The application is scalable to create different roles according to the requirement and accordingly assign those privileges to specific users.

4) A sample screen of user creation is shown in Figure 4:14:

Figure 4:14 – Indicative Screen of User Registration Screen

5) Figure 4:14 displays a user creation and updating screen where the operator details are entered such as user name, login id, password, contact details, account activation, and expiry date and role.

6) The system can also accept the finger key which can be used for biometric access to his/her account. The biometric feature is completely configurable to be turned on or off based on the requirements.

4.7.7.5 Role and Privilege Management

4.7.7.5.1 Role Management

1) Role management will provide the users to create customized roles so that the operational person can be categorized based on their work.

2) The admin can also create roles based on their functionality. For example, if an operator is assigned to perform incident management, a role called Incident Analyst can be created which can perform the only incident-related task.

4.7.7.5.2 Privilege Management

4.7.7.5.2.1 Functional Access Profile (FAP)

FAP can be configured at 2 levels:

1) Role FAP

   a) Role FAP allows hierarchical base Role FAP definitions. Admin of a particular role can create FAP for roles below in the hierarchy. Further admin belonging to the respective roles can only grant permissions on features allowed to him by his senior role/class/category/admin while defining new users FAP or role FAP below to his current role hierarchy.

   b) This is a set of menu items available to a particular role for assigning menus to other users.

   c) Each Role can have only one role FAP.

2) User FAP

   a) User FAP allows the admin to grant permissions on features to the roles below to his in the hierarchy.

   b) This is a set of MENU ITEMS available for a user to navigate the website.

   c) Each role can have multiple User FAP's.

4.7.7.5.2.2   Data Access Profile (DAP)

1) Data access profile needs to be created for the security dimensions of the model. If the data access profile is assigned to the role to which the user is assigned, the user has access to only that model/data.

2) If we partially define access, for example for one of the two secured dimensions, users access only that part of the model.

4.7.7.5.3   *Technical Maintenance Suite*

1) The technical maintenance suite comprises a screen that will allow the user to click on any of the equipment on the map and their relevant data gets shown. In addition to the data that gets shown during the Observation mode, additional maintenance-related data gets shown in the Maintenance mode.

2) All equipment compulsorily shows connectivity information in maintenance mode. Also, they show important technical parameters of all equipment of various subsystems along with various diagnostics.

4.7.7.6   *Notification and Alert Management*

1) Alerts automatically notify users about a serious problem or condition that requires a quick resolution to ensure that the production continues operating normally.

2) When properly configured the system generates alerts for potentially serious problems and should not generate any alerts caused by normal variations in the production performance.

3) Efkon alert management framework notifies users about alerts, escalates unresolved alerts, and documents the current state and history of actions taken to resolve the alert.

4.8   Network Monitoring System

1) A Network Monitoring System (NMS) will be provided to monitor the operation of facilities on the expressway. It consolidates the monitoring function to present the system status concisely to the operator and keep the record of system operation. In case any abnormality or malfunction is detected, the system will issue an alarm together with the information regarding the type and location of the trouble to provide the required support.

2) A centralized solution will be implemented to monitor all the components of all the locations. A centralized dashboard will be created to ease monitoring the status of the devices. It continuously monitors the network for failures and errors. A network analyzer ensures that the network connecting various sub-systems is functioning properly. It provides a central view of network traffic along with

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TECHNICAL PROPOSAL –
HIGHWAY TRAFFIC
MANAGEMENT SYSTEM

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003927

advanced alerting and reporting capabilities that provide superior awareness for the entire network. It has an extensible plug-in interface for monitoring user-defined services.

3) The system is designed for monitoring, maintaining, and optimizing a network. It includes both hardware and software. It monitors the fault & performance management of the server-side infrastructure, IP\SNMP enabled devices like Routers, Switches, Sensors, etc.
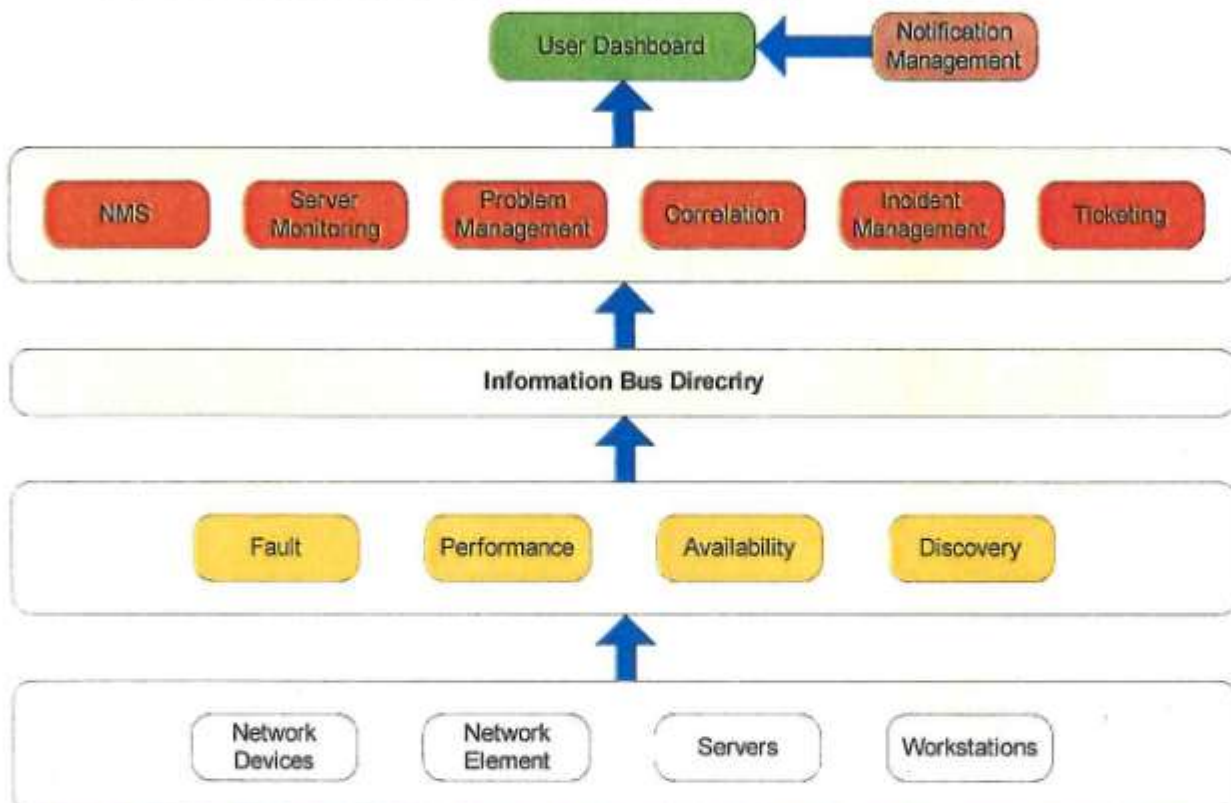
Figure 4:15 – Indicative Architecture of Facility Monitoring System (Network Monitoring System (NMS))

4) The network management systems provide multiple services viz.

a) Network monitoring - NMS software monitors network hardware to ensure all devices are operating correctly and are not near or at full capacity. The alert will be generated & sent to the central monitoring system to notify the operator about the detected problem.

b) Device detection - When a new device is connected to the network, the NMS detects it so that it can be recognized, configured, and added to the network.

c) Performance analysis - An NMS can gauge the current and historical performance of a network. This includes the overall performance of the network as well as individual devices and connections. For example, the NMS may detect aspects of a network where throughput is nearing the maximum bandwidth available. The data can be used to optimize the flow of traffic and recommend the addition of new hardware if needed.

d) Fault management - If a device or section of a network fails, an NMS automatically reroutes traffic to limit downtime. This will be performed on the fly or accomplished using a set of pre-configured rules. When a fault occurs, a network alert or notification is usually sent to one or more network administrators.

5) The Facility Monitoring System (Network Monitoring System (NMS)) will handle the following activities:

a) Fault, notification & alarm management for the network & devices

b) Event management, event & condition-based correlation

c) SLA & availability Monitoring

d) Performance management

e) RCA & Business impact analysis

f) User-specific dashboard & custom reports

g) Monitor servers

h) Predictive performance monitoring

i) Auto-calculate resource utilization baselines for the entire managed systems and networks

j) Fault management to isolate and correct malfunctions in a network, compensate for environmental changes and include maintaining and examining error logs, accepting, and acting on error detection notifications, tracing and identifying faults, carrying out sequences of diagnostics tests, correcting faults, reporting error conditions, and localizing and tracing faults by examining and manipulating database information.

4.9 VMS Module

4.9.1 VMS Application

1) The VMS message boards are used to display the information to road users. The VMS application is used to configure these messages & to provide information about the current message or scenario running on the VMS board to the operator.

2) The following sections will provide some sample screens of the VMS application.

4.9.1.1 Manually Created Message

The VMS application is used to compose the messages to be displayed on the VMS board.

Figure 4:16 – Indicative Screen of VMS Application to Compose Message

4.9.1.2 VMS Predefined Messages

In the system, some pre-defined messages are configured. The VMS application user can select the message from the list of pre-defined messages to be displayed on the selected VMS board.

Figure 4:17 – Indicative Screen of VMS Application to Select Pre-defined Messages

4.9.1.3 Live Messages

The user can retrieve the live messages displayed on the selected VMS board.

Figure 4:18 – Indicative Screen of VMS Application to Retrieve Live Messages

4.10   VIDS Module

The VIDS application is provided to view the log of incidents detected by the VIDS System. The VIDS application operator can validate the alert generated due to the detection of the incident by the VIDS system.

Figure 4:19 – Indicative Screen of VIDS Application to Validate the Alert

4.11   Graphic Display and Dashboard

1)   The graphic display displays the dashboard for the following components of the ATMS solution.

   a)   Map of the stretch

b) Status of each equipment plotted on the Map

c) CCTV Camera live video streaming

d) Traffic condition, count, and classification

e) Traffic event using image icon (type and location)

f) Emergency call status

g) Information provision by VMS

h) Mobile App pop-ups

2) The graphic display will be configured to display multiple sources in one window and can specify time intervals and sequences. The software provides the option to split the entire display into multiple sections and layouts. The operator can define multiple layouts that can be launched based on schedule or sequence as defined by the operator or control room Manager.

3) The display system has two display modes viz. integrated mode and isolated mode. In integrated mode, the video image from a single source is shown on a complete graphic display, while in isolated mode, each unit displays a video image from different sources independently.

Figure 4:20 – Indicative Screen of Video Wall GUI (Notification Windows)

Figure 4:21 – Indicative Screen of Video Wall GUI (CCTV Video Screens)

4.12 Third-Party Software

1) EFKON proposes the following third-party programs which will be used for the application of an Advanced traffic management system in terms of functions, capacity, speed, and interface with other software, maintenance, and user-friendliness.

2) The third-party COTS software includes the following:

   a) Server operating system

   b) Client operating system

   c) Database management software

   d) Microsoft Office Pro 2016 or latest license for all workstations

Sr. No.	Application	Use
1)	Server operating system	The Windows-based or Linux-based server operating system will be installed on servers as per application requirements.
2)	Client operating system	The Windows-based or Linux-based client operating system will be installed on workstations as per application requirements.
3)	Database management software	1) MySQL is a relational database management system to store and retrieve data as requested by other software applications which may run either on the same computer or on another computer across a network (including the Internet).

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Sr. No.	Application	Use
		2) MySQL database software will be provided as a part of the various application solutions requirement.
		3) A centralized database will be implemented & monitored through the NMS solution. Backup & retention policies are configurable. It is a part of the utility software for system backup and restoration, database backup and restoration, and access control and operation log functions. Usage of the server and workstations will be controlled by login/out procedure and different levels of access control will be provided to restrict the use of certain software by unauthorized persons. All operations will be recorded as logs together with a staff identification number.
4)	Microsoft Office Pro 2016 or latest license for all workstations	The latest Microsoft Office software will be installed on the workstations for document management.

4.13   Technical Specifications

The proposed technical specifications for equipment will be as per the "1.2 Division 5A ITS Part-2 -27.08.21".

STRABAG	TECHNICAL PROPOSAL – HIGHWAY TRAFFIC MANAGEMENT SYSTEM	एम एम आर डी ए MMRDA

5 Emergency Call Box (ECB) System

5.1 Introduction

ECB system provides a communication tool for the MTHL users in case of emergency. Any call made from an ECB will be received in a centralized manner by the operator at the ECB workstation in the command control center. The system will operate on a 24-hour a day 7-day a week basis.

ECB will have a good sound quality under the noisy condition on the MTHL.

5.2 System Component

The ECB system will consist of the following components:

1) ECB at roadside
2) CCC server
3) ECB workstation at the command control center
4) Network equipment

5.3 System Architecture
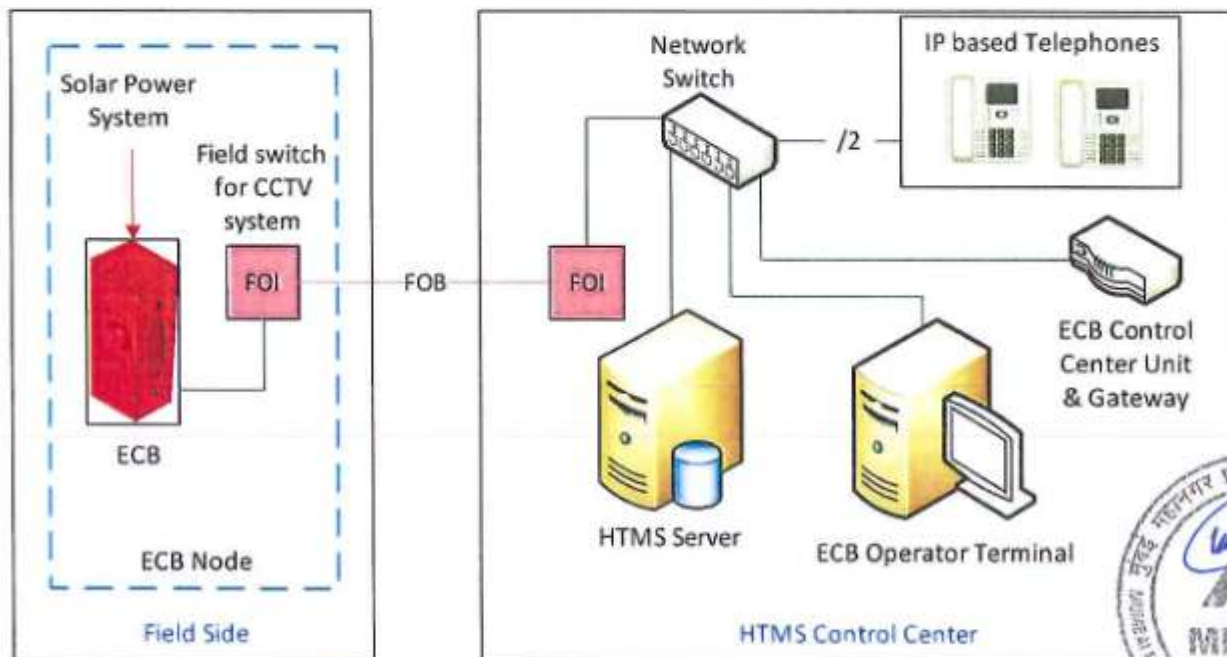
Figure 5:1 – Indicative Interconnection of ECB System

1) ECB is a hand-free type with a microphone, a speaker, and an electrically mechanically robust push button housed together with the power supply, network equipment & terminal board in the cabinet. The cabinet is made of mild steel with an ergonomic design. The SOS symbol or telephone symbol will

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be displayed prominently on the cabinet. The part of the cabinet will be provided with a reflective sheet for easy identification during dark hours.

2) The ECB will be installed at layby locations. The ECB will be installed on either the outside parapet (wall) of the bridge or outside of the guardrail at the earth section. At the guardrail section, the ECB will be installed in such a way that the caller faces the incoming traffic.

3) The standard installation along with the outline dimension of the cabinet & component layout drawing of the emergency call box system is as follows:
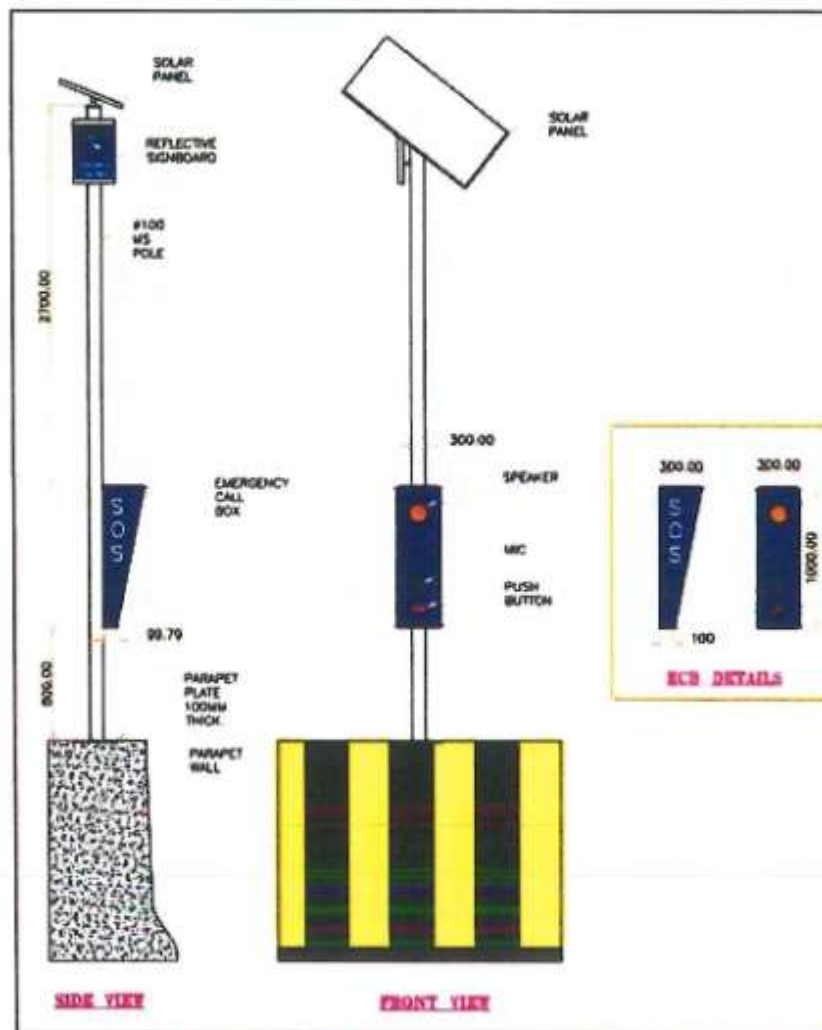
Figure 5:2 – Indicative Installation Drawing Of ECB on Parapet Wall

4) To protect ECB enclosures against rusting due to salt-prone corrosive weather, Dry film corrosion protection treatment will be applied.

5) The guide sign indicates the command control center helpline number & chainage location at 1Km interval. The. guide sign will be made of engineering grade reflective sheet attached to an aluminum plate having the dimension of approximately 1200 mm x 600 mm.

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TECHNICAL PROPOSAL –
HIGHWAY TRAFFIC
MANAGEMENT SYSTEM

एम एम आर डी ए
MMRDA

6) A 3-dimensional view of ECB installation is shown in the image below:
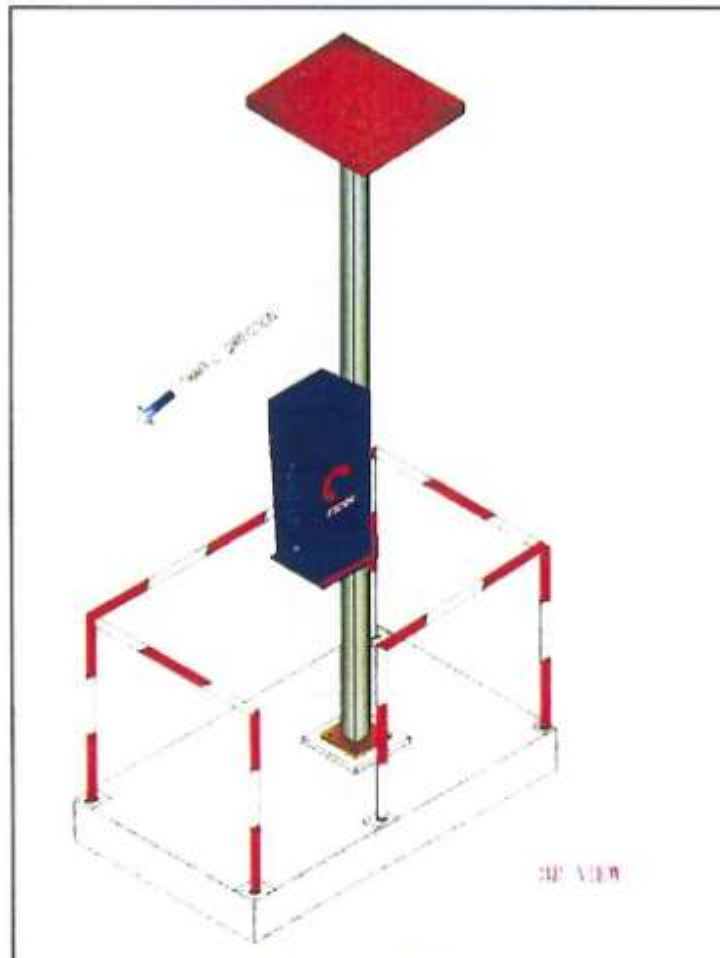
Figure 5:3 – Indicative 3 Dimensional ECB Installation at Ground Level

5.4   System Function

1) A dedicated workstation will be provided at the CCC for handling all incoming calls. IP-based network equipment will be provided to connect the ECB at the roadside with the ECB workstation at CCC.

2) ECB workstation will show the schematic map of MTHL with the location of ECB on the display. The status of each ECB will be indicated in different colours.

3) The following ECB status will be indicated in different colours or flashing:

a) Standby

b) Calling

c) Connected

d) On-hold

e) Transferred

f) Out of order

4) ECB system will be provided with the functions as described below:

	TECHNICAL PROPOSAL – HIGHWAY TRAFFIC MANAGEMENT SYSTEM	एम एम आर डी ए MMRDA
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a) **Call reception function**

    i) ECB users can place a call using the CALL button provided on ECB. It initiates a call to CCC using a communication network. Upon reception of a calling signal, the ECB workstation will issue an alarm on the monitor display of the ECB workstation.

    ii) The monitor display will show the schematic map of the MTHL. The calling ECB will be indicated by a flashing ECB symbol on the map. At the same time, the video wall will show the incoming call by flickering the ECB symbol at the location of calling ECB on the schematic map of the MTHL.

    iii) The call will be connected to the ECB workstation operator's telephone. The communication link will be established by the operator by clicking the calling ECB symbol on the monitor display. The status on the monitor display will change to the connected status. The communication will be two-way.

    iv) Upon termination of a call, the operator will press the END button or click the ECB being connected on the monitor display, upon which the connection will be released. No action will be required for the caller at the roadside to terminate the call.

    v) The ECB system will be capable of handling multiple calls at a time. This will be realized by holding the calls not being attended and re-connecting the call being on hold. The ECB system is capable of handling a maximum of eight calls simultaneously. Received calls are sequentially transferred to the ECB operator. The incoming calls are indicated on the ECB workstation GUI. Any ECB operator can then keep on hold the current call and pick up the next call by clicking on the incoming call. Call on Hold is added to the hold list on ECB workstation GUI. The operator can go back to hold the call also, by clicking on the hold call list.

    vi) ECB Central control unit can create a separate TCP/IP socket for each call. Based on the same, multiple calls can be managed. A separate process running on ECB central control unit manages the transfer of calls to individual ECB workstations. It carries out call connect, holds, re-connect, transfer and call termination activities.

b) **Call transfer**

    i) It is possible to call being received to another ECB receiving telephone installed at the maintenance office, traffic police, ambulance station, and other designated telephones including the landline telephone and mobile phones.

    ii) A maximum of 20 telephone numbers can be designated as ECB receiving telephone. A separate voice gateway is used for this purpose. ECB operators can also monitor calls already transferred to other telephones.

    iii) The monitor display will indicate whether the call is connected or terminated.

c) **Caller location identification**

    i)   ECB Workstation displays caller location on GUI using a combination of IP address and unique equipment site identification number.

    ii)   ECB or the network equipment connected to the ECB will send an ID signal when a call is initiated. The ECB workstation will identify the location of the calling ECB and indicate it on the monitor display in the form of kilo-post and direction.

d) Call recording

    i)   The conversation of all calls including the call transferred to other telephones will be automatically recorded with a timestamp. It will be possible to assign a type of call for each record and search the recorded messages with the type of call, date, and location.

    ii)   All calls received at CCC are recorded, including calls transferred to other telephones with the date and timestamp. Each call message is stored with system generated unique ID, which can be used for message retrieval. It is possible to playback recorded messages and/or search messages with the type of call, date, and location.

e) Call history

    i)   ECB system can display call history list in chronological order together with location of call on ECB workstation monitor and video wall.

f) Call termination

    i)   ECB workstation operator can terminate the call by pressing the "END" button on GUI and the communication link is then released by ECB central control unit.

g) Diagnosis

    i)   ECB central control unit continuously monitors ECB unit status by polling the unit every 5 minutes. On receiving the poll signal, the ECB unit reverts along with ECB status. ECB central control unit then updates ECB status in CCC accordingly.

    ii)   Following types of error and malfunction of the ECB system can be diagnosed from the ECB workstation:

       (1) Low battery voltage

       (2) No communication

       (3) Door status

       (4) Solar vandalism

       (5) Tempering alarm

5.5   Technical Specifications

The proposed technical specifications for equipment will be as per the "1.2 Division 5A ITS Part-2 -27.08.21".

STRABAG	TECHNICAL PROPOSAL – HIGHWAY TRAFFIC MANAGEMENT SYSTEM	एम एम आर डी ए **MMRDA**

6 Closed Circuit Television (CCTV) System

6.1 Introduction

1) The CCTV camera system will be deployed as a part of this project to monitor various parts of the stretch and buildings as per the employer's requirements.

2) In principle, there will be three types of CCTV camera

   a) CCTV camera for traffic surveillance along MTHL

   b) CCTV camera for security surveillance under the bridge along MTHL

   c) CCTV camera for security surveillance at the toll plaza, toll office area, and other locations.

3) Images taken by the cameras will be transmitted to the command control center in real-time using a data communication system installed along MTHL.

4) In the center, images are selectively shown on the monitor display of the CCTV workstation and the video wall. At the same time, images from all cameras will be recorded on the storage device.

5) The IP-based CCTV camera system will operate on a 24-hour a day 7-day a week basis.

6.2 System Component

The CCTV system will consist of the following components;

1) CCTV camera with controller installed along the MTHL and toll plaza area;

2) Command control center CCTV server

3) CCTV workstation with camera control keyboard at the command control center;

4) Video wall at the command control center

5) Network equipment.

6.3   System Architecture
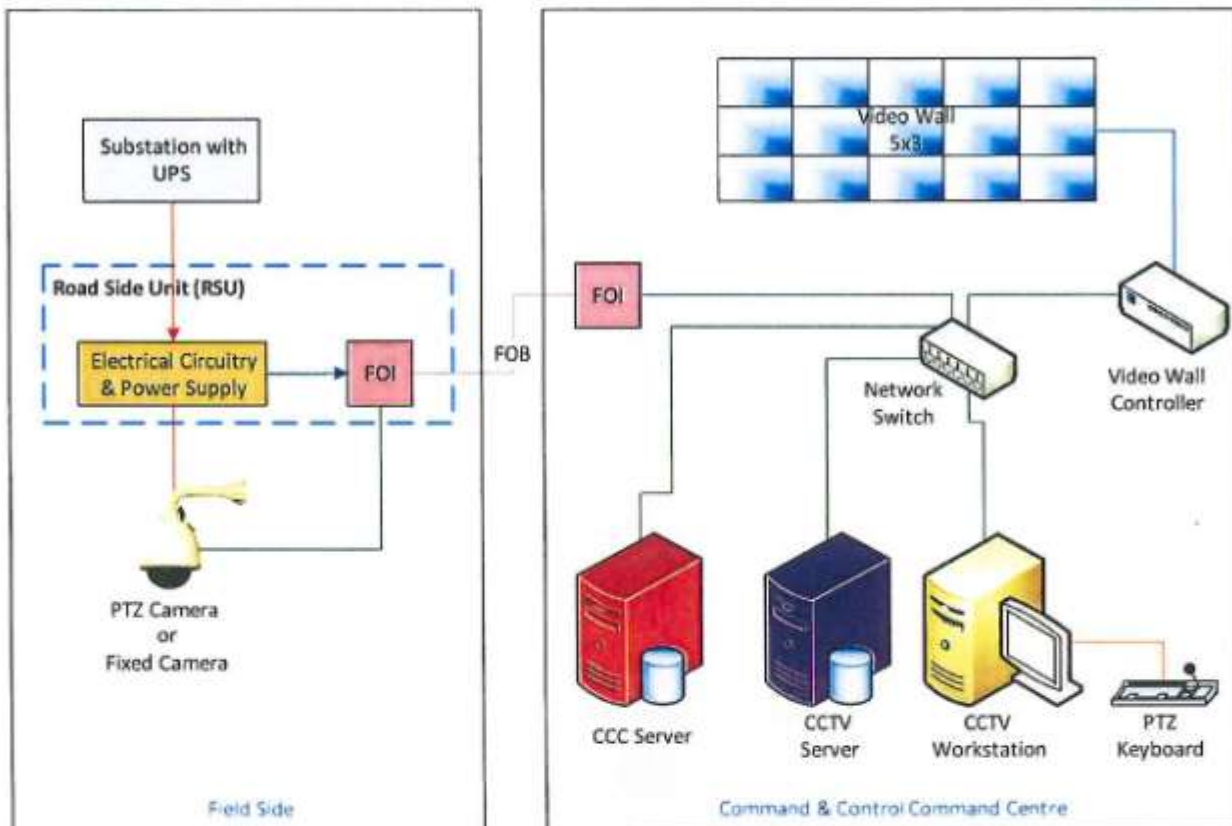
Figure 6:1 – Indicative Interconnection Diagram of CCTV System

1) An indicative interconnection diagram of CCTV system components is shown in the figure above. It shows the interfacing of one camera with the system. The type of camera can change between Fixed or PTZ camera, but the connection will be similar. CCTV camera will be installed as per the following guidelines:

Type	Location	Remarks
Traffic surveillance	Every 333 meters on both sides for the entire section	With PTZ functions
Security surveillance(bridge)	Every 1 km on both LHS and RHSof MTHL	Fixed camera
Security surveillance(toll plaza area)	Toll plaza area	Fixed camera

Table 6:1 – Locations of CCTV cameras

2) Traffic surveillance cameras will be installed either on the gantry for variable message signs or on a pole to be supplied under the Contract. In both cases, clearance of 6 meters will be secured under the installation for the passage of vehicles.

3) Security surveillance cameras under the bridge will be attached to the girder with suitably designed camera mounting brackets.

4) Security surveillance cameras will be installed either on a pole for the camera or attached to the toll plaza building walls.

6.4 System Function

Major CCTV system functions are described in the section below.

1) Monitoring function

   a) The road, traffic, and security videos were taken by CCTV cameras on the MTHL will be transmitted to the CCTV workstation at the command control center. The digital data communication network will be used to transfer this video feed from field cameras to the workstation. CCTV workstation will be capable of selecting and displaying video from any CCTV camera on the connected monitor and/or any of the attached video wall screens.

   b) CCTV workstations will be capable of displaying video from multiple cameras in a sequential manner. This sequence of cameras as well as the interval between the two camera videos can be set from the CCTV workstation.

   c) CCTV workstation will be capable of connecting 2 monitors, which if connected, can display either one image or multiple images at a time. Images on the video wall will be controlled by the CCTV workstation. On the video wall, It will possible to show the image from one camera on one monitor or can be scaled to occupy multiple monitors for a zoomed-in view.

2) PTZ control function

   Each PTZ capable CCTV camera supplied and installed, will be selectable from the workstation to obtain its live view and control its pan, tilt, and zoom functions. Each camera will have a pre-set position of pan, tilt & zoom level set to return to when PTZ control from the CCTV workstation is released.

3) Image recording and retrieval

   a) Each camera installed will have a camera ID and time stamp overlapped on the video feed. All video images from cameras will be recorded automatically in the storage device of the server along with their respective camera ID and time stamp. The frame rate of the video signal will be set to <u>one frame per minute</u> to reduce the requirements for the storage capacity required.

   b) Under this project, it is provisioned to store all images for a minimum of 1 year before taking them back up.

4) Diagnosis

   To keep tabs on the equipment health, the CCTV workstation will ping all cameras installed at a pre-set interval or every 5 minutes in a round-robin fashion. If any camera installed does not respond to the ping within the stipulated time, the workstation will display an alarm and record the fault in a log. Various CCTV Errors or malfunctions which can be diagnosed include:

STRABAG	TECHNICAL PROPOSAL – HIGHWAY TRAFFIC MANAGEMENT SYSTEM	एम एम आर डी ए MMRDA

a) Video tampering detection

b) Intrusion detection

c) Line crossing detection

d) Region entrance & exiting detection

e) Object removal detection

f) Unattended baggage detection

g) Exception detection

6.5 Technical Specifications

The proposed technical specifications for equipment will be as per the "1.2 Division 5A ITS Part-2 -27.08.21".

7 Video Incident Detection System (VIDS)

7.1 Introduction

1) The Video Incident Detection System (VIDS) is capable of monitoring the intended locations on the project stretch. The system automatically detects pre-defined types of incidences and reports them to the control room workstation, so that necessary actions can be taken.

2) VIDS will be installed at every 333 Mtr interval in both directions of MTHL. Images taken by the VIDS camera will be transmitted to the Command Control Centre (CCC) through Optic Fiber cable on a near real-time basis.

3) In the CCC, images are selectively shown on the monitor display of the VIDS workstation. If an incident occurs within the coverage area of the camera, the operator will be able to control the VIDS camera remotely and check the status visually. At the same time, images from all cameras will be recorded on the storage device for the specified period.

7.2 System component

The VIDS system will consist of the following components:

1) VIDS camera and LPU at the roadside

2) VIDS server at Command Control Centre

3) Network equipment

STRABAG	TECHNICAL PROPOSAL – HIGHWAY TRAFFIC MANAGEMENT SYSTEM	एम एम आर डी ए MMRDA

7.3 System Architecture

An indicative interface diagram of one VIDS camera with a control center is shown in the figure below.
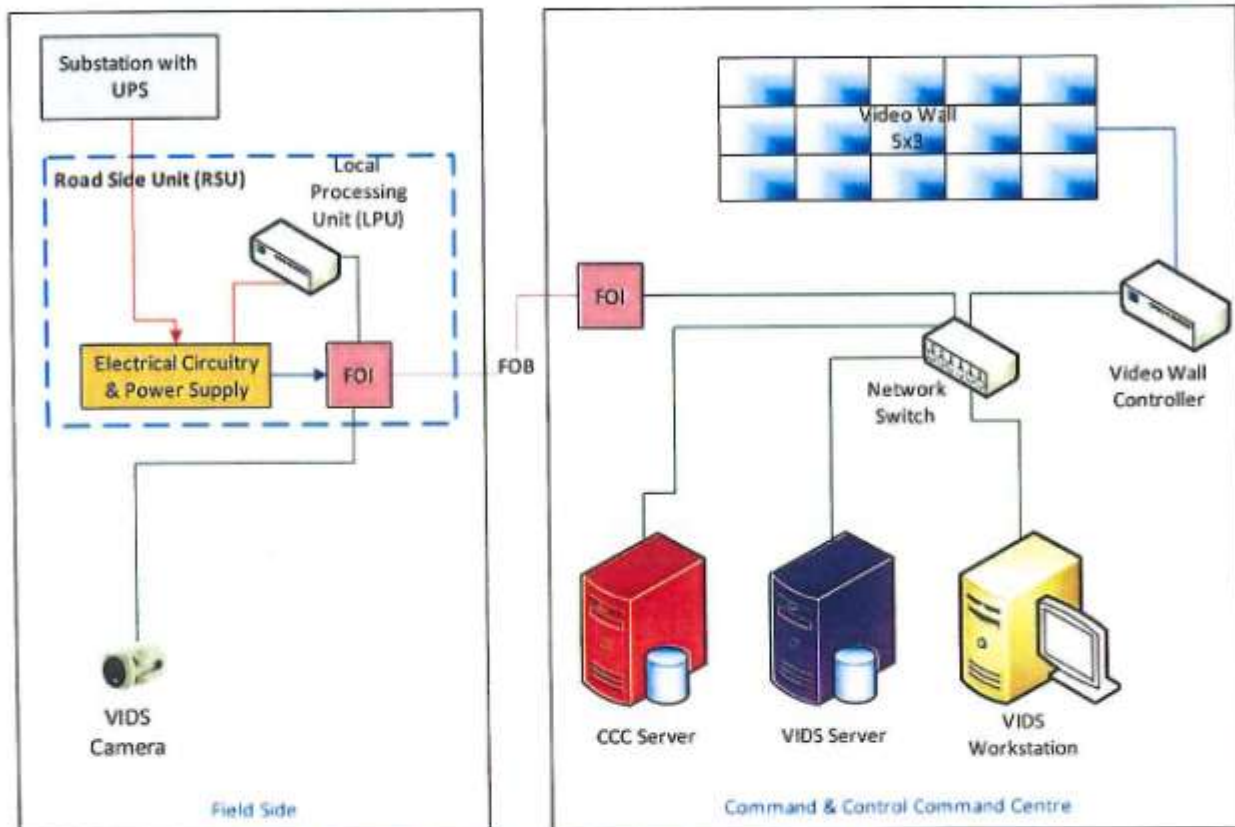
Figure 7:1 – Indicative Interconnection of Video Incident Detection System

1) For Effective traffic management on highways video incident detection system plays an important role with the help of fast video detection, verification, and resolution. The VIDS will be installed at a suitable location from the connecting/merging road to monitor the sectional traffic volume on the main carriageway.

2) For the functioning of the video incidence detection system, bullet or box cameras will be deployed at selected locations on the stretch. Cameras for VIDS will be mounted on poles for the CCTV system with the help of pole mounting brackets specifically designed for selected cameras.

3) Cameras will be connected to the local network switch on the field using CAT 6 cables for data communication. Field network switch will connect to the control room network equipment over a fiber optic interface.

4) The Road Side Unit (RSU) is provided to enclose the local processing unit, fiber optic interface/ network switch, SMPS, MCBs, terminal blocks required for connection with the equipment only.

5) Power the equipment is provided through power conditioning equipment and UPS situated in the control room.

7.4   System Function

1) The VIDS system have an incident detection function to automatically detect incident that occurred within its viewing area when the camera is set at home position. The VIDS system is capable of detecting the following incidences:

   a) Slow-moving vehicle

   b) stopped vehicle

   c) Vehicle running in the opposite direction

   d) Congestion

   e) Pedestrian movement on MTHL

   f) The fallen object on the road

   g) Poor visibility

2) Upon detection of incidents, the HTMS Software will issue an alarm to the CCC, and the incident image will be automatically displayed on the VIDS operator console monitor & video wall. The GIS map also displayed on the graphic display shows the location of the incident with a red dot.

3) The video and images taken by VIDS cameras on the project will be transmitted to the CCC through the communication network. The sequential display function allows the video image from the multiple cameras to be sequentially displayed at a pre-set interval.

4) It is possible to select the cameras for sequential display and to set the display time of the image from each camera. The VIDS console and graphics display will have multiple screen capability and will display either one image or four images at a time.

5) The VIDS system has a diagnosis function to check the connection of the VIDS camera by sending the diagnosis signal every five (5) minutes. If the VIDS camera fault signal is received or there is no response from the VIDS camera, the HTMS Software will issue an alarm on the Graphics display and operator console. The fault will also be recorded in the log.

6) Following types of errors & malfunctions of the VIDS system will be diagnosed from the software. These will be captured in the LPU and transmitted to central application:

   a) Connectivity failure between field and server

   b) Connectivity failure between camera and LPU

   c) Logs when camera settings are changed

   d) Watchdog to monitor applications

   e) Alerts when camera view gets tampered

7) VIDS system follows the following incident detection mechanism:

STRABAG	TECHNICAL PROPOSAL – HIGHWAY TRAFFIC MANAGEMENT SYSTEM	एम एम आर डी ए MMRDA

Cameras are aligned at the field as per the desirable Field of View (FOV)

Zones are created within the FOV, and relevant incidents are tagged to it. Rules like elapsed time or object type & size are configured along with.

The LPU processes the video stream continuously and tracks and identify the objects (vehicle, person, animal and things)

The incident gets visible on central dashboard. If required, video can be fetched from VMS.

Incident image is captured and sent to the control room along with metadata (xml files)

As per the rules defined, the LPU application takes cognizance of the objects and classify them as incidents.

The incident can be acted upon as per the defined SOP

Post action, the incident gets archived for the defined time period.

Figure 7:2 – Incident Detection Mechanism of VIDS System

7.5 Technical Specifications

The proposed technical specifications for equipment will be as per the "1.2 Division 5A ITS Part-2 -27.08.21".

8   Automatic traffic counters-cum-classifier (ATCC) System

8.1   Introduction

1) The Automatic Traffic Count & Classification (ATCC) system will detect, count, and classify vehicles within its sensing area set on the main carriageway. The traffic flow parameters measured by the ATCC will be transmitted to the ITS workstation in the command control center. The system will operate on a 24-hour a day 7-day a week basis.

2) If an abnormal traffic flow parameter is observed at a lane or a section by the automatic traffic counter-cum-classifier, an alarm shall be issued and displayed on the ITS workstation for the operator's attention and appropriate action.

8.2   System Component

The ATCC system will consist of the following components:

1) ATCC camera

2) Command control center server

3) ITS workstation at the command control center

4) Network equipment

8.3 System Architecture
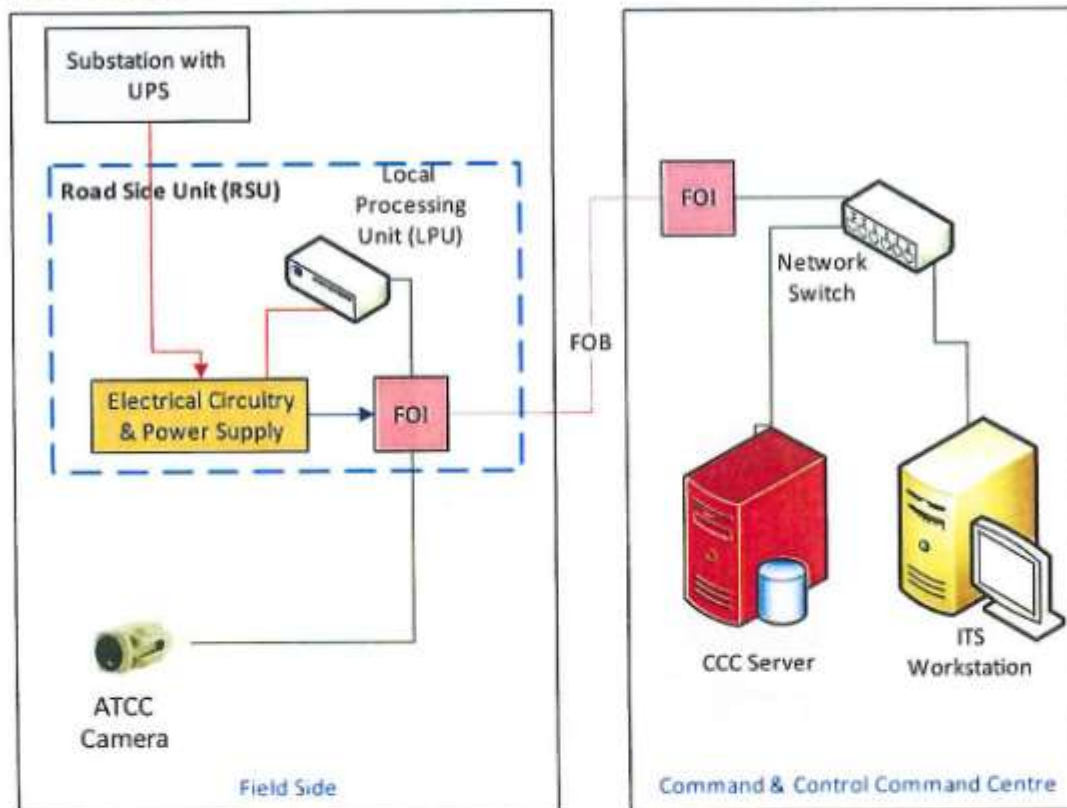
Figure 8:1 – Indicative Interconnection of ATCC System

1) For the ATCC system to function, cameras will be installed to monitor the portion of the road as per the employer's requirements stated in the tender document. Cameras will be installed on the gantry deployed for variable message signboards with the help of camera mounting brackets designed for the selected camera. The installation will maintain a minimum clearance of 6M below it for allowing the road vehicles to safely pass from below the gantry.

2) Cameras will be connected to the local field network switch using CAT 6 cables for data communication. The field network switch will be connected to the control room using the fiber-optic interface.

3) Power to the field equipment will be provided through UPS installed at the nearest control room.

4) A server and an ITS workstation will be provided in the command control center for receiving and monitoring pre-processed data from ATCC roadside equipment on the MTHL. The data collection interval will be pre-set to one minute.

8.4 System Function

1) The ATCC module will be provided in the HTMS software for automatic traffic counting and classification of vehicle class based on the data collected through the suitable sensor.

003949

2) The system will identify and record all types of vehicles on the highway for effective monitoring and data collection at HTMS Control Centre. The vehicle classification is user selectable based on the length of the vehicle. The software analyzes the data from the output of vehicle counts, classifications speeds, and headways.

3) The data will be segregated and provided in the report format based on Section wise, direction-wise, class-wise, etc.

4) ATCC system will provide the following major functions:

   a) **Image taking**

      i) The ATCC will continuously take video-based images of the coverage area set on the main carriageway. It will be possible to adjust the angle and coverage area of the image sensor to maximize the detection accuracy.

   b) **Image processing**

      Image taken by the sensor will be processed to obtain traffic flow parameters. The processing unit will be capable of:

      i) Detecting vehicle running in any direction and recognizing the shape or edge of the vehicle.

      ii) Counting the number of vehicles that pass the sensing area during the unit measurement time on a lane basis.

      iii) Classifying the vehicle as set forth by MORTH. The definition of classification will be made according to the vehicle length and axels and the classification parameter will be adjustable.

      iv) Calculating the time occupancy rate per unit measurement time.

      v) Calculating a mean speed per unit time which is an arithmetic mean of the speed of vehicles passed in the past unit measurement time.

   c) **Error checking and substitution**

      i) Traffic flow parameter data sent from roadside equipment will be tested first for possible errors. Malfunction of the image sensor and processing unit, and interruption of power supply will cause vehicle detector output in continuous detection state for error checking purposes.

      ii) Thresholds will be pre-defined for traffic flow parameters and detector data will be compared with them. If the detector is judged abnormal or an error signal is sent from ATCC roadside equipment, it will be marked malfunctioned and an alarm will be issued to the ITS workstation for warning and maintenance operation.

      iii) The faulty detector will be recorded in the operation log. The data judged abnormal will not be used for further processing.

      iv) Data from the vehicle detector marked as malfunctioned will be checked continuously for data abnormality. If data is judged normal, normal processing of the data will resume automatically.

	TECHNICAL PROPOSAL – HIGHWAY TRAFFIC MANAGEMENT SYSTEM	एम एम आर डी ए MMRDA
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d) **Processing**

   i) The ITS workstation will collect the data from ATCC at the unit measurement interval. The unit measurement time will be one minute. The unit measurement time will be a system parameter and will be adjustable.

   ii) The ITS workstation will accumulate the data collected and produce five minutes of data for the same traffic flow parameters.

   iii) In addition, the ITS workstation will calculate sectional traffic flow parameters at the location of ATCC.

   iv) If a traffic flow parameter at a lane or a section is lower or higher than the predetermined threshold, the ITS workstation will issue an alarm to the monitor display as abnormal traffic condition or malfunction of the ATCC sensor. The threshold for alarm will be user-configurable for each location for the different time zone of the day. The system will be initially pre-configured with reasonable values of the threshold based on engineering judgment.

   v) The 5-minute traffic flow parameters will be accumulated and converted to 15- minutes flow parameters for display purpose and hourly traffic flow parameters as statistics.

e) **Diagnosis**

   i) The ATCC system will have a diagnosis function. The ITS workstation will inquire about the connection with the ATCC and the status of ATCC by sending the diagnosis signal every five (5) minutes. If the ATCC fault signal is received or there is no response from the ATCC, the ITS workstation will issue an alarm and the fault will be recorded in the log.

   ii) Following types of errors and malfunctions of the ATCC System can be diagnosed from the ITS workstation:

      (1) No communication with the camera

      (2) No communication with the local processing unit

      (3) Connectivity failure between field and server

      (4) Logs when camera settings are changed

      (5) Watchdog to monitor applications

      (6) Alerts when camera view gets tampered

f) **Check and set up of ATCC monitor**

   i) To check or set up ATCC at the location of ATCC roadside equipment, the ATCC will be provided with an output terminal through which video signal from the sensor unit can be monitored.

g) **Display and report**

   i) It will be possible to monitor in real-time traffic flow parameter data through monitor display of ITS workstation and printed report. Traffic flow parameters of individual and multiple lanes can

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be specified for monitoring. Both numerical and graphical presentations of the data will be provided. Monitoring will be prompted by the operator but the data on the display will be automatically updated at the unit time of data.

ii) Real-time monitoring of the operating condition of ATCC roadside equipment will also be possible.

h) **Data recording and statistics**

i) All hourly and daily data will be recorded and stored in the database for analysis and future use. A data retrieval and presentation software will be provided that can easily retrieve and show the traffic flow parameters and operating condition of the specified ATCC location at the specified time, hour, or day.

ii) Graphical presentation of historical traffic flow parameters such as hourly variation and daily variation will also be possible.

i) **Operation log**

i) Status of ATCC (normal or malfunctioned) will be recorded in the database as an operation log and for future reliability analysis together with error code and time stamp.

5) The proposed ATCC system is implemented and successfully running at the "Hyderabad Outer Ring Road project" executed for "Hyderabad Growth Corridor Limited". Accuracy data collected at the actual installation location is provided in the table below:

Table 8:1 – ATCC accuracy at ORR project

ATCC Accuracy Test Results - V 5.0								
LOCATION :- Cha No:130.120 - Peddagolconda (Pole) Inner - DAY - 07.10.21								
Date	Period of testing(h)	Overall Count Accuracy	Overall Class Accuracy	TOTAL Count	Overall Correct	Overall Incorrect	Overall Missing	Overall Duplicate
7-Oct-21	09:48 PM – 10:48 PM	98.95%	97.89%	95	93	1	0	1

6) Accuracy summary:

Table 8:2 – Summary of ATCC accuracy report at ORR project

Class	Accuracy	TOTAL	Correct	Incorrect	Missing	Duplicate
LMV	99%	83	82	0	0	1
LCV	100%	4	4	0	0	0
Truck/Bus	88%	8	7	1		0
Overall Count Accuracy	98.95%					

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Class	Accuracy	TOTAL	Correct	Incorrect	Missing	Duplicate
Overall Class Accuracy	97.89%					

8.5 Technical Specifications

The proposed technical specifications for equipment will be as per the "1.2 Division 5A ITS Part-2 -27.08.21".

9 Meteorological observation (MET) system

9.1 Introduction

MET system will collect weather condition data at the meteorological observation stations continuously. The data collected will be transmitted to the server at the command control center for data processing and logging. In case of adverse weather, the system will automatically issue an alarm to the system operator. There will be a total of three (3) meteorological observation stations along the MTHL. They will operate on a 24-hour a day 7-day a week basis.

Figure 9:1 – Typical installation of MET Sensor

9.2 System Component

The Meteorological Observation System will consist of the following components:

1) Thermometer
2) Rain gage
3) Rainfall detector
4) Ultrasonic anemometer
5) MET observation station (data logger)
6) Command control center server
7) ITS workstation at the command control center
8) Network equipment

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9.3 System Architecture
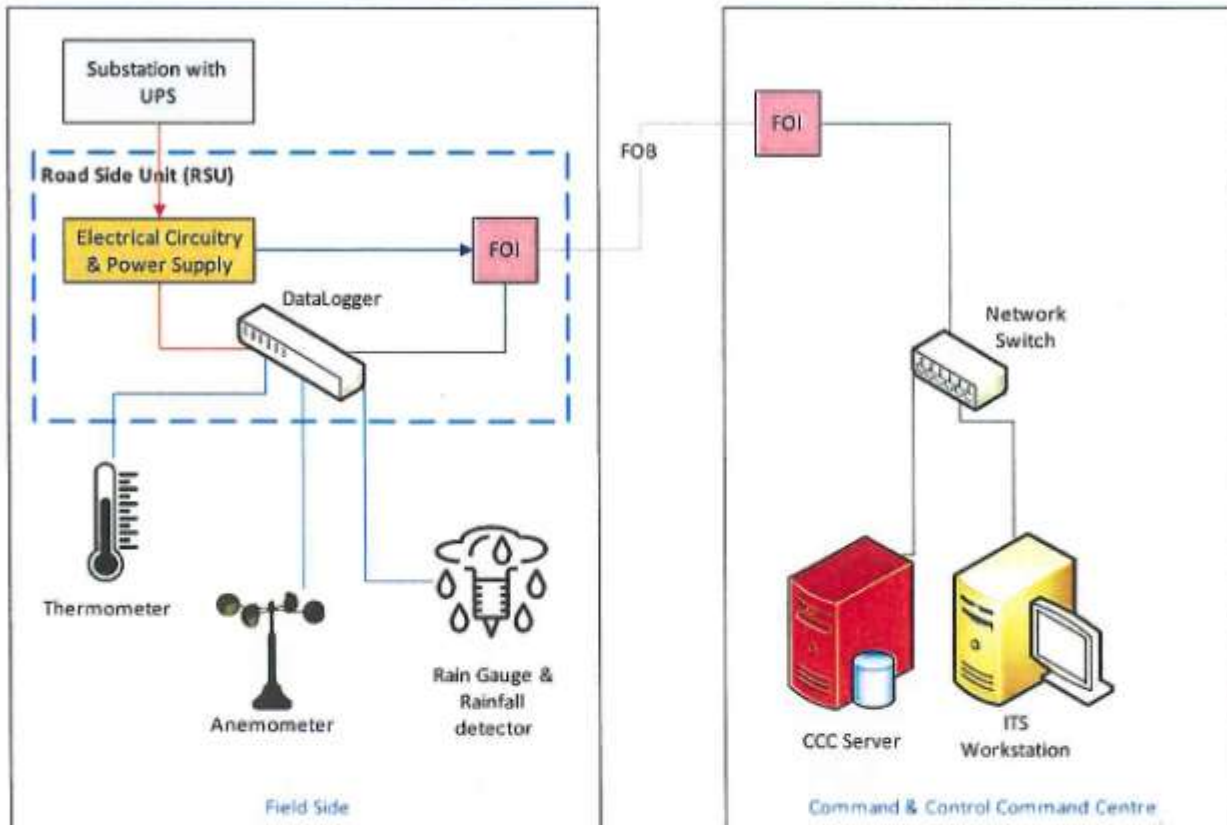
Figure 9:2 – Tentative Interconnection of MET System

1) ITS workstation will be provided to the command control center for receiving all MET data. IP-based network equipment will be provided to connect the meteorological observation stations with the ITS workstation at the command control center.

2) The meteorological observation station will be established at the following three (3) locations:

    a) Kilo post 1+660 (on VMS gantry)

    b) Kilo post 9+000 (self-standing or on CCTV pole)

    c) Kilo post 16+660 (on VMS gantry)

3) The following measurement equipment will be provided to each meteorological observation system:

    a) **Thermometer**

    The thermometer will continuously measure ambient air temperature at the range of 0 to 70 degrees Celsius in units of 0.1 degrees. The measured data will be sent to the server at the command control center at one-minute intervals as per current air temperature.

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b) Rain gauge

A tipping bucket rain gauge will be provided. The rain gauge will produce a pulse of contact signal every time precipitation reaches 0.5 mm. The signal will be converted into a voltage or current signal for transmission to the server at the command control center.

c) Rainfall detector

The rainfall detector will output an ON signal when rain is detected and an OFF signal when the rain stops.

d) Anemometer

The anemometer will measure the wind velocity at the range of 0 m/sec to 60 m/sec in units of 0.1 m/sec. The anemometer will also detect wind direction and convert it into one of 16 directions.

9.4 System Function

1) The meteorological observation station will perform the following process:

a) Data validity check

Error checking will be performed for the received data by comparing them with the pre-defined threshold. The threshold may include upper limit, lower limit, and variation from the previous data. The threshold will be user-definable. The data judged faulty will not be used as observed data. The defective device that has produced faulty data will be recorded in the operation log and an alarm will be issued.

b) Calculation of hourly and cumulative precipitation

Precipitation data will be processed into hourly precipitation and cumulative precipitation. The following processed data will be transmitted from MET to ITS workstation at the center every one minute.

i) The maximum and minimum value of wind speed and visibility in the past one minute

ii) The wind direction at the maximum and minimum wind speed

iii) The instantaneous value of ambient temperature and rainfall detection on every one minute

iv) Hourly cumulative value of rainfall in the past one hour

v) Cumulative value of rainfall from the start of the rainfall

The data received from the station will be converted to the physical weather data.

The ITS workstation will perform the data processing as listed in the table below for display and logging. The display will be updated every minute.

Data	Display	Logging
Temperature		

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Data		Display	Logging
Instantaneous (every 1 minute)		Yes	No
Instantaneous (every 5 minutes)		No	Yes
Wind velocity			
Maximum during previous 1 minute		Yes	Yes
Wind direction			
Direction at maximum wind during previous 1 minute		Yes	Yes
Precipitation			
Moving total for previous 1 hour		Yes	Yes
Total continuous precipitation		Yes	Yes

Table 9:1 –Data Log & Display interval of MET system

i) A warning system will be introduced in which an alarm is issued to the system operator when the wind data or precipitation data exceeds the pre-defined threshold. After the measured value has exceeded the threshold, another warning will be issued when the measured value becomes lower than the threshold to notify the system operator that the measured value is within the normal range. Several types and values of the threshold will be provided and the threshold will be alterable.

ii) All meteorological observation data will be recorded in the database in the form of 5- minute, daily, and monthly data, and data retrieval software will be provided for easy access to the recorded data. It will be possible to show graphically the retrieved data from the database.

c) **Diagnosis**

i) The ITS workstation will inquire about the connection with the MET and the status of MET by sending the diagnosis signal every five (5) minutes. If the MET fault signal is received or there is no response from the MET, the ITS workstation will issue a warning and the fault will be recorded in the log.

ii) Following diagnostics can be detected by the MET workstation:

(1) Sensor not responsive

(2) Data logger network failure

2) Please refer below image for Sonic anemometers ISO certificate (for reference).

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Werkszeugnis DIN EN 10204/3.1
Inspection certificate
Certificat d'usine

CERTIFIED
DIN EN ISO 9001
NR 70100222
CERTIFICADO

Lufft

Smart Weather Sensor

Model type	WS200
Serial number	180.0119.0811.227

This is to certify that this Lufft product has been tested according to the QM of the G. LUFFT Mess- und Regeltechnik GmbH manual in accordance with DIN EN ISO 9001. Ordering specifications are complied with. Execution of instruments / systems as well as testing of accuracy was carried out following LUFFT quality assurance procedures. Quality inspection was successfully passed. The Lufft product has been calibrated according to specifications using references traceable to international standard units administrated by the national metrology institutes like PTB, NIST, NPL or other recognized national standard laboratories.

Wind direction and speed
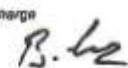
Angular deviation (0° ... 360° in steps of 22.5°)

	2.0 m/s	5.0 m/s	10.0 m/s	20.0 m/s	50.0 m/s	Status
RMSE	0.4°	0.3°	0.4°	0.7°	0.7°	✓

Wind speed

	2.0 m/s	5.0 m/s	10.0 m/s	20.0 m/s	50.0 m/s	Status
RMS	2.0 m/s	5.0 m/s	10.0 m/s	20.0 m/s	49.8 m/s	✓

This test certificate may not be reproduced other than in full except with the permission of the issuing company. Test certificates without signature are not valid.

Datum Date	Qualitätssicherung Quality control	Bearbeiter Person in charge
18.01.2019	i. V. Rolf Großmann	i. A. Bernhard Lenz

9.5 Technical Specifications

The proposed technical specifications for equipment will be as per the "1.2 Division 5A ITS Part-2 -27.08.21".

10 Variable Message Sign (VMS) System

10.1   Introduction

1) VMS system is intended to provide the MTHL users with the information of road, traffic, and weather conditions of MTHL to promote safe and comfortable drive. The VMS will provide information related to the MTHL. The system will operate on a 24-hour a day 7-day a week basis.

2) The VMS will be capable of creating, managing, and displaying messages in three languages (English, Marathi, and Hindi) separately, alternately, and simultaneously. Simultaneous display in multiple languages will display a one-line simple message in three languages in three lines for drivers who understand only one of these three languages.

Figure 10:1 – Indicative Image of VMS Gantry

10.2   System Component

The variable message sign system will consist of the following components:

1) Variable message signboard

2) Variable message sign local controller

3) Command control center server

4) VMS workstation at the command control center

5) Network equipment.

10.3   System Architecture
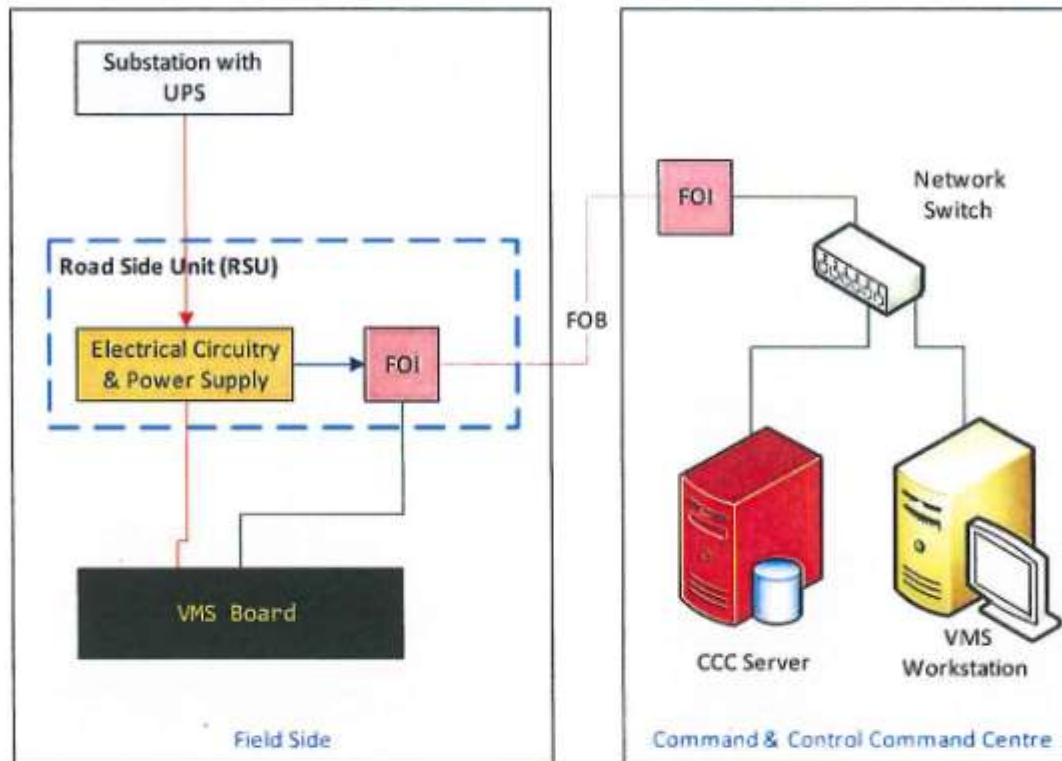
Figure 10:2 – Indicative Interconnection of Variable Message Sign (VMS) Board System

1) High-intensity LED (light-emitting diode) will be used as a light source for VMS. Three color elements, blue, red, and green, will be provided and a total of five (5) colours of white, yellow, green, red, and blue will be displayed. Brightness and colour will be uniform throughout the surface.

2) The life of the LED unit will be long enough to withstand the severe environmental conditions in which the signboard operates.

3) The type of LED and the dominant wavelength range of LED will be as indicated below.

LED colour	Type	Dominant wavelength
Blue	InGaN (Indium-Gallium-Nitride)	460~485nm (±5nm)
Red	AlInGaP (Aluminium – Indium – Gallium – Phosphide	625~630nm (±5nm)
Green	InGaN (Indium-Gallium-Nitride)	510~550nm (±5nm)

Table 10:1 – Dominant LED wavelengths

4) A dedicated VMS workstation will be provided to the command control center for message preparation, monitoring, and control of the variable message signs. IP-based network equipment will be provided to connect the VMS with the traffic management system at the center.

5) The VMS will be mounted on a gantry crossing the entire width of the road in each direction of the main line section. A gantry mechanism will be provided with a tilting angle between 0 degrees (vertical) and 10 degrees (tilted forward).

6) At the time of writing this document, the following LED is used for VMS boards:

   a) Source: Lite – Max Optoelectronics co., Ltd.

   b) Type: Ø5mm round shape, AlGaInP, InGaN, InGaN

   c) Part Number: LM – R05ARCD – SX, LM-R05BCD-SX-B, LM-R05FCD-SX-G

7) However, it needs to be noted that the actual manufacturing of the VMS boards is a made-to-order activity and will be taken up only once the project is awarded. At the time of manufacturing, the model number & source of the LEDs may vary as per availability in the market. This change, however, will not deviate from the customer's requirement of purchasing LEDs from a reputed manufacturer and its overall technical requirements.

8) The proposed VMS boards are EN12966 certified which in turn certifies their optical performance. EN12966 certificate is attached along with this technical proposal in a separate section dedicated to datasheets and certificates.

9) The proposed VMS board has power-saving features and the power consumption of the VMS board will be less than 4000W when 50% of the LEDs are glowing whereas it will be less than 2000W when 25% of the LEDs are glowing. This way, most of the time, the actual power requirement of the VMS board will be very less than the maximum power requirement of the board.

10) Snippets from VMS support calculations are as follows:

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Gantry - 2.5m x 22.0m for VMS Sign

A) Dimensional & Material Data

Span of gantry	22.00 m
Clear Height to bottom of board	6.25 m
Height of VMS Board	2.3 m
Length of VMS Board	11.5 m

Grade of Concrete	M25
Grade of Reinforcement	Fe 500
Grade of Steel for Tubes	$F_y = 410$ Mpa
Grade of Steel for all other items	$F_y = 250$ Mpa

B) Loading Data

Dead Loads:

a) Self weight of the supporting structure:		included directly in analysis model
b) Self weight of VMS Sign Board:		1500 kg
	=	130.4 kg/m
c) Self weight of Floor Grating in the maintenance walkway		40 kg/m2

Live Loads:

a) Live Load in the maintenance walkway	200 kg/m2

Wind Loads:

Wind Pressure:
Factors for basic wind speed:

Wind speed (V) =	47 m/s	
$K1$ =	1.0	(general buildings & structures)
$K2$ =	1.03	(Category I, Class B)
$K3$ =	1.0	
Designed wind speed V_z =	48.4 m/s	
Designed wind pressure P_z =	1406.1 N/m2	
Wind pressure normal to board =	143.3 kg/m2	

Case 1: Wind Normal to the board

Height of Board	2.3 m
Force Coefficient, Cf	1.2
Force on sign board = Cf x pz x Area per m	396 kg/m

Case 2: Wind Oblique to the board

Height of Board	2.3 m
Force Coefficient, Cf	1.2
Force on board at up wind = 1.7 x Cf x pz x Area per m	673 kg/m
Force on board at up wind = 0.44 x Cf x pz x Area per m	174 kg/m

Wind on Columns

Force Coefficient, Cf	1.2
Maximum projected dimesnion of vertical members is	273.0 mm
Forces on vertical members = Cf x pz x Projected Area per m	47.0 kg/m

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HIGHWAY TRAFFIC
MANAGEMENT SYSTEM

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C) Foundation Data

Soil Bearing Capacity:	15.0 ton/m2
Depth of Footing (from Ground Level)	2.0 m

(See separate sheet for footing design)

D) Bolt Calculation
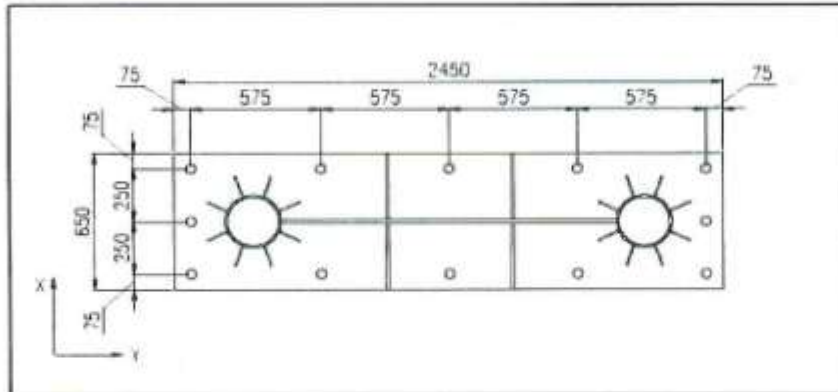
Moment about the X axis

Maximum Moment .... 293.2 kNm

Let A be the area of each bolt
Spacing of bolts (y) = ... 550 mm

With the given bolt numbers and arrangement,
$(3A (2y)^2 + 2A (y)^2) \times 2$ .... 8470000 A mm2

Distance to the farthest bolt .... 1100 mm
Tension in the farthest bolt .... 38.1 kN

Moment about the Y axis

Maximum Moment .... 9.1 kNm

Let A be the area of each bolt
Spacing of bolts (y) = ... 250 mm

With the given bolt numbers and arrangement,
$(5A (y)^2 \times 2$ .... 625000 A mm2

Distance to the farthest bolt .... 250 mm
Tension in the farthest bolt .... 3.6 kN

Therefore max tension in any bolt = ... 41.7 kN
(neglecting effects of compressive forces)

Calculating Shear on bolts

Moment about the Z axis

Maximum Moment .... 5.4 kNm

Let A be the area of each bolt

With the given bolt numbers and arrangement, $\Sigma Ar2$ 9095000 A   mm2

Distance to the farthest bolt   1128.1 mm
Shear in the farthest bolt   0.67 kN
Component of Shear in X direction   0.65 kN
Component of Shear in Y direction   0.15 kN

Shear
Shear in X direction   4.2 kN
Shear in Y direction   43.0 kN
Shear in X direction per bolt   0.35 kN
Shear in Y direction per bolt   3.58 kN

Total Shear in X direction in a bolt   1.00 kN
Total Shear in Y direction in a bolt   3.73 kN
Resultant Shear =   3.9 kN

Using M24 bolts:
Allowable Tension   42.0 kN
Allowable Shear   28.1 kN

Checking for shear plus tension   1.131 < 1.4   Hence OK

E) Base Plate Design

Assuming the following size for the base plate:

Length (L)   2450 mm
Width (B)   650 mm
Thickness (t)   25 mm
Area of plate (A)   1592500 mm2

Resultant Loads on the base plate
Axial Load (P)   69.4 kN
Bending Moment (about X axis), Mx   293.2 kNm
Bending Moment (about Y axis), My   9.1 kNm
eccentricity ex = Mx / P   4225 mm   > L/6
eccentricity ey = My / P   131 mm   < L/6

Stress due to Axial Force (σ_a) = P/A   0.04 MPa
Max Stress due to bending about X axis = $6Mx / BL^2$ 0.45 MPa
Max Stress due to bending about Y axis = $6My / B^2L$ 0.05 MPa
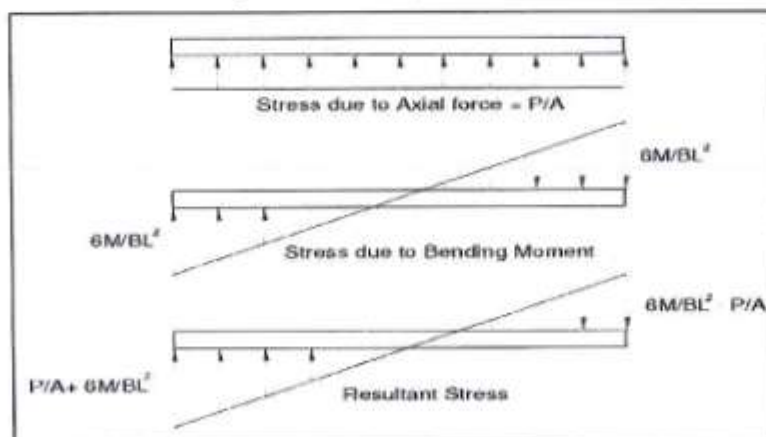
Stress due to Axial force = P/A

Stress due to Bending Moment

Resultant Stress

<u>Calculating base plate bending moments for bending about X axis:</u>
Maximum bending moment will occur at the face of the SHS

Cantilever length	214.0 mm
Moment due to Axial stress	1.00 kNm / m
Moment due to stress developed by Mx	10.3 kNm / m
Total Moment	11.3 kNm / m
Bending stress σ_{bx}	108.7 MPa

<u>Calculating base plate bending moments for bending about Y axis:</u>
Cantilever length	189.0 mm
Moment due to Axial stress	0.8 kNm / m
Moment due to stress developed by My	0.9 kNm / m
Total Moment	1.7 kNm / m
Bending stress σ_{by}	16.5 MPa

$\sigma_{bx} + \sigma_{by} = 125.2 < 165 \times 1.33 = 219$ Mpa
Hence ok

<u>Checking for bearing stress in concrete pedestal</u>
Max bearing stress =	0.55 MPa	
Allowable bearing stress = 0.25 * fck	6.25 MPa	Hence Ok

F) Concrete Pedestal Design

Length of pedestal	2600 mm
Width of pedestal	800 mm
P =	69.4 kN
Self weight of pedestal	93.6 kN
Total Axial force (P)	163.0 kN
Mx (major axis moment)	370.6 kNm
My (minor axis moment)	16.7 kNm

Factored forces
Pu	245 kN
Mux	556 kNm
Muy	25 kNm

Pu/fckbd	0.0047
Mux/fckbd2	0.0041
Muy/fckdb2	0.0006

Using SP16 tables
p/fck	0	
Providing minimum reinforcement	0.15%	3120 mm2
Using 6-T20 + 34-T12		5727 mm2

10.4 System Function

1) The message to be displayed on the VMS will be concise and clear as drivers driving a vehicle have to read and understand the message in a short time. Messages will have a uniform structure and simple words will be used. Messages on the VMS will be in expressed English, Marathi and Hindi.

2) Three message composition methods will be provided;

    d) Manual input

    e) Combination of pre-defined phrases

    f) Selection of ready-made messages

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TECHNICAL PROPOSAL –
HIGHWAY TRAFFIC
MANAGEMENT SYSTEM

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3) As the display area of VMS is divided into three (3) lines, the message composed will fit into each line without splitting a word at the end of a line. The controller will have automatic layout and centering functions to arrange words into rows.

4) The VMS workstation will be provided with updating and editing functions of pre-defined words, phrases, messages, and symbols. Editing of the symbol will be possible on a pixel basis. Messages in languages other than English are created in the form of an image and displayed.

5) If an incident is detected by a CCTV system or adverse weather condition is detected by the meteorological observation system, these systems will send an alarm to the VMS system. VMS system will then create a warning message indicating the location, type of incident and action to be taken. The message thus created will not be displayed automatically on the signboard. Instead, a recommendation will be displayed on the VMS workstation indicating the contents of the message and the location of VMS for which message is recommended. Upon confirmation of the recommendation, the message will be displayed on the specified message.

6) The ready-made message selection method will allow the system operator to choose one of the ready-made messages. If the ready-made message mode is selected, the VMS workstation will indicate the list of ready-made messages grouped into categories for the system operator to select. The message set will have a capacity of 100 messages in each language.

7) Graphic symbols that show typical incidents such as expressway closure, construction work, and rain graphically will be provided to complement the text message.

8) The VMS system will be provided with an automatic message selection function based on the priority or severity of the events and coefficient that represents the importance of the event to each VMS. The function will select and recommend the message to be shown separately for each VMS when there are two or more events to be informed to the MTHL users.

9) The typical flow of VMS message creation is as depicted in the flow chart below:

Start

Login to VMS Master module

In "SEND MESSAGE" tab, Select "VMS Group" from drop-down list

Select "Message Type" from drop-down list.

Enter custom message in "VMS Message" text box
OR
Select a pre-configured message from the "VMS List".

Select "Message Type" from drop-down list.

The preview of the message will display in "DISPLAY ON VMS" section

Select various parameters, such as character spacing, line spacing, vertical & horizontal alignment, text colour, font, size etc. from the fields provided.

Select message display time, move time etc. from the fields provided.

Click on "Send" button to send the configured or selected message to the selected VMS Group.

Stop

Figure 10:3 – VMS Message Creation Flow Chart

10) Each message is displayed on the VMS will be assigned with a time-to-live (TTL) value, during which the message is displayed, to prevent inadvertently displaying false messages after the event has been removed. Upon expiration of TTL, a message will be automatically extinguished. A warning will be issued to the operator console before TTL expires for the operator to choose the extension of TTL or termination of the display as scheduled.
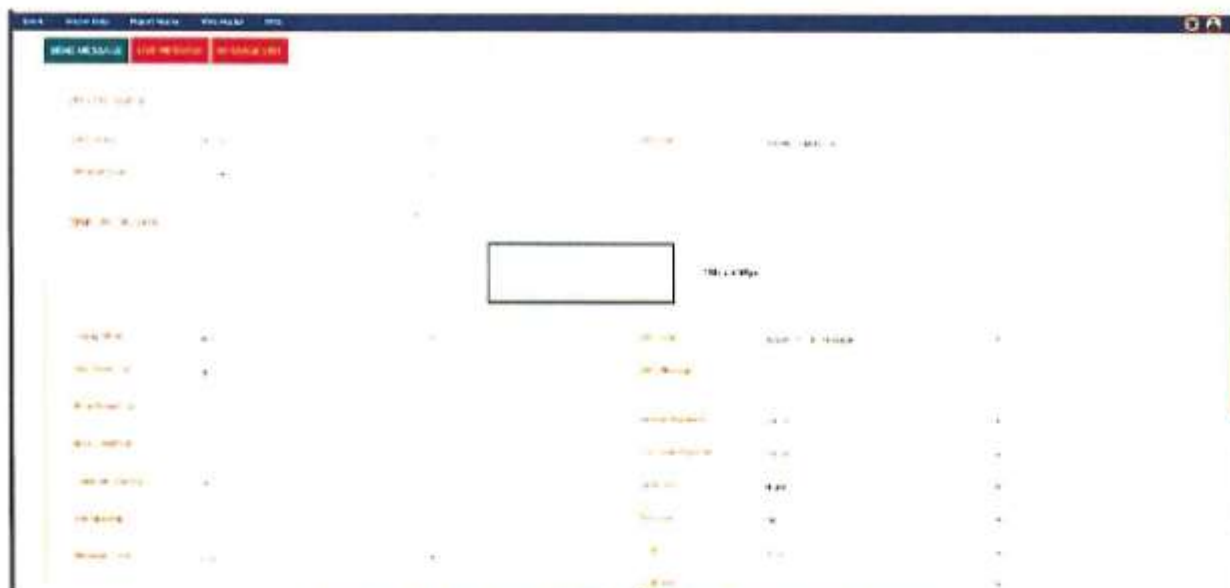
Figure 10:4 – Indicative VMS Message Creation Screen

11) The VMS system will have an alternate display function, in which a maximum of three sets of messages will be displayed alternately. The function is intended to display a message in three different languages (English, Marathi, and Hindi) of the same contents.

12) If multiple messages are displayed alternatively, it will be possible to adjust the display duration of each message in the range of one to four seconds in units of one second. The changeover of the messages will take place instantaneously without a noticeable mixture of two messages.

13) The VMS workstation communicates with the operator through a monitor and keyboard for message composition, message display, and operation monitoring. Message composition will be made interactively with one of the methods described above. The graphic user interface will be adopted in the interface as much as possible for user-friendly operation and a fail-safe mechanism will be incorporated to prevent the VMS system from showing inadequate messages inadvertently.

14) The system will be equipped with a text input method in Marathi and Hindi languages commonly used in India through the standard keyboard.

15) Text and symbol messages to be displayed will be converted to pixel image data to control the display unit before transmitting to the variable message sign.

16) The VMS fault diagnostics is provided to include the following as a minimum:

   a) Display line Failure

   b) Incoming data reception/communication error detection

   c) A temperature within the enclosure information

   d) Door status

   e) Panel inner temperature status

17) Message displayed together with the starting and ending time will be recorded as an operation log. Status or malfunction of the variable message sign and the local controller will also be recorded. Data retrieval software will be provided and the operation log can be retrieved for display on the monitor and as a printed report.

18) VMS Board

a) The character size of the VMS on the MTHL will be a minimum of 400 mm in height excluding blank rows between lines. The VMS will be capable of displaying a total of 22 English characters of the standard width including space between words in one line.

b) The width will be adjusted proportionally for each character to display a message in the proportional font. The display panel will be capable of displaying all characters used in three languages.

c) Spacing between lines will be at least 10% of the character height.

d) Dimming function will be provided to VMS to reduce the brightness depending on the ambient light levels and prevent glaring during the dark hours. There will be at least four (4) levels of brightness. Dimming control may be activated by a photo electric cell attached to the signboard, local timer, or command from the Control Centre. A mechanism will be provided to prevent chattering.

e) The VMS will be equipped with a temperature sensor or sensors to measure the temperature inside the cabinet and ventilation fans to control the temperature inside the cabinet. The temperature will be continuously measured and the data will be sent to the command control center as one of the monitoring data.

f) A safety mechanism will be provided that shuts down the VMS if the temperature inside the cabinet reaches a pre-define threshold temperature that will be manually adjustable with the default setting of 60 degrees Celsius.

g) The VMS will be provided with the display off mode, in which it will operate normally both in local mode and remote mode but the display units will be turned off for the testing purpose.

10.5   Technical Specifications

The proposed technical specifications for equipment will be as per the "1.2 Division 5A ITS Part-2 -27.08.21".

STRABAG	TECHNICAL PROPOSAL – HIGHWAY TRAFFIC MANAGEMENT SYSTEM	एम एम आर डी ए MMRDA

11 Vehicle Actuated Speed Warning System (VASS)

11.1 Introduction

On any highway, most of the accidents are due to over speeding and rash driving. A simple indication of current vehicle speed and a warning to slow down to the rash driver will most of the time warn the driver to slow down to safe speeds. Vehicle Actuated Speed Warning System (VASS) will be deployed at required locations on the project stretch. This simple system will possibly prevent many road accidents.

11.2 System Component

The VASS system will consist of the following components;

1) VASS integrated speed display
2) VASS integrated speed detection RADAR

11.3 System Architecture

1) VASS system capable to cover all lanes in a direction will be installed at required locations under the project. Locations will be approved by the client's designated engineer before installation.

2) Speed detection system RADAR will be installed so that it tracks the speed of oncoming traffic between a minimum of 25 to 10 M from the installation location. Once a vehicle's speed is detected, it will be displayed on the speed display to immediately warn the road user.

3) Controlled power at each node will be provided by the UPS backup system installed at the central location. Appropriate power cabling will be provided for the power supply from the central location UPS to the field system.

4) Radar-triggered VASS will be co-located on the VMS gantry along with the VMS board. It sends the command to the VASS display for displaying the real-time speed of the vehicle. The VASS displays the speed of the vehicle to the driver and alerts the driver about the current vehicle speed and prevents over-speeding.

STRABAG	TECHNICAL PROPOSAL – HIGHWAY TRAFFIC MANAGEMENT SYSTEM	एम एम आर डी ए MMRDA

11.4 System Function

2) RADAR DETECT THE CARS' DRIVE SPEED

YOUR SPEED 30

1) THE CAR IS DRIVE NEAR THE SIGN

3) THE SIGN SHOW THE SPEED OF THE CAR
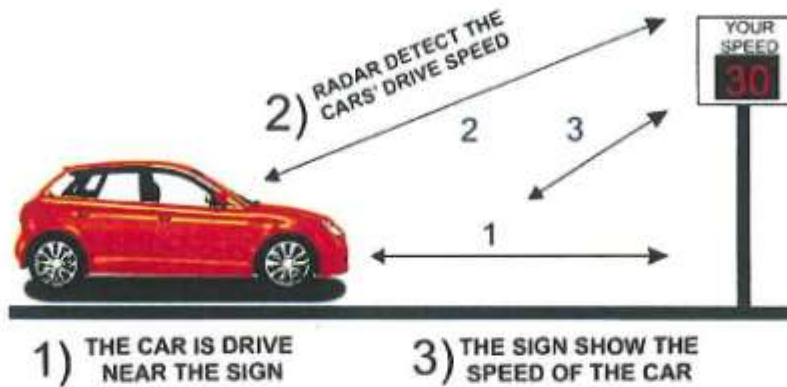
Figure 11:1 – Tentative Image of Radar Based Speed Display System

1) The system is an LED display with an inbuilt Radar. The Radar sends high-frequency waves which are reflected from the vehicle on the road. The reflected waves are read by the radar to detect the speed of this vehicle. Once a vehicle speed is detected it will get displayed on the display board in real-time.

2) Measurements for the VASD system as below:

   a) Speed range: 10km/h to 200 km/h

   b) Maximum measuring errors: Up to 100 km/h (+/- 5km/h), Above 100 km/h (+/- 7km/h)

   c) Minimum monitored section length: 30 M

11.5 Technical Specifications

The proposed technical specifications for equipment will be as per the "1.2 Division 5A ITS Part-2 -27.08.21".

12 Mobile Radio Communication System

12.1 Introduction

Mobile Radio Communication System (MRCS) will be used to provide private wireless communication for the personnel engaged in the MTHL operation and maintenance. The system will cover the entire MTHL with high quality of voice communication.

12.2 System Component

The MRCS consists of the following major components

1) Towers for the repeater station

2) Repeater Stations

3) Base Station

4) Hand-held units

5) Vehicle-mounted units

12.3 System Architecture
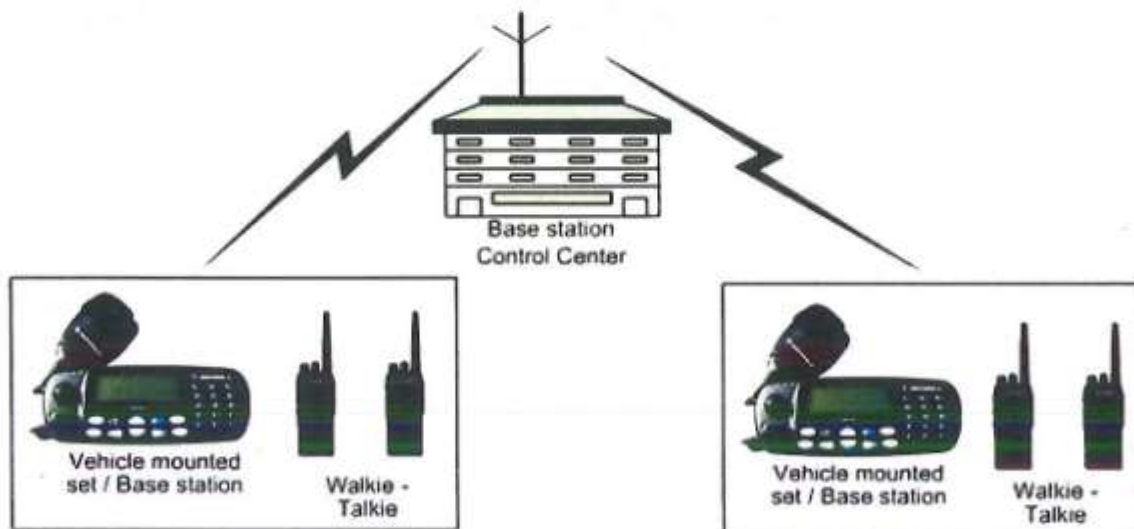
Figure 12:1 – Typical scheme of MRCS

1) MRCS is a combination of Wireless Communication System Controller, Wireless Communication Repeater, and Mobile Station.

2) In the MRCS system, the radio control will be managed in Command Control Centre. A repeater station may be established to ensure the coverage area of the entire MHTL. Repeater station if established will be connected to the base station through a wireless link or digital transmission system. The mobile unit

003972

will be installed in the vehicles used for MTHL operation and maintenance. A portable unit will be provided for use by the staff engaged in operation and maintenance work.

a) Mobile radio workstation

i) The Command Control Centre workstation will consist of but is not limited to, radio equipment (transmitter and receiver), antenna, coaxial arrester, communication control equipment, and radio communication console. Two sets of transmitter and receiver will be installed as a hot standby system.

ii) The radio communication console equipped with a microphone will have such functions as to select and communicate with any mobile unit or mobile unit group to be preset, select transmitter and receiver to be used, control the base station equipment, track vehicle location, and log operation record through the communication control equipment.

iii) 8-element Yagi type antenna or equivalent will be used to transmit the radio signal effectively. The coaxial arrester will be installed to protect the equipment from lightning surges.

iv) The power supply to each piece of equipment will be made from a DC power supply or Uninterruptible Power Supply (UPS) with the battery having enough capacity to supply power until the emergency generator starts.

b) Base Station / Repeater

i) The base station will consist of but is not limited to, repeater equipment including two sets of transmitter and receiver, control equipment, antenna (8-element Yagi type or equivalent), and coaxial arrester. The base station will have the following functions.

(1) To connect and communicate with CCC workstation and mobile units

(2) To receive a control signal from CCC workstation or mobile units and initiate repeater equipment

(3) To change over transmitter or receiver based on the control signal from CCC workstation

(4) To detect transmitter and receiver failure, and have automatic radio changeover function

(5) To send operating status in compliance with a control signal from the CCC workstation

ii) The power supply to each piece of equipment will be made from a DC power supply or UPS with the battery having enough capacity to supply power until the emergency generator starts.

c) Mobile Station

i) Both vehicles mounted type unit and portable type mobile unit with cradle type battery charger will be provided. The mobile unit will be compact and light in weight in consideration of usability.

12.4 System Function

The MRCS system shall have the following functions.

STRABAG	TECHNICAL PROPOSAL – HIGHWAY TRAFFIC MANAGEMENT SYSTEM	एम एम आर डी ए MMRDA

1) Radio Dispatch

    a) Two-way individual, group, and all calls from SmartPTT Dispatch Console

    b) Conference calls to individuals or groups

    c) Recording of all voice calls even individual between subscribers

    d) Hotkeys for quick private and group calls

    e) Calling Subscriber Identification

    f) Emergency calls

    g) Voice calls and text message exchange between dispatchers (Intercom)

    h) Radio check

    i) Call alert

    j) Flexible sound control

    k) Configurable profiles to manage access of dispatchers to control stations, groups, services.

    l) Channel Selector for switching channels at the control stations

    m) Muting of talk groups

2) Events & voice logging

    a) SmartPTT voice logging system stores sound files in MP3 format. Files can be played back from the dispatcher console event viewer or by an ordinary sound player from the folder where the MP3 files are stored. Subscribers of all types, Control Stations, and Groups can be arranged in the flexible category tree.

    b) Each subscriber can belong to multiple categories simultaneously. In addition, the set of custom subscriber properties can be defined for every subscriber. This feature allows users to have business-specific subscriber attributes, for example, vehicle type, vehicle ID, etc.

3) GPS-Tracking

    a) Know exact GPS location of subscribers

    b) Control subscribers in the dangerous zone

    c) Track where the subscriber was at what time

    d) Subscriber positioning in real-time

    e) Subscriber location history

    f) Track animation

    g) Track details and reporting

    h) Speeding and stops control

    i) Automatic and manual location request

    j) Different map formats supported (vector, raster, online)

    k) Integration with Google Earth (export locations to KML)

003974

4) Text & Data Transfer

   a) **Text Message Service**

   SmartPTT Dispatcher Console allows sending text messages either to individual subscribers or groups. Subscribers with the radio having a display and keyboard can send a text message back to the Dispatcher Console.

   b) **Status Control**

   SmartPTT supports a flexible list of statuses for subscribers. Every status can have its colour. Statuses can be assigned to subscribers, either from the dispatcher console or by pressing the accessory button on the subscriber radio. Status filter in the dispatcher console allows easy selection of the subscribers having specific status.

5) Simulcast

   Broadcasting the voice message to all Mobile Stations simultaneously.

12.5   Technical Specifications

The proposed technical specifications for equipment will be as per the "1.2 Division 5A ITS Part-2 -27.08.21".

13 Data Communication System

13.1 Introduction

The fiber optic backbone is proposed as a transmission system for connectivity between the HTMS field/roadside equipment with the central equipment at the Traffic Management Centre and Sub-Centres to transmit Data and Voice. This system is installed to perform the service of data and voice communication.

13.2 System Components

1) Network Switches

2) Optical fiber cable & other accessories

13.3 System Architecture
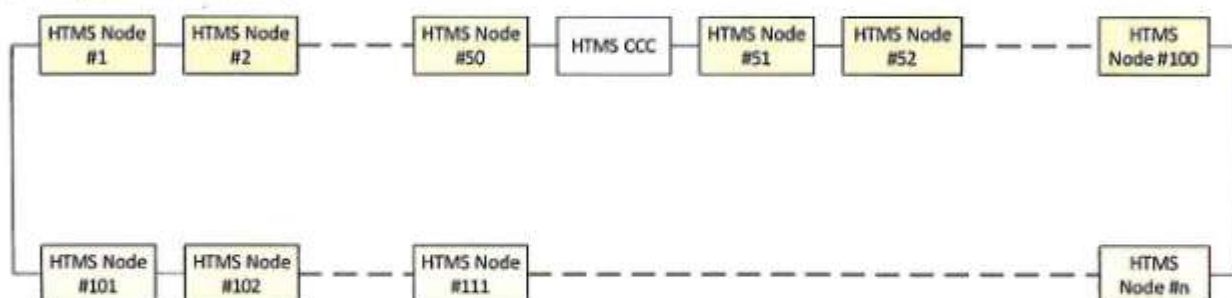
Figure 13:1 – Indicative System Architecture of Data Communication System

1) The Data Communication System will provide data communication service along the MTHL for toll management system, traffic management system, security surveillance system, and other applications.

2) The data communication system will be an IP-based system and all data, video images, and voice signals will be transmitted through the standard TCP/IP protocol. The system will operate on a 24-hour a day 7-day a week basis.

3) The data communication equipment, cabinets that accommodate the equipment, cable, and connector, terminal board, conduit, handhole, manhole, cable tray, fixing metals, control and monitoring software, and other device and accessories to establish a functional data communication system will be provided.

4) Optic fiber cable will be laid along both sides of the MHTL to connect the toll management center and command control center at the mainline toll plaza, toll plaza office at Shivaji Nagar Interchange, command control sub-center new Sewri Interchange, and various roadside equipment

13.4 System Function

1) The data communication system consists of layer 3 switch (L3-SW), layer 2 Switch (L2-SW), small form-factor pluggable (SFP), and optic fiber cable.

2) Four (4) Ethernet rings will be established using the optic fiber cable to be installed along both sides of the MTHL. Optic fiber cable on each side will form a ring connecting alternately along the MTHL and cables on both sides will be connected at the end of the cable route. Normally, one side of the optic fiber cable rings will be used as an operating ring. In the event of interruption of the operating ring, the system will automatically switch over to the standby ring.

3) The network will be provided with the operation, administration, maintenance, and provisioning (OAM & P) features as defined by IEEE 802.1ag and will be provided with connectivity fault management (CFM) functions including connectivity check, loopback, and link trace. A virtual LAN (VLAN) will be established by the network management system workstation and the system parameters will be set up by the workstation.

4) L2 switch & SFP will be installed at the location of the CCTV camera for traffic surveillance. A dedicated cabinet for L2 switch, FP, and optic fiber cable terminating unit will be provided and installed in the equipment room at toll plaza building and server room at command control center, Shivaji Nagar interchange, and command control sub-center at Sewri IC.

5) Offered OFC cable is water blocking type and has armor for protection. An indicative cross-sectional view of the offered cable is depicted in the diagram below:
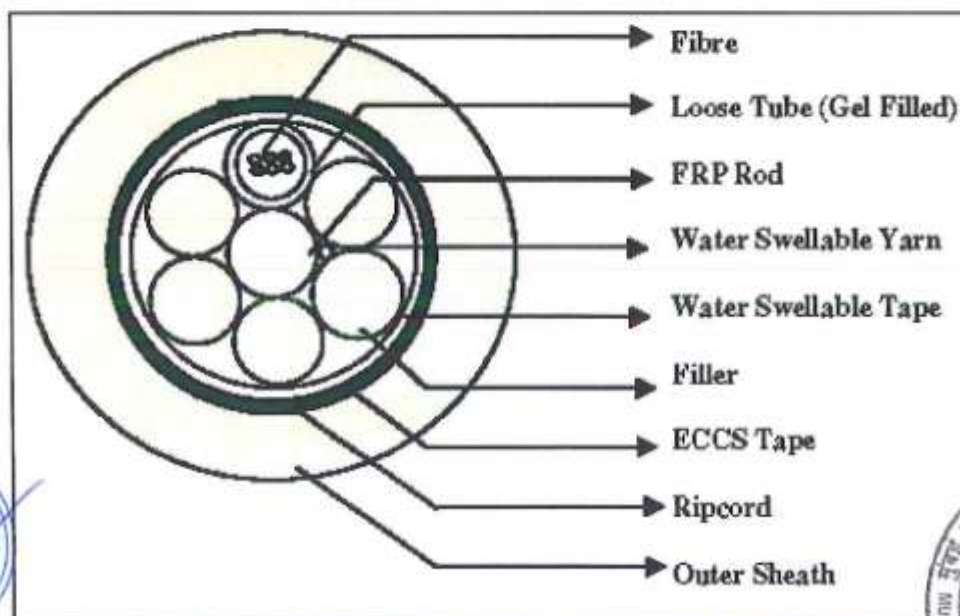
Figure 13:2 - Indicative Cross-Sectional View of Optical Fiber Cable

13.5 Technical Specifications

The proposed technical specifications for equipment will be as per the "1.2 Division 5A ITS Part-2 -27.08.21".

	TECHNICAL PROPOSAL – HIGHWAY TRAFFIC MANAGEMENT SYSTEM	एम एम आर डी ए MMRDA
STRABAG		

14 Safety Plan

14.1 Introduction

1) The safety and accident prevention of the public/employees/site personnel is a prime aim of EFKON. This includes the safety and well-being of employees and the general public as well as the prevention of wasteful, inefficient operations and damage to property and equipment. We are committed to safety. For this, required awareness and training will be provided to all site personnel.

2) The Accident Prevention Officer and the personnel for safety will be sufficiently assigned to assuring safety.

3) The Project Manager along with Accident Prevention Officer will regularly check the conditions of safety devices and use of them by all site personnel. The obstructions and excavations in the work areas will be adequately fenced and guarded at all times and proper traffic control equipment will be installed to protect the workers and the public. Particular attention may be paid to the positioning of traffic barriers and traffic cones.

4) Adequate traffic control equipment will be placed before work begins and all such equipment will be removed immediately when the work is completed. As work progresses, warning devices which were appropriate at one time, but are no longer applicable will be removed immediately.

5) The signs, lights, barriers, and other traffic control equipment will be maintained in good order and the correct position during the day and night. The signs will be neat, clean, and legible at all times.

14.2 Design / Approach

EFKON will pay utmost attention to the work area safety and traffic safety during the installation works. During the construction or installation of the worksite, all persons will wear the proper personal protective equipment including a hard hat and reflective safety vest, etc.

1) Warning Signs

   a) A "LANE CLOSED AHEAD" and a "LANE CLOSED" signs will be placed upstream of the lane closure site at a distance of approximately 100 meters and 50 meters respectively when one lane of the roadway is closed. These signs will be placed further upstream of the work area if more than one lane of the roadway is closed.

   b) All work area warning signs will be made of reflective sheets or material to remain signs in place during hours of darkness.

2) Temporary Warning Flashers

   a) The warning flashers will be used on the VMS poles, for the duration of the incident detection.

   b) The lamps will be kept illuminated at all times.

   c) The flashers will mark the site of obstructions and delineate the transition zone.

1933

3) Plant and Equipment

    a) All equipment for installation works and obstruction on the roadway will be removed at night if the traffic is allowed to use the roadway during the installation works and it is possible to remove the equipment and obstruction.

    b) In case of the equipment and/or obstruction located at 2 meters from the edge of the roadway, the installation works and obstructions on the roadway will be demarcated with two red lights during nights for clear visibility to the road users for safety.

    c) The red lights will be vertically suspended from the point of the obstruction. During the day, a red flag will be projected on the roadway side beyond the equipment and obstruction.

4) Vehicles for the Works

    a) The vehicles used for the works and that are required to travel slowly or to stop frequently will be made as conspicuous as possible. This will be achieved by painting them in distinctive colour or painting the rear portion with diagonal stripes of a contrasting colour or providing flashing lights on the top of the vehicle.

    b) They will be having a plate on the rear side with the words "SLOW MOVING".

    c) The vehicle will also have a radium detector for visibility at night.

5) Safety Plan

    a) EFKON will prepare and submit a Safety Plan before the commencement of the work at the site for approval of MMRDA. The safety plan will describe the precautions and measures to be followed by all members to prevent the staff and the general public from accidents during work.

    b) It will also contain emergency response measures in case of an accident.

15 Software Quality Assurance Program

15.1 Description

1) EFKON Quality Management System (QMS) is designed to support our commitment towards providing quality products and services (Quality Assurance) to its worldwide customers.

2) The objective of the QMS is to deliver high-quality services while meeting quality, budget, schedule, and client satisfaction-related goals. Quality is defined as conformance to the requirements, written contracts, and quality procedures. The products and services are not characterized as having good or bad quality, only conforming, or not conforming to requirements. Our policy is to build and offer products and services exactly as per requirements. The requirements can be changed by mutual agreement between EFKON and the client.

3) EFKON QMS consists of a set of processes and milestones to ensure that due emphasis is provided to the development process and milestones (Assurance) to discover non-conformance early in the stage than at the later stages of product testing.

15.2 Design / Approach

1) EFKON has expertise in managing product development by defining key goals and methodologies in the following key process areas. All phases are maintained and planned in the task management tool:

   a) Requirement development and management

   b) Planning and initiation

   c) Execution monitoring control and closure of project phases

   d) Project/ product quality assurance

   e) Configuration management

   f) Change management

2) The phase management is carried out as per the workflow provided in Figure 15:1.

STRABAG	TECHNICAL PROPOSAL – HIGHWAY TRAFFIC MANAGEMENT SYSTEM	एम एम आर डी ए MMRDA
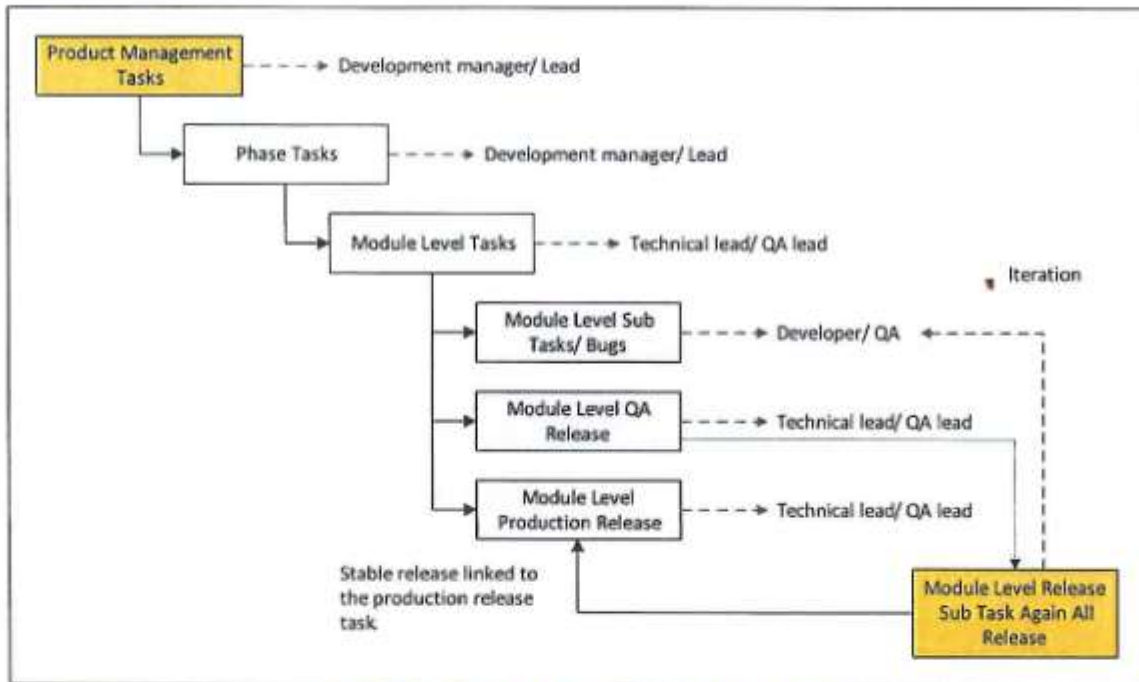
Figure 15:1 – Phase Management Workflow

3) Change Control and Configuration Management Processes

EFKON Change Management process addresses the controlled implementation of Change Request (CR) to the Customer IT environment. EFKON has a well-defined configuration management process to do risk change management.

15.3 Configuration Management flow
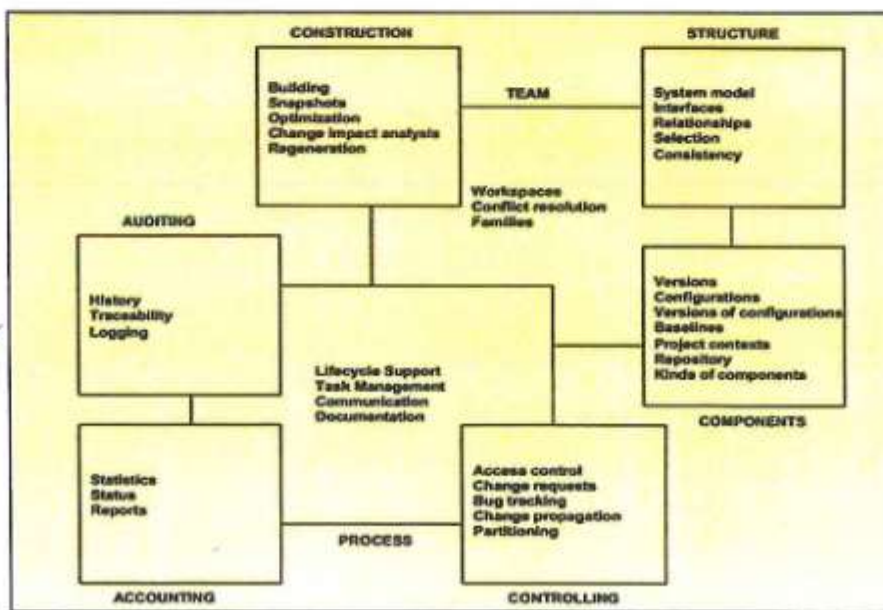
Figure 15:2 – Configuration Management Functionality Requirements

4) Following key tools and documents are used to manage the same

    a) SVN

    b) JIRA

    c) Configuration Management plan

    d) Backup and Disaster recovery plan

15.4 Release Process

Release Flow

- All release are done specific to modules.
- All modules have two tasks created for tracking the internal release and production release.
- All release history pertaining to the project phase can be traced from here.
- All individual module releases are maintained in separate subtask of release type

Release Schedule

- The GO LIVE date will be updated by the implementation team in the production release task. All production release will have the release initiator details.
- All releases will be thoroughly reviewed by the QA lead. If the QA release found stable, move to production release. Production release will be phased by Field Testing at site and Operational Readiness Testing.
- The implementation team will accordingly comment on the acceptance of the same. The implementation team will update the site coordinator for the successful release.

Release Information

- The release task will have reference to task, bugs and subtasks against which a particular version is getting released.
- Description and steps to follow as part of prerequisite for deployment
- Any additional frameworks or supporting installation must be maintained and attached to the release.
- It can be linked as an attachment or reference to its location can be mentioned.
- All database related changes must be linked or mentioned.

STRABAG	TECHNICAL PROPOSAL – HIGHWAY TRAFFIC MANAGEMENT SYSTEM	एम एम आर डी ए MMRDA

15.5 Versioning Scheme

Versioning Pro	X.SVN NO.Y. ZZZ → Custom Release → Minor Release → SVN Version → Major Release

Versioning Scheme	Release Type	Description
X	Major Release	Indicates the major release version. This will only change the minor release has reached a certain level like 30 to 50 then the decision may be taken to make it a major release
SVN NO		SVN Code base revision number for the respective release
Y	Minor Release	Increment only in case of a) Major Enhancement like feature additions b) Towards code standardization c) New feature addition d) Any feature Enhancement
ZZZ	Custom Release	Increment only on case of a) Small Changes in code with respect to hardware b) Bug solving related to stability, performance, test cases c) Any project specific report additions

15.6 Change Management flow
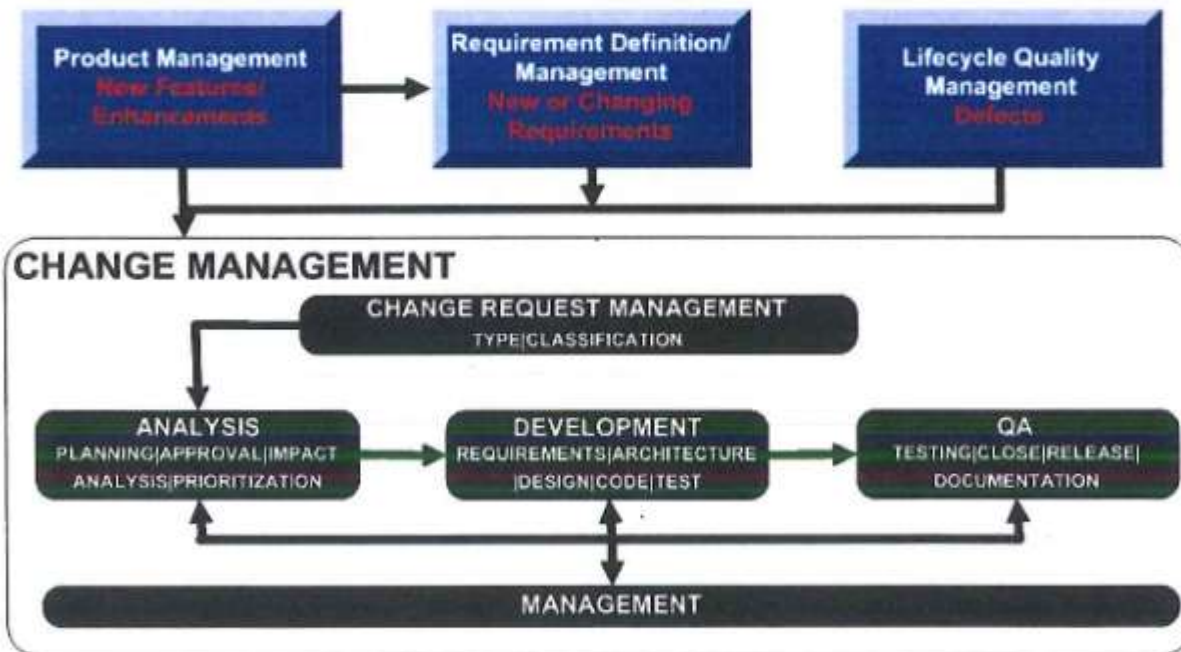
Change management process and change request log are maintained in the JIRA tool for detail recording.

STRABAG	TECHNICAL PROPOSAL – HIGHWAY TRAFFIC MANAGEMENT SYSTEM	एम एम आर डी ए MMRDA

5) Quality Assurance
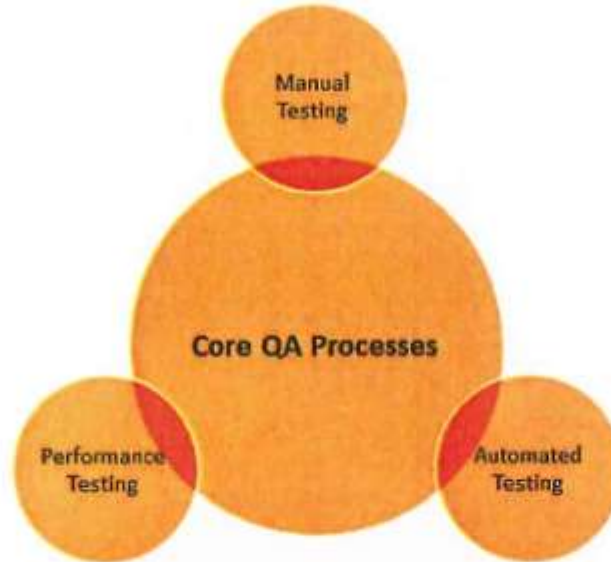
Figure 15:3 – EFKON Quality Assurance Methodology

15.7 EFKON Testing Process Overview

1) EFKON Testing Process (ETP) is a risk-based, customizable, and technology-independent methodology for testing software applications. The test reports and issue reports allow management to assess the readiness of the product for release. They are also used to facilitate testing analysis and process improvement. The key to process improvement is our Understand-Plan-Act-Review cycle. We are constantly reviewing the results of our actions and creating a better plan for the next cycle.

2) EFKON Testing Process (ETP) contains our core processes which are indicated in the diagram above. The core processes are the foundation of the test program and support manual testing, automated testing, and performance testing.

STRABAG

TECHNICAL PROPOSAL –
HIGHWAY TRAFFIC
MANAGEMENT SYSTEM

एम एम आर डी ए
MMRDA

3) **Test Plan**: A Test Plan is developed to describe the test program, timelines, resources, and tests to be performed for the test cycle leading to the release of a product.

4) **Test Suites**: The Test Suites are groupings of similar test cases that are used to plan and manage the testing process.

5) **Test Cases**: The Test Cases describe the tests to be executed. The tests may be Manual, Automated, Performance, or a combination of all three. The manual tests may be structured or unstructured using exploratory testing or a combination of either.

6) **Test Tasks**: A Test Task is any task that will be carried out to implement the Test Plan. It may be a Test Case that is assigned to a tester for execution on a specific configuration.

7) **Issue Tracking**: the issues or defects discovered through test execution are entered and tracked to resolution using the JIRA tool.

8) **Test Reports**: The Test Reports are generated to signify what has been tested and what remains to be tested.

9) **Issue Reports**: The Issue Reports are generated to provide metrics regarding both outstanding and resolved issues.

10) **Retrospective**: If an Agile methodology is used, a Retrospective is conducted by following each iteration. If a Waterfall methodology is used, a Project analysis is conducted at the end of the project. The purpose of the Retrospective analysis is to review what happened, what worked, and what did not work. This information is used to make improvements for planning the next iteration or project.

11) EFKON testing team performs the following key testing and uses **QTP, Selenium,** and **Test-complete** tools to manage various types of testing requirements.

    a) Automated Testing

    b) Manual Testing

    c) Integration Testing

    d) System Testing

    e) Regression Testing

    f) Performance Testing

    g) Project Management

    h) Requirements Management

    i) Exploratory Testing

Technical Proposal

Method Statement

Toll Management System

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EFKON

Technical Proposal

Of

ITS Part-1: Toll Management System

for

Mumbai Metropolitan Region Development Authority (MMRDA)

at

Mumbai Trans Harbour Link (MTHL) Project

Document name: MMRDA-MTHL/ITS Part-1 TMS/TP/001/V1/R0

STRABAG	TECHNICAL PROPOSAL – TOLL MANAGEMENT SYSTEM	एम एम आर डी ए MMRDA

Table of Contents

1943 81

List of Figures

List of Tables

	TECHNICAL PROPOSAL – TOLL MANAGEMENT SYSTEM	एम एम आर डी ए MMRDA
STRABAG		

Abbreviations

Abbreviation	Description
ALB	Automatic Lane Exit Barrier
AVC	Automatic Vehicle Classifier
EDI	Electronic Data Interchange
ETC	Electronic Toll Collection
ICD	Interface Control Document
ICS	Incident Capture System
IR	Infrared
LC	Lane Controller
LED	Light Emitting Diode
LPIC	License Plate Image Camera
LSDU	Lane Status Display Unit
MCBF	Mean Cycle Between Failures
MCU	Master Communication Unit
MIS	Management Information System
MLB	Manual Lane Barrier
MMRDA	Mumbai Metropolitan Region Development Authority
MTBF	Mean Time Between Failures
MTHL	Mumbai Trans Harbour Link
MTTR	Mean Time to Repair
OHLS	Over Head Lane Sign
PCI	Peripheral Component Interconnect
RAID	Redundant Array of Inexpensive Disks
RFID	Radio Frequency Identification
TCD	Toll Collector Display
TCK	Toll Collector Keyboard
TL	Traffic Light
TMS	Toll Management System
UFD	User Fare display
UPS	Uninterrupted Power Supply
USB	Universal Serial Bus

1   About Efkon India

EFKON is a global leader in Intelligent Traffic and Transportation systems. Solutions developed by the EFKON R&D team are running on a large number of highways across the world including more than 50 plus live projects in India. Efkon is the industry leader because:

✓ EFKON is a part of € 20 billion groups, STRABAG SE, the largest European INFRA company
✓ 500+ technical people
✓ Global Innovation center in India with 60 + R&D team
✓ 24x7x365 support network

Established in India in 1999, Efkon India has provided several first-of-its-kind solutions to the industry. Its wide range of customers includes IHMCL, Tata Reality, GVK, Uniquest, L&T, Oriental, HCC, Jaypee, IL&FS, Axis Bank, Maruti Suzuki, Daimler, and Indian Oil Corporation.

The Central Ministry of Urban development awarded Highway Traffic Management Systems at NOIDA as BEST Intelligent Transportation System. Confederation of Indian Industry (CII) has ranked EFKON among the top 25 Innovative Companies in India.

Many reputed organizations from India and abroad have appreciated the Intelligent Traffic Management system developed by EFKON.

A software and hardware R&D team of more than 60 people are dedicated to creating products and solutions that save lives and ensure smooth traffic flow.

EFKON India has a unique distinction of developing technologies in both software and hardware area that are increasingly being used in both developing and developed countries.

The Efkon India R&D team, an indispensable part of the Efkon Global R&D team has been instrumental in devising cost-effective and quality solutions.

EFKON India Pvt. Ltd is an ISO 9001:2008 certified company for the functions of product development and product delivery (including system integration, system installation, project management & system maintenance).
Our system can be integrated to deploy various technologies to work in conjunction with existing systems to upgrade for –

- Integrated VTS systems for patrolling vehicles with RTMS systems.
- Congestion and emission pricing systems to monitor & control pollution and urban traffic congestion.

STRABAG	TECHNICAL PROPOSAL – TOLL MANAGEMENT SYSTEM	एम एम आर डी ए MMRDA

EFKON Toll Management System has been developed over the years to give the best reliability as per international standards and suitability to the Indian conditions.

Efkon is the first system integrator to have successfully implemented RFID based ETC system. Total RFID-based Lane deployed is 115 all over India.

The only company in India to have implemented all the three technologies IR based, Microwave Based and RFID-based ETC.

ETMS is designed to easily upgrade it to incorporate features like Automatic Number Plate Recognition System (ANPR), speed enforcement system, video incident detection system (VIDS), vehicle tracking system, weigh in motion system (WIM), surveillance system, etc.

Being a Turnkey Solution Provider, the key phases of our projects include consulting, system design, hardware manufacturing and software development, documentation, field implementation/installation, commissioning & testing, and operation & maintenance.

Recently Efkon India has been awarded Asia's most trusted Company Award 2019 in Electronic Tolling, Transport management systems, and Solutions Category by International Branding Consulting Corporation, USA.

2 Overview

- The MTHL (Mumbai Trans Harbour Link) connects Sewri on the Mumbai side with Chirle on the Navi Mumbai side in Maharashtra State, India.

- The proposed solution covers the "Design, Manufacture and Factory Test, Shipping to Site, Installation, Testing and Commissioning of The Toll Management System for the Mumbai Trans Harbour Link (MTHL), Mumbai, India"

- The proposed Toll Management System (TMS) will be installed at Toll Plazas of the Mumbai Trans Harbour Link (MTHL) project in Mumbai, India. The Toll Plaza System (TPS) will be established at two locations comprised of a total of 38 hybrid lanes.

- The proposed TMS system is a part of "**Package** 4- Design, Supply, Installation, Testing and Commissioning of Intelligent Transport System (ITS), Toll Management System, Electrical works, Highway Illumination System, Construction of Toll Plazas and Administrative Buildings including Command Control Centre." of the MTHL project.

MUMBAI TRANS HARBOUR LINK PROJECT
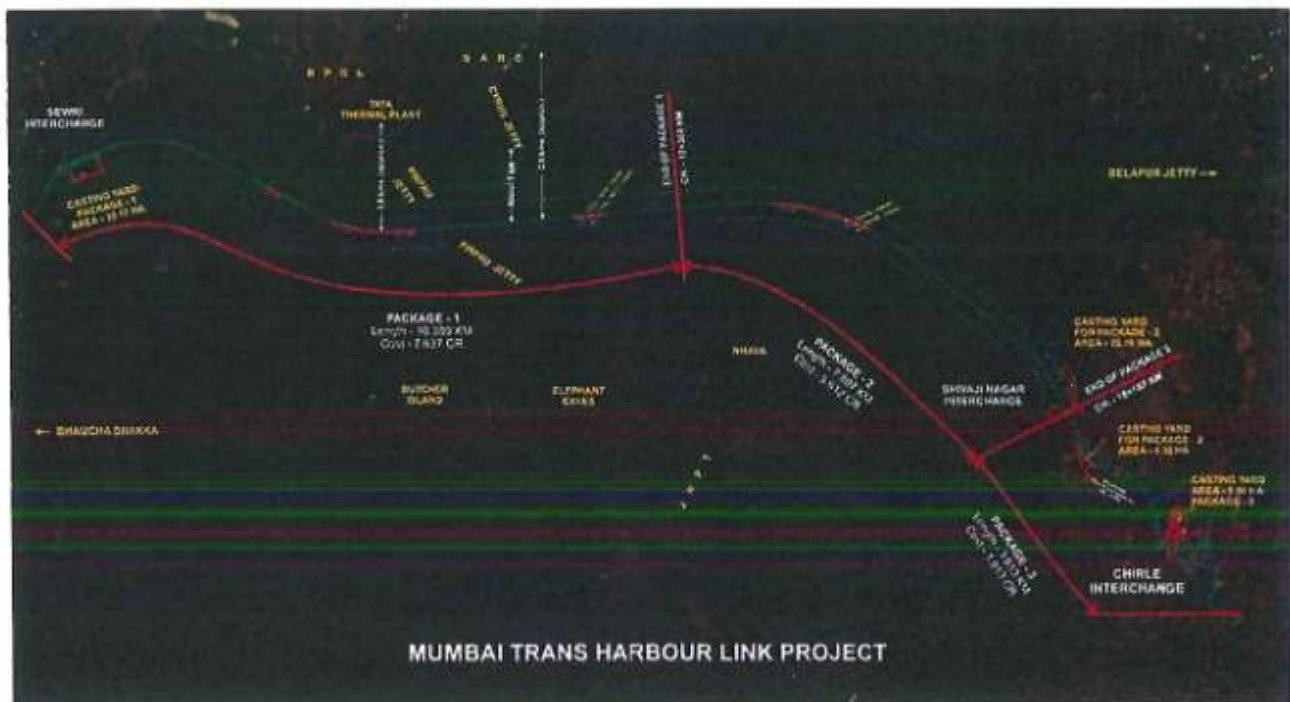
- On this MTHL Project, Toll Plaza will be established at two locations. The Mainline toll plaza will be located at the section between Shivaji Nagar IC and SH54 IC (i.e., at Gavan) whereas another toll plaza will be located at Shivaji Nagar Interchange with a tollgate at all on/off ramps. Each tollgate handles the vehicles along the specific route. All lanes will be equipped with the manual, QR, Credit/Debit card system, ETC payment modes to allow the lanes to accept payment via all modes all the time.

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- Toll plaza locations & their lane configurations are listed in Table 2:1.

Table 2:1 – Location and Number of Tollbooth

Location	Toward	Type	# of Hybrid lanes	Location
Mainline Toll Plaza	Sewri	Mainline	8	KM 19+370
	Chirle	Mainline	8	
Shivajinagar Interchange	AP-Sewri	Entry 1	6	KM 17+400
	JNPT-Sewri	Entry 2	3	
	AP-Chirle	Entry 3	3	
	Sewri-AP	Exit 1	4	
	Sewri-JNPT	Exit 2	3	
	Chirle-AP	Exit 3	3	
Total			38	

- The Lane system facilitates the collection of tolls and recording each of the transactions. Various equipment is proposed to perform toll collection activities, record transactions, manage the traffic flow, etc.

- The Toll Plaza System (TPS) facilitates monitoring and control over the plaza and lane equipment. It maintains the central records for the current plaza and also facilitates Plaza level MIS Reporting.

- The Toll Management System Control Central (TMS) facilitates the collection of data at a central location and management of the same.

- The connectivity between the toll management system center and toll plaza system will be formed using the optic fiber cable (laid as a part of HTMS solution) & layer switches.

- The document discusses **EFKON's Toll Management System** hardware and software architectures. This technical proposal elaborates the system components, functionality, and their respective specifications and interconnection between hardware and software components for the proposed TMS.

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3 System Description

3.1 Introduction

- The system design and architecture are such that all lanes are covered and there is a maximum collection of revenue. The basic system requirements kept in view while designing the system has been:

  a) Ruggedness, reliability, and speed of operation with efficiency

  b) Ability to prevent fraud and ensure maximum collection of revenue

  c) The toll collection philosophy and the toll collection system ensure that road users do not cross the plaza without paying a toll.

- EFKON's TMS design is capable of handling all types of toll operations along with the proposed computerized toll fare collection lanes.

- The lane level equipment is distributed & installed in booth, island & lane areas to execute TPS operations.

3.2 EFKON TMS

- EFKON's TMS is a smart way of collecting tolls on the roads/ expressways.

- The system utilizes sensors, electronic devices, computers, network systems for the toll plazas. An intelligent package of software programs is used to perform these functions.

- The objective of the system is as below:

  a) Implementation of an efficient toll collection and management system.

  b) To incorporate leading-edge technology and international best practice into the Project.

  c) To ensure the maximization of toll revenues and minimization of revenue leakage

  d) Implementation of NPCI's latest Electronic Toll Collection process (ICD 2.5)

- The system performs the following main functions:

  o Processing of toll transactions, their status, and toll information

  o Display for toll payment to the road user

  o Automatic classification of a vehicle at lane

  o Incident management of transactions with transaction review functionality to prevent loss of revenue

  o Traffic and revenue integrity

  o Seamless data integrity & data redundancy

  o Ease of use for operators & hassle-free frequent user processing

  o Systematic database management of toll transaction data

  o Automatic storage of transaction data

- o Accurate, robust, and flexible reporting system to ensure all transactions, incidents, traffic, and revenue as a part of MIS

- The TMS includes all lane equipment, Automatic Vehicle Classification, and counting system, Automatic Lane Barrier, Lane Controller, LPIC Camera, etc. The Plaza equipment and software comprises Servers Infrastructure, TMS software, the latest RDBMS Database & other plaza software required for the execution of EFKON's TMS system.

- Each lane operates in Hybrid mode i.e., the user can pay toll using either FASTag or in Cash. The operation of all lane equipment will be monitored continuously by a Toll Plaza System (TPS) which also compile, audit, and prepare the statistical data for record & display in the control room.

- A set of equipment will be installed on the booth, island, lane, canopy, plaza building, and software like toll management software application for monitoring of toll collection, operation, and management.

3.3   Toll System Configuration

- A combination of the open and closed toll system will be introduced to the MTHL, where toll plaza is placed on the mainline between Chirle IC and Shivaji Nagar IC at Gavan. In addition, tollgates are placed at all entry and exit ramps of Shivaji Nagar for the vehicles that use Shivaji Nagar IC.

- The toll management system will have three tiers of a hierarchy consisting of Toll Management System at the top, Toll Plaza System at each toll plaza, and Toll Lane system at each tollgate as shown in Table 3:1.

Table 3:1 – Toll System Configuration

Location	Shivajinagar				Mainline Toll Plaza	
Toll management center system					Yes	
Toll plaza system	Yes				Yes	
	Entry		Exit		Eastbound	Westbound
Equipment	To Sewri	To Chirle	From Sewri	From Chirle		
Cash/QR code	Yes	Yes	Yes		Yes	Yes
ETC	Yes	Yes	Yes		Yes	Yes
Cash/QR refund				Yes		
ETC refund				Yes		

- A toll management system center will be established at the mainline toll plaza located at Gavan. The toll management system will supervise the entire TMS. At the mainline toll plaza and Shivajinagar, a toll plaza system will be provided to monitor and control the toll lane system at the tollgate.

- A set of toll lane equipment will be installed in the tollbooth, on the toll island, or its vicinity for toll collection operation. The operation of all lane equipment will be controlled and monitored continuously by the toll lane controller at each toll lane and toll plaza system (TPS). The toll plaza system will also compile, audit, and prepare the statistical data for printout and display and onward transmission to the toll management system.

- The toll plaza system will also provide management facilities such as attendance recording of staff, reconciliation between declared and expected toll collection, control of cash and changes transferred between the toll plaza and the bank, reconciliation of the ETC revenue sent to the acquirer bank, and received from the issuer bank, settlement of payment made by credit/debit card, etc.

- The toll plaza system will operate as an autonomous system with no data communication between the plaza and toll management system center system. Likewise, the toll lane system will also operate normally even when the data link with the toll plaza system is interrupted. During the interruption, the toll lane system will operate normally and store the transaction data. Upon recovery of communication link with toll plaza system, toll lane system will send all data stored during the interruption and the entire system will operate as if there has been no interruption.

3.4   Toll Collection Location

- Due to the location of tollgate, vehicles that travel between two ends of MTHL pass through tollgate one time at mainline tollgate at Gavan between Sewri and Chirle. While the vehicles that travel between Shivaji Nagar and Chirle pass through the tollgate twice. To avoid double payment and underpayment, the toll will be collected at the locations summarized in Table 3:2.

Table 3:2 – Toll Collection Location

From	To	Toll payment at	Tollgate type	Remarks
Sewri	Shivaji Nagar	Shivaji Nagar	Exit	
	Chirle	Mainline toll plaza	Mainline	
Shivaji Nagar	Sewri	Shivaji Nagar	Entry	
	Chirle	Shivaji Nagar	Entry	Need to surrender proof of payment at the mainline toll plaza

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From	To	Toll payment at	Tollgate type	Remarks
Chirle	Shivaji Nagar	Mainline toll plaza	Mainline	Need to refund at exit tollgate
	Sewri	Mainline toll plaza	Mainline	

- The toll will not be collected from the vehicles that use the section between SH54 IC & Chirle IC. To cope with the system configuration, the following measures will be followed for toll payment.

  - Payment by cash/QR code:

    - The receipt for cash and QR code payment will have a second part that carries a bar code indicating the date, time, interchange, and other details of the payment made.

    - Vehicle traveling from Shivajinagar to Chirle will pay the toll in cash or QR code at the Shivajinagar & receive a receipt. At the mainline toll plaza, the vehicle will surrender the second part of the receipt to the toll collector as proof of entry at Shivajinagar and payment already made. The toll collector scans the bar code on the receipt and lets the vehicle proceed. If no proof is shown, the vehicle is considered to have entered MTHL at Sewri and the full amount of toll will be charged.

    - Vehicles traveling from Chirle to Shivajinagar will pay the full amount of toll at the mainline toll plaza. At the exit at Shivaji Nagar, the vehicle will surrender the second part of the receipt to the toll collector as proof of payment at the mainline toll plaza. The toll collector scans the barcode to confirm the payment has already been made, refunds the toll difference, and lets the vehicle proceed.

  - Payment by ETC

    - For all transactions executed using FASTag, the entry and exit will be detected by the RFID readers installed in the lanes.

    - For every ETC transaction, the blacklist as sent by the CCH (NPCI) will be checked in the lane and upon successful validation, the vehicle will be allowed to proceed.

    - If the vehicle is found in the blacklist entry, the user will be required to pay the toll by other methods of payment.

    - All the entry and exit pair transactions will be sent to the acquirer bank for a further demand of the toll fee from the Issuer bank with NPCI being the CCH.

  - Payment by credit/debit card

    - The receipt for credit/debit card payment will have a second part that carries a barcode indicating the date, time, interchange, and other details of the payment made.

    - For toll payment paid by credit/debit card; the refund required for the trip from Chirle to Shivajinagar will be treated as a payment of a negative amount and the transaction will be sent to the acquirer bank.

3.5 Toll Exemption

- The Mechanical Vehicle as mentioned in "National Highways Fee (Determination of Rates and collection) rules, 2008 [GSR 838(E) dated 5/12/2008 – point no 11" will be exempted from payment of toll.

- The toll collector terminal will be provided with a key for toll exempted vehicles. The toll exemption transaction at toll lane will be the same as cash payment operation except no cash is paid and data including a snapshot of the vehicle will be taken for toll exempted transaction for verification purposes.

3.6 Code System

The proposed system assigns a unique number for all entities which are part of the system. This includes system records and transactions, system users, equipment that are installed as a part of the system.

3.6.1 Toll Collection Facilities

Each interchange is assigned a unique ID consisting of alphabetical characters of location & direction of the lane. These codes will be used in the identification of the transaction and identification of toll collection facilities.

Location	Toward	Type	ID Assigned
Mainline Toll Plaza @Gavan	Sewri	Mainline-Westbound	MTPWB
	Chirle	Mainline-Eastbound	MTPEB
Shivajinagar Interchange	AP-Sewri	Entry 1	SHEN1
	JNPT-Sewri	Entry 2	SHEN2
	AP-Chirle	Entry 3	SHEN3
	Sewri-AP	Exit 1	SHEX1
	Sewri-JNPT	Exit 2	SHEX2
	Chirle-AP	Exit 3	SHEX3

3.6.2 Transaction

1) In the proposed TMS, each transaction will be identified with a unique transaction number which includes:
   a) Date and time of transaction
   b) Plaza and lane ID
   c) Sequential number assigned based on the above data
2) Each transaction data contains at least the following information:
   a) Vehicle classification (by TC & AVC)

b) Toll collector ID

c) Toll amount collected

d) Method of Collection of Toll (Cash/QR/ETC/Cr or Dr cards)

e) Fine/ penalty and another amount charged

f) Exceptional transaction (exemption, military convoy, and other cases)

g) Discrepancy in vehicle classification if any

h) Image and video for the transactions

i) LPIC image and output

3) E.g., a vehicle user enters the stretch from the Sewri for going towards Chirle, then he has to cross MTP at Gavan. As if he took lane 04, on 15th Jan 2022 at 10:45 am, then the toll transaction will be generated at the eastbound lane of MTP is stored with a number MTPEB0420220153870000225 where,

MTPEB : Plaza ID for MTP toward Chirle for Eastbound traffic

04 : Lane number

2022 : Year

015 : 15th day of the year

38700 : Time in seconds (10:45 am)

00225 : Sequence number

4) Using the above data, the user can search for a particular transaction or a set of transactions from the database. The facility is provided at the Audit Workstation.

5) In the event of the lane, the equipment operates in a standalone mode due to interruption of the data link between lane equipment and TPS server, the transaction time data is marked accordingly & upon restoration of the data link between lane equipment and plaza server, the data will transfer from lane equipment to TPS server. The server will check the date and time data and difference with the system clock if any will be corrected.

3.6.3 Staff ID

Each user of the system is registered in the system and assigned a unique ID. The staff ID is generated based on the user category. The system supports various user categories such as Toll Collector, Supervisor, Administrator, etc. The user's categories are customizable as per the requirements during system operations. Each user category is assigned a different access level that controls the access to the system functions.

3.7 Vehicle Classification

3.7.1 MTHL Vehicle Classification

- o The vehicles will be classified into Seven (7) types by toll collector & the AVC system. The vehicle classification will be made based on the following parameters:

  - a) Height of the vehicle above the first axle
  - b) Overall height
  - c) Number of axles

- o The type of vehicle & basis of the system to classify the vehicle is as follows:

Table 3:3 – Vehicle Classification

MTHL Vehicle Class	Type of Vehicle	Definition
1	Car, Jeep, Van or Light motor vehicle	A car, jeep, van, or light motor vehicle is defined as any mechanical vehicle, the gross vehicle weight of which does not exceed seven thousand five hundred kilograms or the registered passenger carrying capability as specified in the certificate of registration issued under the motor vehicle act, 1988 does not exceed 12 excluding the driver.
2	Light commercial vehicle, Light good vehicle, or Minibus	Light commercial vehicle or light good vehicle or minibus is defined as any mechanical vehicle, with the gross vehicle weight exceeding seven thousand five hundred kilograms but less than twelve thousand kilograms or the registered passenger carrying capability as specified in the certificate of registration issued under the motor vehicle act, 1988 exceeds twelve but does not exceed thirty-two excluding the driver.
3	Bus or Truck	A truck or bus is defined as any mechanical vehicle, with the gross vehicle weight exceeding twelve thousand kilograms but less than twenty thousand kilograms or the registered passenger carrying capability as specified in the certificate of registration issued under the motor vehicle act, 1988 exceeds twelve exceeds thirty-two excluding the driver.
4	Up to 3 Axel Vehicle	3 axle vehicle means a mechanical vehicle having 3 axels or a vehicle with a gross weight exceeding twenty thousand kilograms but less than sixty thousand kilograms.

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MTHL Vehicle Class	Type of Vehicle	Definition
5	4 to 6 Axel Vehicle	**4 to 6 axle Vehicle** means a mechanical vehicle having 4 to 6 axels or vehicle with the gross weight exceeding twenty thousand kilograms but less than sixty thousand kilograms.
6	HCM / EME	**HCM or EME** means heavy construction machinery of earthmoving equipment or mechanical vehicle having 4 to 6 axels or vehicle with the gross weight exceeding twenty thousand kilograms but less than sixty thousand kilograms.
7	Oversized vehicle (7 or more axles)	**An oversized Vehicle** means a mechanical vehicle having more than seven axles or a vehicle with a gross weight exceeding sixty thousand kilograms.

3.7.2 FASTag Vehicle Classification

The FASTag is proposed as an RFID tag for ETC. The FASTag adopts the vehicle classification in Seven (7) categories. The mapping of the FASTag vehicle class with MTHL vehicle class is shown in Table 3:4.

Table 3:4 – Mapping of FASTag Vehicle Class with MTHL Vehicle Class

Tag class	Description	Tag colour	MTHL Vehicle Class
4	Car / Jeep / Van	Violet	1
	TATA Ace and similar mini light commercial vehicle	Violet	2
5	Light commercial vehicle / Mini bus	Orange	2
6	Bus 3 Axle/Truck 3 Axle	Yellow	4
7	Bus 2 Axle / Truck 2 Axle	Green	3
12	Tractor / Tractor with trailer / Truck 4/ 5/ 6 Axle	Pink	5
15	Truck 7 Axle and above	Blue	7
16	Earth Moving / Heavy Construction Machinery	Black	6

3.8 System Components

The system components are distributed under the following main categories:

- Toll Lane System Equipment
- Toll Plaza System Equipment
- Toll Management System Equipment

1958

STRABAG	TECHNICAL PROPOSAL – TOLL MANAGEMENT SYSTEM	एम एम आर डी ए MMRDA

3.8.1   Toll Lane System Equipment

- In the proposed TMS hybrid lane system, the user can pay the toll fare amount in Cash/QR code payments, credit card and debit card payments, ETC payments. The toll lane will be provided with the following equipment. The Bar code reader (BCR) will be provided in all exit lanes at mainline and Shivajinagar interchanges.

    1) **Booth equipment**

        a) Toll Lane Controller (TLC)

        b) Toll Collector Terminal (TCT)

        c) Receipt Printer (RPR)

        d) Emergency Foot Switch (FSW)

        e) Intercom Communication Unit Slave (ICUS)

        f) Tollbooth camera (TBC)

        g) Exempt Document Viewer (EDV)

        h) QR Code Board (QRC)

        i) Barcode Reader (BCR)

        j) Fingerprint Scanner (FPS)

        k) Handheld RFID Reader (HHDR)

    2) **Lane equipment**

        a) RFID Antenna & Reader (ANT)

        b) Manual Lane Barrier (MLB)

        c) Overhead Traffic Light (OHTL)

        d) Lane Traffic Light (LTL)

        e) User Fare Display (UFD)

        f) Automatic Lane Barrier (ALB)

        g) Amber Siren Beacon (ASB)

        h) Lane Camera (LCM)

        i) Number Plate Capture Camera (NPCC)

        j) Automatic Vehicle Classifier (AVC)

- Figure 3:1 shows an indicative TMS lane peripheral layout & tentative location of the equipment.
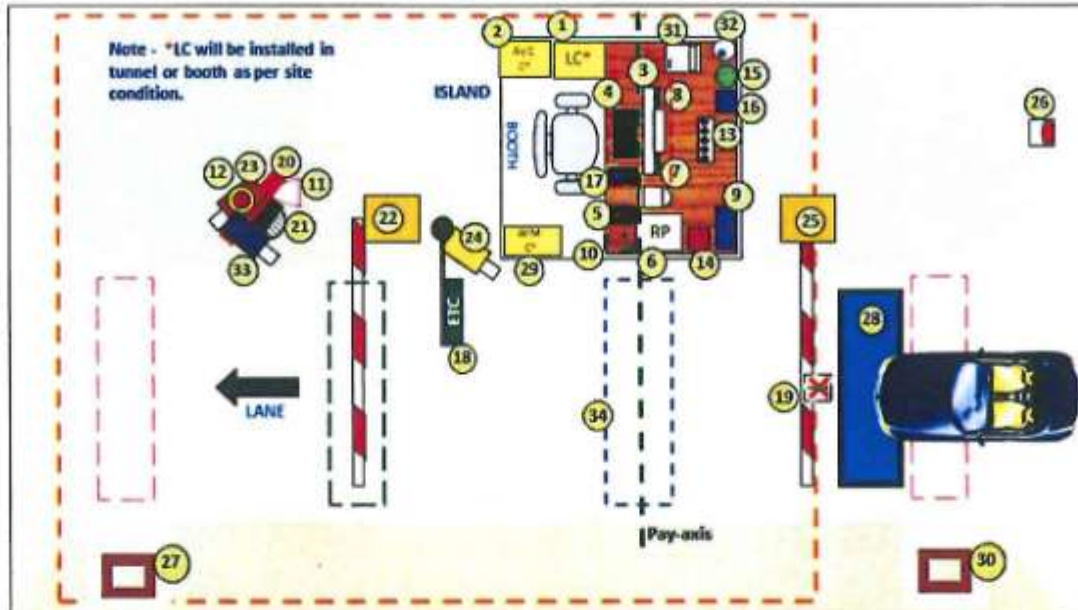
1.	Lane Controller*	13.	Manual Booth Controller	25.	Manual Lane Barrier (MLB)
2.	AVC Controller*	14.	Exempt Document Viewer Camera (EDV)	26.	Flashing light
3.	Toll Collector Display	15.	ETC Handheld Terminal (HHT)	27.	Laser based AVC Profiler
4.	Toll Collector Keyboard	16.	Wi-Fi Router for HHT	28.	MSWIM Platform
5.	Contactless Smart Card Reader/Writer	17.	Fingerprint Scanner for Login	29.	WIM Controller
6.	Receipt Printer	18.	ETC RFID Reader/ETC Transceiver	30.	Vehicle separator for MSWIM & Queue length monitoring
7.	Barcode Reader	19.	Overhead traffic light (OHTL)	31.	Intercom Slave Communication Unit
8.	Integrated Cash Drawer	20.	User Fare Display (UFD)	32.	Toll Booth Camera
9.	Fake Note Detector	21.	Lane traffic light (LTL)	33.	Lane Monitoring Bullet Camera
10.	Foot switch for Panic Alarm System	22.	Automatic Lane Barrier (ALB)	34.	Presence Loop
11.	Siren for Panic Alarm System	23.	ICS Camera		
12.	Amber Light for Panic Alarm System	24.	LPIC Camera		

Figure 3:1 – Indicative TMS Lane Peripheral Layout & Tentative Location of the Equipment

3.8.2   Toll Plaza System Equipment

- The toll plaza system will be a server-based system installed at the mainline toll plaza at Gavan and Shivajinagar interchange to control and monitor the operation of toll lane equipment.
- The Toll Plaza System (TPS) will have the following three main functions:
  1) Data acquisition from lane equipment and provision of real-time monitoring facilities via visual display unit in the control room of the plaza building
  2) Data processing and plaza management via visual display units, printer terminals, and data transfer facilities
  3) Sending and receiving the ETC related data and files as per NPCI latest ICD manual
- The TPS is proposed with the following configuration:
  1) Toll plaza servers in a hot standby configuration
  2) TPS backup server
  3) Auditor's console
  4) Workstations
     a) Lane status display unit (LSDU) workstation
     b) Audit workstation
     c) Snapshot image workstation
     d) CCTV monitoring equipment
     e) Tour of duty workstation
     f) Point of sales workstation
  5) Networking system components
  6) Printers
  7) Intercom unit master
- It shall be noted that the auditor's console accommodates lane status display unit workstation, audit workstation, snapshot image workstation, CCTV monitoring workstation, and master communication unit.
- The TPS servers will be configured in a hot standby configuration with TOR switches and SAN storage devices. The TPS will comprise various inter-linked software modules, some of which will carry out real-time functions, such as data communication with lane equipment and provision of detailed monitoring facilities.
- Each TPS will be interfaced via an optical fiber cable network to the TMS system. The TPS will make available data files relating to plaza operations for transfer to the TMS system and will receive data files such as operating parameters from the TMS system.

- Visual display units and printer terminals will be provided for control, selection, and data input and output. Back-up facilities will be provided through the use of appropriate external storage devices to ensure that no loss of data or restrictions on operation occurs as a result of the failure of either the TPS or of the data transmission link with the TMS system.
- The diagram shows the equipment interconnection proposed for Toll Plaza System.
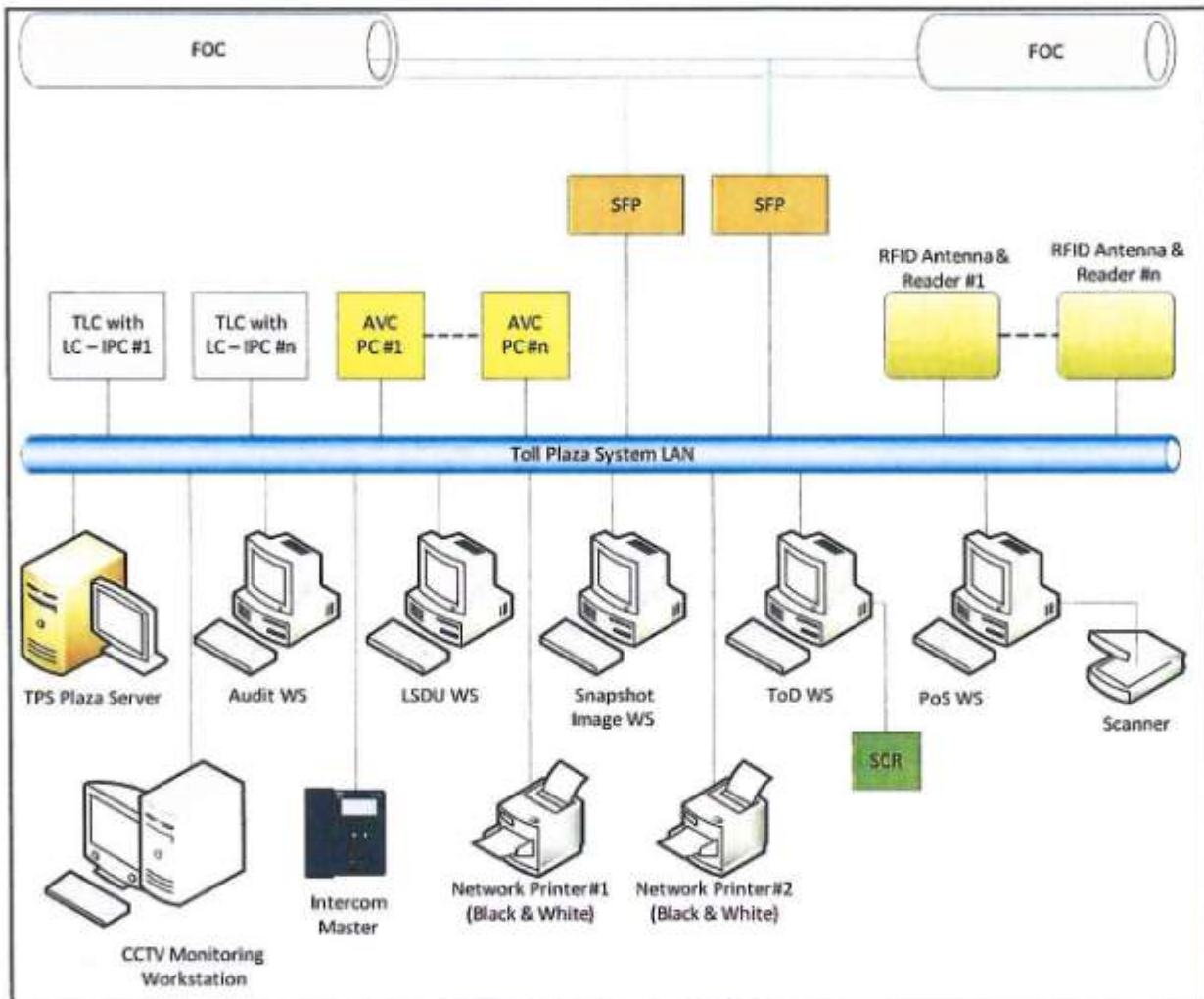
Figure 3:2 – Toll Plaza System (TPS) Equipment

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3.8.3   Toll Management System Equipment

- The toll management center system will be a server-based system installed at the toll management system center to be established at the mainline toll plaza at KM 19+370.

- The TMS is proposed with the following configuration:

  1) TMS Server in a hot standby configuration

  2) TMS backup server

  3) TMS administration workstation

  4) TMS reporting workstation

  5) Financial management workstation

  6) Snapshot image workstation

  7) Video Wall and Video Storage devices

  8) Networking system components

  9) Printers

  10) The TMS system shall have the following main functions: -

      a) Data acquisition from TPS.

      b) Data processing and validation via visual display units, printer terminals, and data/parameter transfer facilities.

      c) Downloading of operational parameters to TPS.

      d) Interfacing with backup TMS system for backup and standby operations.

  11) The TMS servers will be configured in hot standby configuration with top-of-rack (TOR) switches and storage area network (SAN) storage devices.

  12) The TMS system will be interfaced, via an optical fiber cable network to the TPS. The TMS system will make available operating parameters relating to plaza operations for transfer to the TPS and will receive data files from the TPS.

  13) Visual display units and printer terminals will be provided for control, selection, and data input and output.
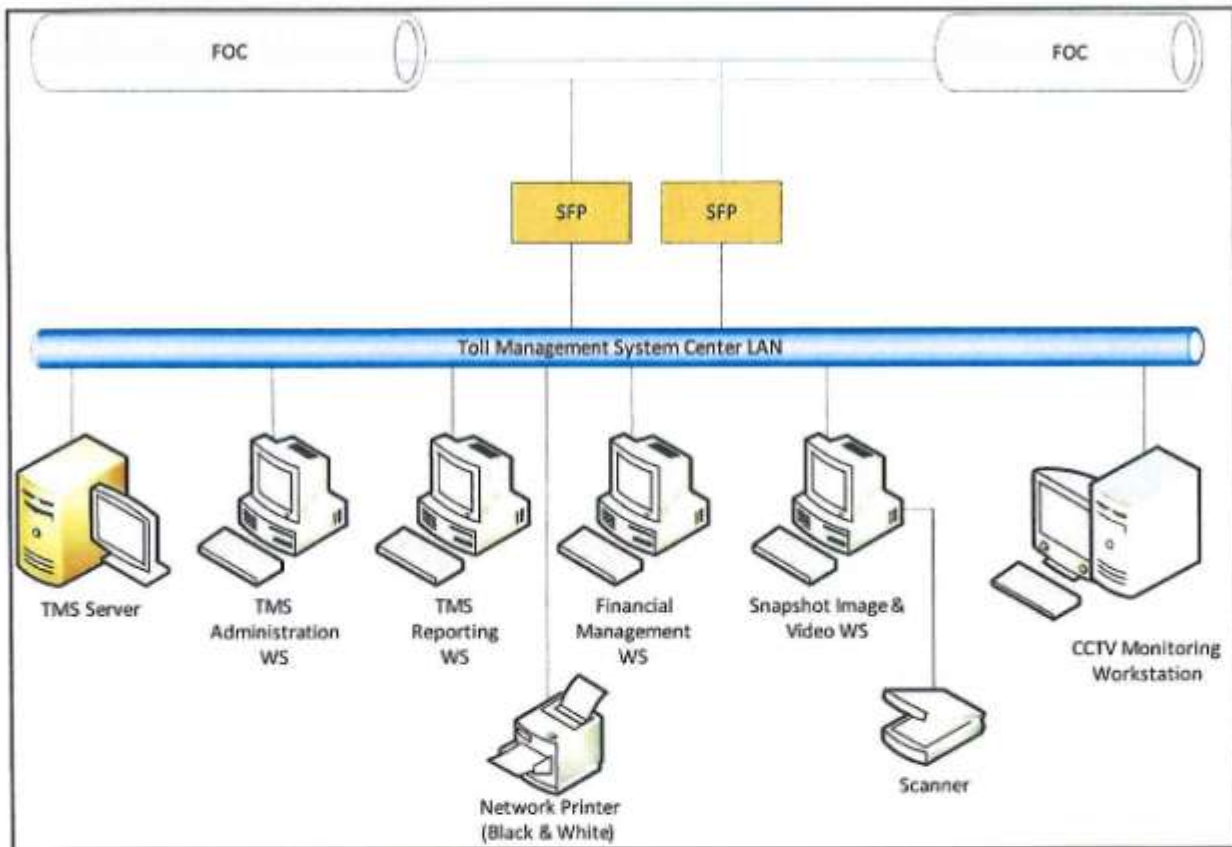
Figure 3:3 – Traffic Control System (TMS) Center Equipment

3.9 Software

The proposed system uses the software applications developed and customized as per the system requirements and the third-party software licenses to run the same.

3.9.1 Proposed Application Software Licensing

The application software developed and customized for the Toll Management System consists of various modules performing defined functionality. The Toll Plaza Level application software package consists of the following.

1) **Toll Plaza Lane Software**

2) **Toll Plaza TPS Software**

    a) TPS server interface

    b) Audit and reporting software

    c) Lane status display system software

    d) Snapshot image & Video workstation software

    e) Tour of duty software

    f) Incident management software

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g) Bank-in software

The figure shows the communication between software modules at the plaza level.

i. The typical flow of operations starts with the operator marking attendance at TOD WS.

ii. The operator goes to the lane assigned to him and logs into the system.

iii. He performs the toll transactions which are stored locally in the lane controller.

iv. The lane controller then sends this transaction data to the plaza server.

v. Along with storing the transactions, the lane controller sends the equipment status to the LSDU workstation and incident images to the Snapshot workstation.

vi. The LSDU operator sitting in the control room monitors the status of each lane, incidents and the Snapshot WS operator monitors the incidents.

vii. The plaza server stores the transactions from all the lanes and distributes the updated data such as fare tables, user account details, shift timings, etc. The backup module takes the backup of the server data at scheduled intervals.
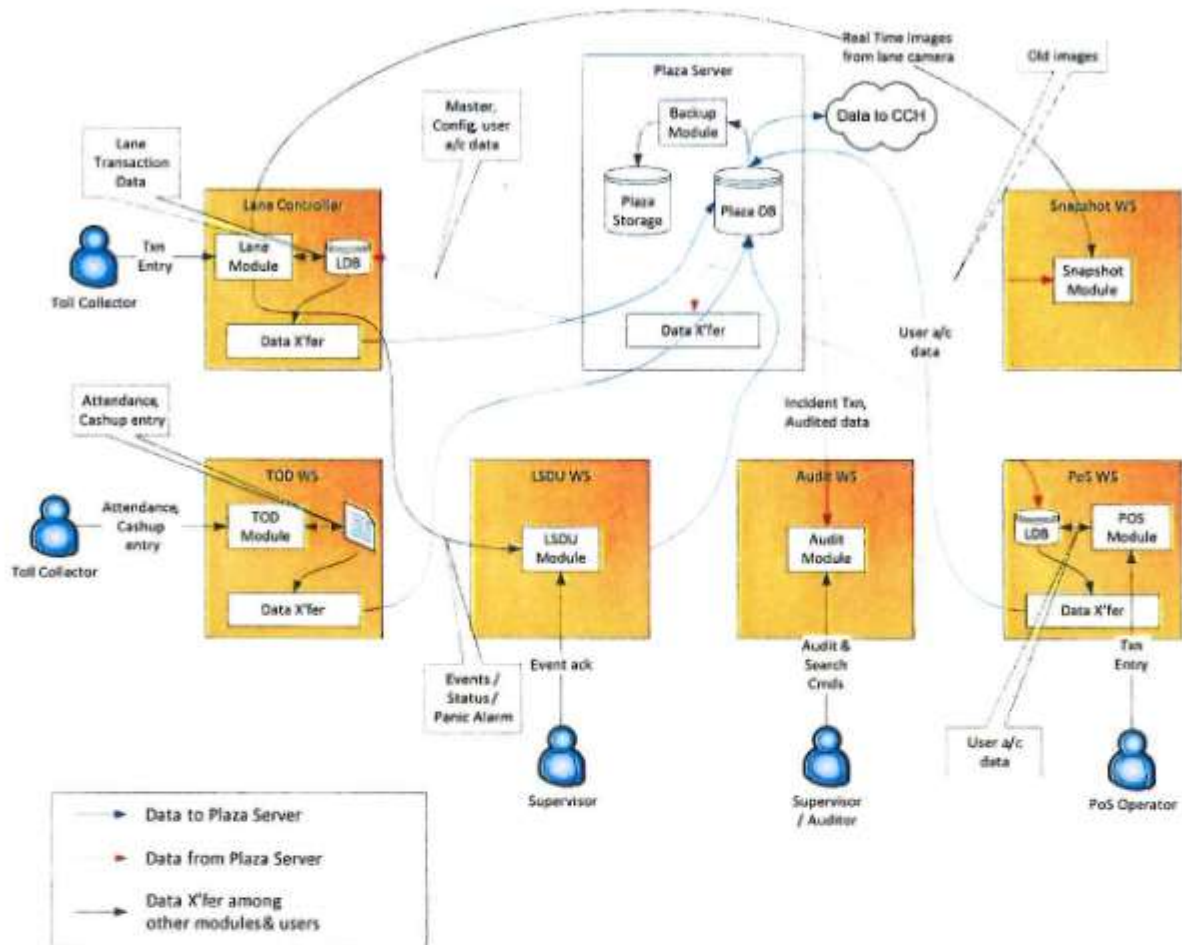
Figure 3:4 – Software Modules proposed at plaza Level

3) **The TMS Level application software**

  a) TMS server interface

  b) TMS audit software

  c) TMS reporting software

  d) Snapshot Image TMS central software

  e) Utility software

  f) Maintenance activity tracking and logging software
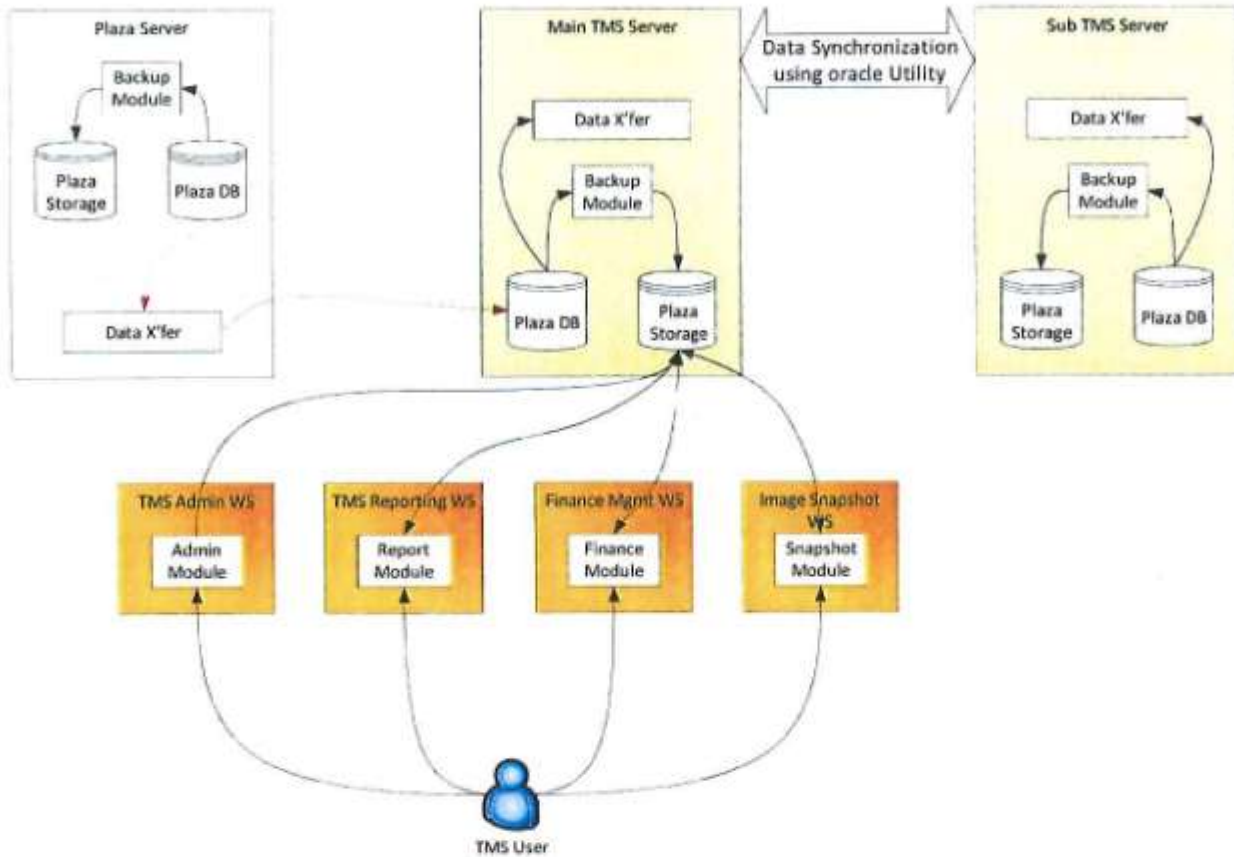
Figure 3:5 – Software Modules proposed at TMS Level

3.9.2 Software Environment – Third-Party Software

- The proposed application software is developed using Dot Net 2008/2012/2016 framework 4/4.6 on Microsoft Windows 10 platform.

- The database proposed is Oracle standard edition for plaza servers and Oracle Enterprise Edition for TMS Servers.

- The Operating system installed on the plaza servers is the latest Microsoft Operating system.

- The operating system installed on the workstations and lane controllers is Microsoft windows 10.

- Antivirus software with a firewall is proposed.

3.9.3   **Software Quality Assurance**

During the development and customization of the software for the project, Efkon is committed to using the method of development and procedures to meet the client's requirement for the application execution.

3.9.3.1   *Integration With External Applications*

➤ Toll System Application consists of many modules that are largely relevant to toll operations. As a result, there will be huge data accumulation at varying levels within the database. For example, the following types of information will be present:

Module	Information	Usability
User Management	All personnel information	Payroll, Attendance, etc
Transaction Management	Financial Data	Accounting
Traffic Data	Traffic count according to required classification	Data ware-housing

➤ While the proposed application does not inherently handle all these usabilities, the application is transparent enough to provide information for external sources in the following manner:

  o The proposed application uses Crystal Reports for all its reporting. One of the output formats of crystal reports is ".xls". Based on the requirement, the application can be enhanced to give the required output in the desired format as a ".xls" file.

  o In addition to this, on an as-needed basis, specific output as desired by the client in the pre-defined format (Example: .xml) can be developed to interface with external applications.

➤ As required, the applications can be enhanced to allow the Toll plaza system (TPS) and Toll management system (TMS) to operate with other systems such as traffic management systems interfaced to the data network and involving the bi-directional transfer of files.

3.9.3.2   *Application Enhancement*

The applications can be enhanced & customized further to provide features like

▪ Leave planning

▪ Tour of duty planning for staff

3.10 Network Equipment

- The proposed system uses network switches for the interconnection of lane and plaza computers and/or workstations. The plaza-level connectivity is provided using fiber. The connectivity from TPS and TMS is also achieved using fiber (which will be laid as a part of the ATMS solution).
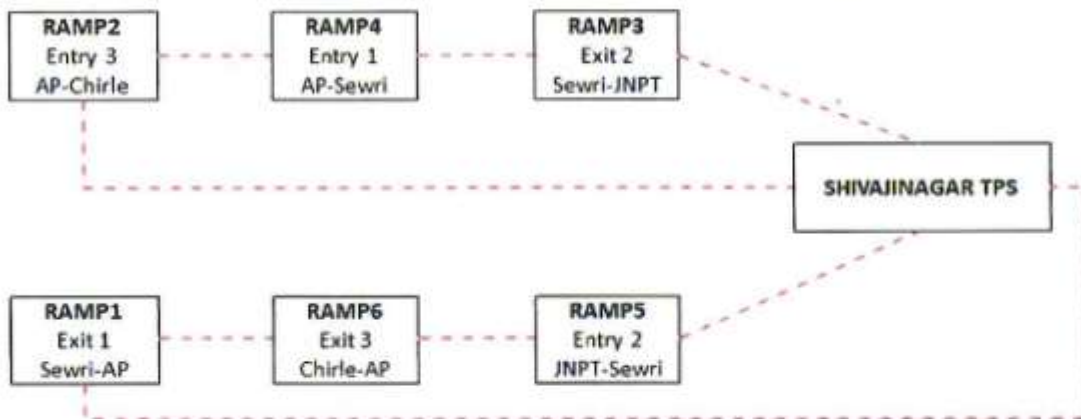
Figure 3:6 – Typical Interconnection diagram for Shivajinagar Interchange

- The proposed network comprises layer 2 switches with 1000 BaseX ports. A loop of layer 2 switched is formed at each plaza which is connected to two different groups of media converters. This configuration offers redundancy in the network. Even in case of failure in one fiber link, the data transmission is guaranteed via an alternate path.

3.11 Power Supply

- The proposed system uses a power supply made available at each plaza as a source of 440V, 3phase.
- This source is used to power the UPS system and charging batteries. UPS offers an uninterrupted power supply to complete lane equipment, plaza equipment with 30 minutes backup. UPS provides 240VAC, 50 Hz as suitable to the proposed toll equipment.
- **Distribution**
  - The Output of UPS is distributed using Power Distribution Boards to feed power to various groups of equipment. These power distribution boards are wall mounting type and equipped with MCBs that allow distribution feeders to be switched ON and OFF whenever required as shown in Figure 3:7.

004014
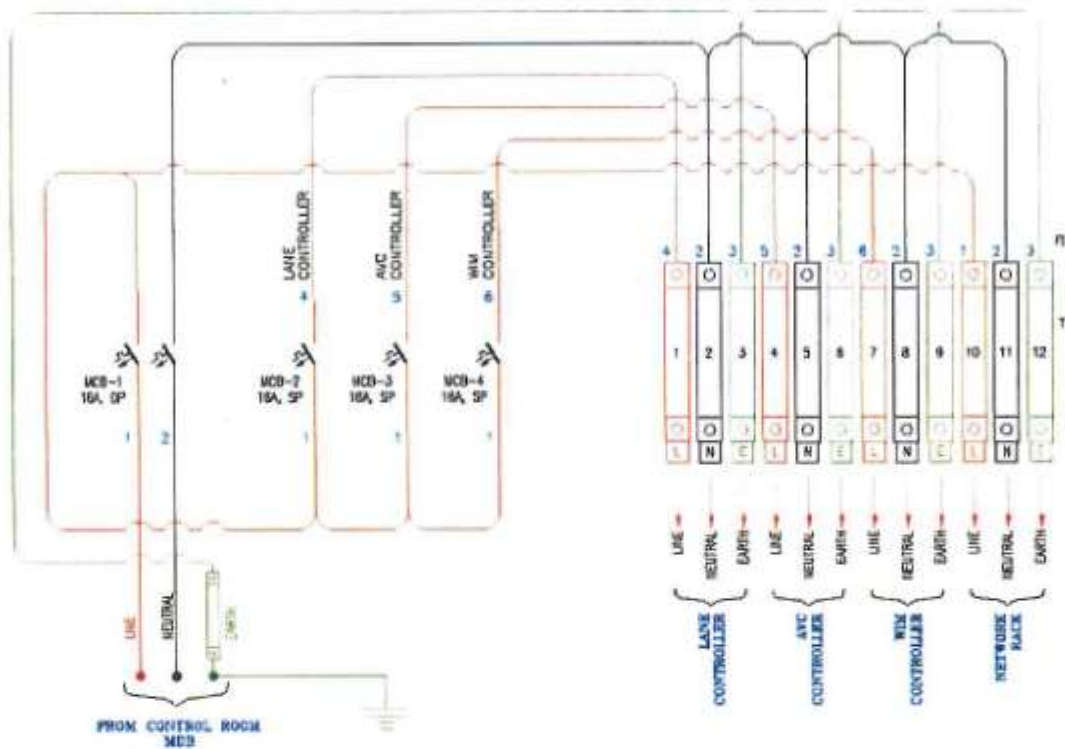
Figure 3:7 – Tentative Power Distribution for Lane Equipment from PDB

- As individual feeder is laid up to respective equipment (e.g., Lane Controller) power distribution box is deployed for allowing power cable to be looped to the equipment and main loop to next equipment as shown in the block diagram below.

Figure 3:8 – Power Distribution from MCB to Lanes

3.12   Booth Communication System

An intercom system is proposed to have voice communication between the control room and booth. The system uses a master intercom unit installed in the control room and slave units. The operator can initiate communication to the control room during emergencies. The control room operator can communicate with all slave units broadcasting the messages.
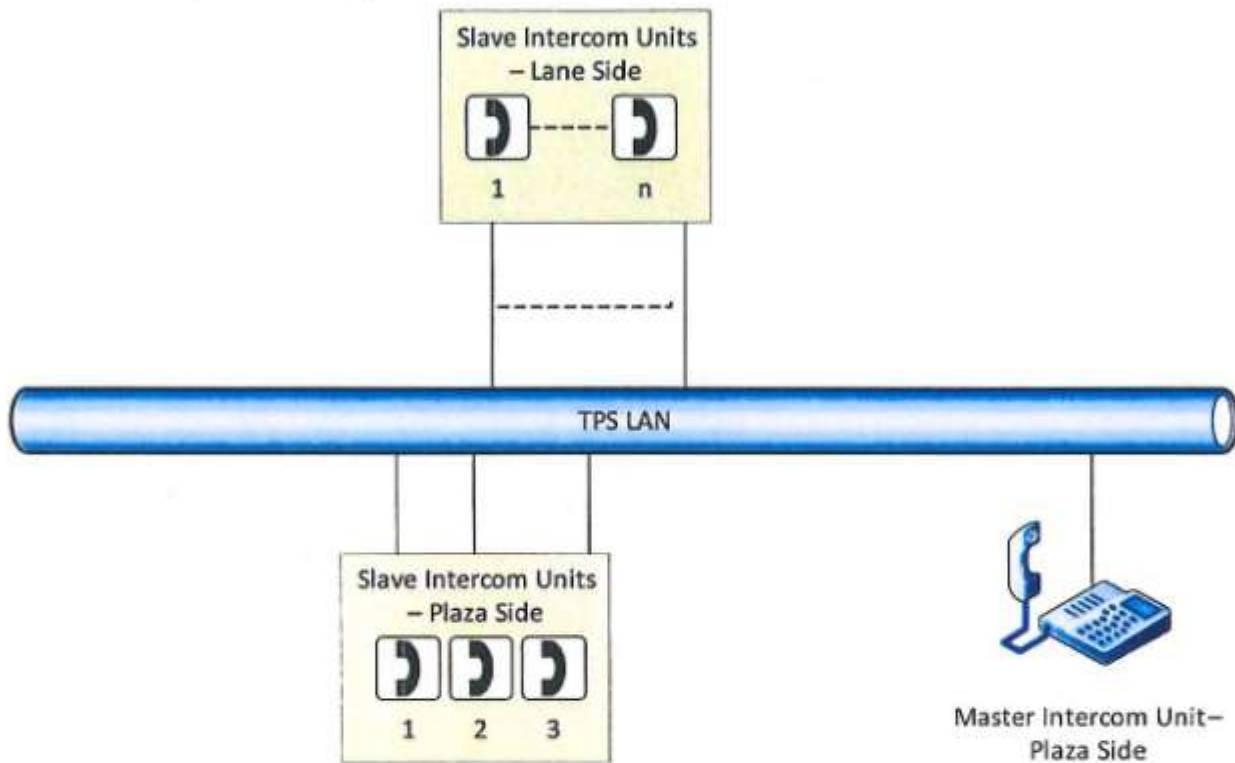
Figure 3:9 – Plaza Level Booth Communication Intercom System

3.13   CCTV system

- The system proposes four types of cameras to be used for surveillance and security purpose. These are booth monitoring cameras, lane monitoring cameras, plaza surveillance cameras, and plaza building security cameras.

- The Booth monitoring Cameras are proposed to install inside the toll booth to observe the activities of the toll operator while doing the transactions. The Lane monitoring cameras are proposed to install on the island to observe toll lane area movements. The plaza Surveillance CCTV cameras are proposed to install on a sufficient height mast and used for general surveillance of the toll plaza and walkways. The Plaza Building Security CCTV cameras are proposed to install for monitoring of security areas such as the plaza compound, general parking area, Toll Control Room, cash room, plaza building lobby, toll collector walkway, server room, UPS room, and cash van loading area.

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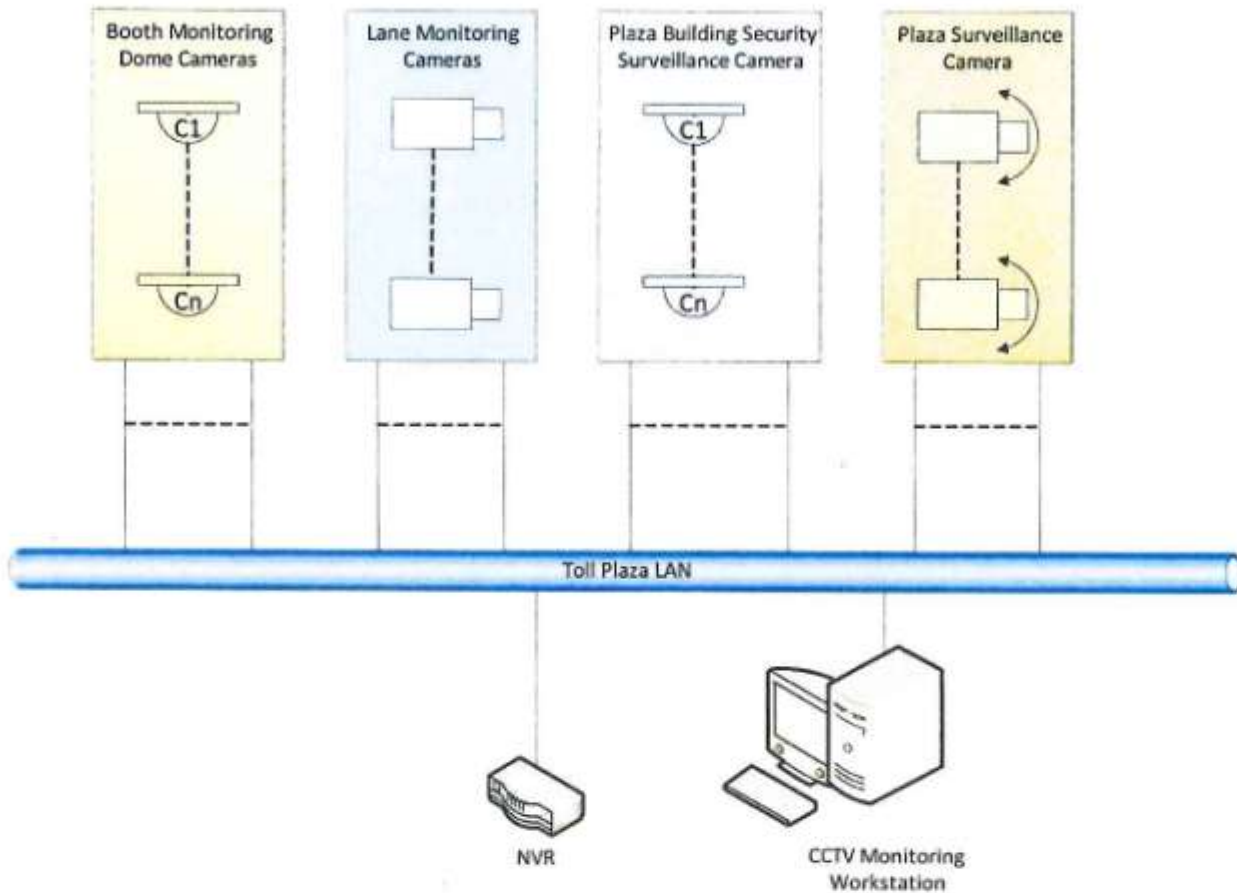
Figure 3:10 – CCTV System

3.14 Design Life

- The proposed equipment is chosen considering the tender specifications, system operations, and site conditions observed during the site visit. The outdoor equipment is proposed with suitable protection standards and/or suitable housing based on their application.

- **Design life**: This is the Period for which a component, device, or system is expected to function at its designated capacity without major repair.

- We confirm that offered equipment with the following exclusions will work within its specified parameters for a life of 10 years. The consumables are excluded from this.

   o A battery of UPS, Tag having fixed expected life on charge-discharge cycles

   o Printer cartridges having fixed life (consumable)

   o A lamp inside flasher (consumable)

   o Barrier motor, mechanical parts designed for 10 million opening and closing cycles

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3.15   Storage Capacity

- The proposed toll management system is designed with a sufficient capacity in terms of response time, transaction processing speed, data transmission bandwidth, and storage capacity to process a maximum of two hundred thousand transactions per day and up to five million RFID accounts.

- The proposed system meets the functional requirements of the Toll Management System. The current system is capable of handling 38 lanes distributed over two toll plazas, controlled by two local toll plaza system centers & monitored by two toll management system centers.

- Each transaction data will contain the following information:

  1) Vehicle classification (by toll collector and by AVC)
  2) Discrepancy in vehicle classification if any
  3) Image and video for the transactions
  4) LPIC Image and output
  5) Toll collector ID
  6) Toll amount collected
  7) Method of Collection of Toll (Cash/QR/ETC/Cr or Dr cards)
  8) Fine and other amount charged
  9) Exceptional transaction (exemption, military convoy, and other cases)

- The space required for one toll transaction including an image of the license plate is ~350Kb.

- If the transaction comes under Exceptional exempt transaction, then the EDV image for the verification will be attached to the exempt transaction and will be stored in the database for future audit. Space required for this ~30Kb.

- The space required for data generated by the AVC system for the transaction is ~20Kb.

- Hence, the space required per transaction per day is ~400 Kb

- The exit of the vehicle from the AVC detection area will trigger the incident capture camera installed in the lane to capture the Image and five (5) second video of the rear side of the passing vehicle. The video will be recorded at 1080P resolution, H265 compression, 15FPS. The storage space required for this is ~1.5Mb.

- Hence, considering storage space required for the overall transaction is ~2Mb

- In addition to this, storage space required for five million RFID accounts is ~ 50 Gb & other data for the transaction such as tariff table, etc. is 1 Gb

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3.15.1 Calculation of Disk Capacity for Lane Controller

The calculation for Toll Transactions Space for 30 Days			
Description	**Transaction Count**	**Size**	**UOM**
Transaction per day/ lane	5265		Nos.
Space required/ transaction		2	MB
Total space required/ day		10530	MB
Total space required for 30 days transaction data		309	GB
Storage space required for five million RFID accounts		50	GB
Other data for the transaction such as tariff table, lane application, etc.		1	GB
Total		360	GB

- Based on the above considerations, the space required to store data in Lane Controller for 30 days = 360GB. Any additional storage requirement during O&M shall be charged additionally.

3.15.2 Calculation of Disk Capacity for the Disk Connected with TPS On-line

  o The Shivajinagar interchange consists of 6 ramps, which have a total of 22 lanes. Hence, a maximum of 22 lanes of data will be stored at the Shivajinagar TPS

  o Out of 5265 transactions per day per lane, we assumed that 10% incidental transactions.

  o The image & video of the vehicle that has caused an incident will be kept for one year and the snapshot & video of the vehicle without any incident will be kept for one week.

Calculation of Disk Capacity for the Disk Connected with TPS On-line			
Description	**Transaction Count**	**Size**	**UOM**
Transaction per day/ lane	5265		Nos.
Number of incidental transactions (@10%) per day/ lane	527		Nos.
Normal transaction without any incident per day/ lane	4738		Nos.
Space required/ transaction		2	MB
Total space required to store incidental transactions (@10%) for one year (365 days)/ lane		376	GB
Total space required to store normal transactions data without any incident for a week (7 days)/ lane		65	GB
Total space required to store incidental transactions data (@10%) for one year (365 days) of 22 lanes		8272	GB

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Calculation of Disk Capacity for the Disk Connected with TPS On-line			
Description	**Transaction Count**	**Size**	**UOM**
Total space required to store normal transactions without any incident for a week (7 days) of 22 lanes		1430	GB
Total Space required to Store 22 lanes data (Incidental transactions data for one year (365 days) + Normal transactions without any incident for a week (7 days))		9702	GB
		10	TB

3.15.3 Calculation of Disk Capacity for the Disk Connected with TMS On-line

- o The TMS is provided at the two locations in a cluster mode, i.e., Primary at Gavan & Secondary at Shivajinagar.
- o Out of 200000 transactions per day per lane, we assumed that 10% incidental transactions.
- o At the TMS, the snapshot image & video of the incident will be kept for five years for all types of transactions, and images of all vehicles that have passed through the toll lane without any incident will be kept for three (3) months regardless of the payment mode.

Calculation of Storage Space for Disk Connected with TMS Server On-line			
Description	**Transaction Count**	**Size**	**UOM**
Transaction per day for all lanes	200000		Nos.
Number of incidental transactions (@10%) per day	20000		Nos.
Normal transaction without any incident per day	180000		Nos.
Space required/ transaction		2	MB
Total space required to store incidental transactions data (@10%) for one year (365 days) of all lanes		14258	GB
Total space required to store incidental transactions data (@10%) for five years		71290	GB
Total space required to store normal transactions without any incident for 3 months (92 days) of all lanes		32343.75	GB
Total Space required to store all lanes data (Incidental transactions data for five years + Normal transactions without any incident for 3 months)		103633.75	GB
		102	TB

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4 Toll Lane Equipment

4.1 Operating Procedure

- The system is proposed by considering standard configuration for toll management system consisting of mainline tollgate at Gavan between Shivaji Nagar and Gavan interchanges and ramp tollgate at Shivajinagar interchange. The vehicles will pass through one or two tollgates depending on their entry and exit points.

- The toll management system will be designed to cope with the configuration of the MTHL as shown in Table 4:1.

Table 4:1 – Type of Toll Collection Procedure

Procedure	Location	Route		Remarks
		From	To	
Payment	Mainline westbound	Gavan	Shivaji Nagar Or Sewri	Pay full amount from Gavan to Sewri
	Shivaji Nagar	Airport Or JNPT	Sewri Or Gavan	Pay amount corresponding to the destination
		Sewri	Shivaji Nagar	Pay amount corresponding to the destination
	Mainline eastbound	Sewri	Gavan	Pay full amount from Gavan to Sewri
Refund	Shivaji Nagar Exits	Gavan	Shivaji Nagar	Surrender second part of the receipt given at mainline toll gate and received Refund
Exit Pass	Mainline eastbound	Shivaji Nagar	Gavan	Exit passage on Bar code scan

- Different toll collection procedures will be adopted regardless of the payment method (Cash/ QR code/ Card/ ETC).

- Before starting the systems operations, the system is installed properly and powered on. The data initialization (configuring basic parameters in the system), data distribution (sending master data to lane PCs) is done and the system is ready to perform transactions.

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- A typical process starts with user registration. Before starting the toll collection operations each user of the system is assigned a unique username and password. The user details are registered into the system and privileges are assigned to each user depending on his / her role.

- Each time while accessing the system the user has to log into the system.

- A normal sequence of operations for toll collection is:

  - Creation of user login ids (one time job)
  - Logging into the system
  - Performing toll transactions and collecting toll
  - Conducting a transaction review for incidental transactions
  - Handing over the cash to cashier/supervisor
  - Reconciling the differences
  - Generating end of shift report
  - Closing the shifts

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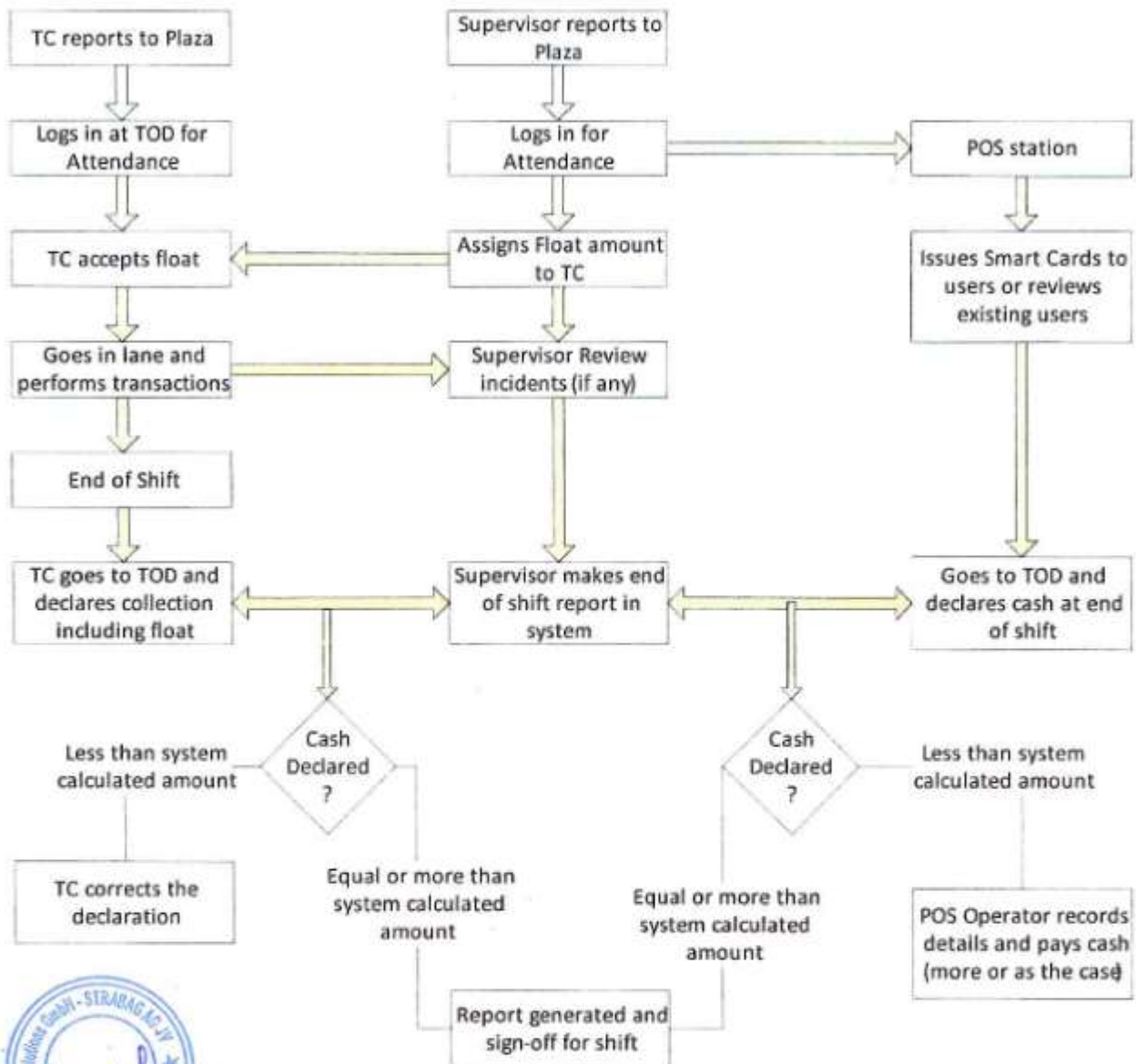
Figure 4:1 – Sequence of Operations

4.2 Manual and QR Code System

4.2.1 Initial Conditions

The lane equipment has the following status before logging into the system, indicating "lane is closed".

Equipment	Status
TLC with Industrial PC	Installed with lane application waiting for the operator to log in
Toll Collector Display	Connected to LC Displaying login screen of lane application
Toll Collector Keyboard	Connected to LC waiting for user's input of login
Receipt Printer	Connected to LC ready for receipt printing
Smart Card Reader	Connected to LC waiting for card input

Equipment	Status
User Fare Display	Connected to LC, showing text "Lane Closed"
Lane Traffic Light	Connected to LC via a controller card, showing the "RED" aspect.
Panic Switch	Ready for input from TC.
Amber Light	Ready for input from the panic switch, & in the off condition
Siren	Ready for input from the panic switch
Overhead Traffic Light	Connected to LC via a controller card, showing "Red Cross"
Incident capture camera	Connected to LC, waiting for input to capture an image
AVC System	Waiting for vehicle presence for classification.
Automatic Lane Barrier	Connected to LC via a controller card and kept closed.
Manual Lane Barrier	Connected to LC via a controller card and kept closed
Lane Monitoring Camera	Connected to network switch & in Off mode.
Booth Monitoring Camera	Connected to network switch & in Off mode.

4.2.2 Login Procedure

o To start lane operations, the toll collector first marks his attendance at the TOD workstation. The system randomly assigns the lane to the toll collector. The toll collector unlocks the booth, arranges the float, logs in into the lane system using the biometric fingerprint reader, and makes the entry into the system. The lane system does not allow the operator to log in without marking the attendance.

o While logging in, the operator uses his login credentials to access the lane. In case of link failure, the supervisor's credentials will be used to log in to the system. Once the fingerprint input has been accepted by the equipment, the toll collector will be deemed to be 'logged-in' to the lane equipment.

o The proposed login process is as below:

Mark attendance into the system before start of the shift

Make an attendance entry and issue float to the operator

Log in into the lane using credentials& fingerprint

Valid ID and password? Attendance marked?

Connectivity available?

Yes

No

No

Yes

Use Supervisor's credentials to open the lane.

Open the lane for operations changing the equipment status

Start Lane Operations

Figure 4:2 – Proposed Process of Logging

4.2.3 Lane Open Procedure

The lane equipment changes its status after logging into the system, indicating "lane is opened".

Equipment	Status
TLC with Industrial PC	Installed with lane application with operator logged in.
Toll Collector Display	Connected to LC Displaying initial screen, waiting for TC input
Toll Collector Keyboard	Connected to LC waiting for user's input.
Receipt Printer	Connected to LC, ready for receipt printing
Smart Card Reader	Connected to LC waiting for card input
User Fare Display	Connected to LC showing text "Welcome"

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Equipment	Status
Lane Traffic Light	Connected to LC via a controller card, showing the "RED" aspect.
Panic Switch	Ready for input from TC.
Amber Light	Ready for input from the panic switch
Siren	Ready for input from the panic switch
Overhead Traffic Light	Connected to LC via a controller card, showing "Green Arrow"
Incident capture camera	Connected to LC, waiting for input to capture an image
AVC System	Waiting for vehicle presence for classification
Automatic Lane Barrier	Connected to LC via a controller card and kept closed.
Manual Lane Barrier	Connected to LC via a controller card and opened for vehicle entry

4.2.4   Logout Procedure

o   While the shift is about to end the system warns the operator showing an appropriate message on TCT. For the end of shift logout operations, the toll operator uses the "log out key" followed by the "enter key" to confirm log out. Using the "cancel key", the operator can cancel untimely pressing of logout key.

o   Alternatively, there is also an option of automatic log-out at the end of the shift. The system logs out automatically exactly when the shift ends. In case the operator has done a transaction partially; the system waits for the operator's input and then logs out. The operator has to log in again if he has to continue a few transactions in the next shift.

o   The system facilitates to log out from the system in between and any other operator to log in as a reliever.

o   The lane equipment change its status after the logout same as an initial condition, indicating "lane is closed".

4.2.5   Cash Transaction

o   The vehicle enters into the lane observing OHTL status. The vehicle user stops near the toll booth pay-axis. The LPIC camera detects the vehicle registration number plate automatically & displays the output on the TCT. The toll collector enters the appropriate vehicle classification, journey type & verifies the vehicle registration number displayed on the screen & corrects it if required. The class entered by the along with applicable toll tariff, including vehicle overweight charges (if any) will be displayed for the vehicle used on the user fare display (UFD) and to the toll collector on the TCT. The vehicle user pays the displayed amount to the toll collector. The toll collector will take the amount

tendered and provide change if any. On this, the toll collector presses the "Cash" key to generate a toll transaction receipt. Receipts will be numbered sequentially for audit purposes.

o On completing the transaction, a receipt is printed and handed over to the user which gives the details of the transaction and the toll amount paid. The traffic light is made green, the barrier is opened, and the vehicle is allowed to exit the lane.

o While the vehicle is exiting the lane, the AVC system classifies the vehicle. The exit of the vehicle from the AVC detection area will trigger the incident capture camera installed in the lane to capture the Image and five (5) second video of the rear side of the passing vehicle. If there is any discrepancy in the class declared by the toll collector and the class detected by the AVC, the same will be reported to the audit workstation in the Plaza Control Room along with the vehicle image and video was taken by the incident capture camera.

o The system records all transactions, issued number of receipts, the number of vehicles detected as leaving the lane & as detected by the AVC system. The AVC system sends data to the plaza control room LSDU using different network channels.

4.2.6 QR Code Transaction

o The vehicle enters into the lane observing OHTL status. The vehicle user stops near the toll booth pay-axis. The LPIC camera detects the vehicle registration number plate automatically & displays the output on the TCT. The toll collector enters the appropriate vehicle classification, journey type & verifies the vehicle registration number displayed on the screen & corrects it if required. The class entered by the along with applicable toll tariff, including vehicle overweight charges (if any) will be displayed for the vehicle used on the user fare display (UFD) and to the toll collector on the TCT.

o The vehicle user scans the QR code posted on the outside wall of the booth using the Smartphone & pays the toll fare amount as displayed on the UFD. It shows the transaction screen to the toll collector for showing the status of the transaction. The toll collector confirms the successful execution of the QR code payment by pressing the "QR Code" key on the TCK.

o On completing the transaction, a receipt is printed and handed over to the user which gives the details of the transaction and the toll amount paid. Receipts will be numbered sequentially for audit purposes. The traffic light is made green, the barrier is opened, and the vehicle is allowed to exit the lane.

o While the vehicle is exiting the lane, the AVC system classifies the vehicle. The exit of the vehicle from the AVC detection area will trigger the incident capture camera installed in the lane to capture the Image and five (5) second video of the rear side of the passing vehicle. If there is any discrepancy in the class declared by the toll collector and the class detected by the AVC, the same will be reported

to the audit workstation in the Plaza Control Room along with the vehicle image, and video captured by the incident capture camera.

o The system records all transactions, issued number of receipts, the number of vehicles detected as leaving the lane & as detected by the AVC system. The AVC system sends data to the plaza control room LSDU using different network channels.

4.2.7 Credit/ Debit Card Transaction

o The vehicle enters the lane observing OHTL status. The vehicle user stops near the toll booth pay-axis. The LPIC camera detects the vehicle registration number plate automatically & displays the output on the TCT. The toll collector enters the appropriate vehicle classification, journey type & verifies the vehicle registration number displayed on the screen & corrects it if required. The class entered by the along with applicable toll tariff, including vehicle overweight charges (if any) will be displayed for the vehicle used on the user fare display (UFD) and to the toll collector on the TCT.

o The vehicle's user informs the toll collector that he wants to pay the toll fare amount using the Credit/ Debit card. The toll collectors press the "Credit key" provided on the TCK. On this, the system sends the toll amount to the Credit/ Debit card reader. The toll collector swipes the card through the card reader. Upon acceptance of the card & confirmation of the payment, the bank receipt is printed automatically. The toll collector will return the card and hand over the receipt to the motorist. On the completion of the transaction, the traffic light is made green, the barrier is opened, and the vehicle is allowed to exit the lane.

o While the vehicle is exiting the lane, the AVC system classifies the vehicle. The exit of the vehicle from the AVC detection area will trigger the incident capture camera installed in the lane to capture the Image and five (5) second video of the rear side of the passing vehicle. If there is any discrepancy in the class declared by the toll collector and the class detected by the AVC, the same will be reported to the audit workstation in the Plaza Control Room along with the vehicle image and video captured by the incident capture camera.

o The system records all transactions, issued number of receipts, the number of vehicles detected as leaving the lane & as detected by the AVC system. The AVC system sends data to the plaza control room LSDU using different network channels.

4.2.8 Refund Transaction

o For the refund procedure, the receipt issued at the entry lane will be checked by the toll collector at the exit lanes of the Shivajinagar interchange. On this, the system identifies the entry location of the vehicle.

o The driver surrender/ provide receipt issued at the mainline tollgate to the toll collector. The toll collector reads the barcode printed on the receipt using the barcode reader. The relevant information will be displayed on the TCD & the refund amount will be displayed on TCD & UFD. The toll collector provides the refund toll difference to the driver, issues a new receipt, and collects the receipt issued at the mainline tollgate.

o The toll collector declares the completion of the transaction by pressing the "Refund" ley provided on the TCK. On the completion of the transaction, the traffic light is made green, the barrier is opened, and the vehicle is allowed to exit the lane.

o If the motorist who is entitled to the refund does not have a receipt, then he must pay the full applicable toll amount for the journey. Also, if the user took more time to reach the exit location than defined in the system, then the refund will not be paid.

4.2.9 Correction In Transaction

o At any time during the transaction up to the selection of 'CASH', 'QR Code', 'Credit / Debit', 'PAID' or 'REFUND', the toll collector may use the "Correction" key to abort the current transaction and the start the transaction procedure again.

o On pressing the "Correction" key, the information displayed on the TCD and UFD relating to the previous classification will be canceled & the system is ready to accept a further classification input.

4.2.10 Violation Transaction

o If a vehicle is detected by AVC, when the traffic light is red and independent of the operator's input, the transaction is a violation.

o On detecting a violation, an alarm is raised in the control room and the amber siren is activated.

o The system captures the image of the vehicle, and the transaction is treated as an incident.

4.2.11 Exempt Transaction

o As per the government notification Police Patrol Vehicle, ambulances, Fire brigade trucks are exempted from paying the toll.

o Therefore, as the toll operator classifies these vehicles into any one of the exempt categories, the auditor authorizes the transactions. The exempt transaction will not proceed further if the auditor does not authorize the transaction.

o On successful of the transaction, the traffic light is made green, the barrier is opened, and the vehicle is allowed to exit the lane.

o While the vehicle is exiting the lane, the AVC system classifies the vehicle and sends this class to the lane controller. The incident capture camera is triggered, and an image of the vehicle is captured. The exempt transactions are treated as incidents and the vehicle image is captured for all such transactions.

4.2.12   HP & MC Convoy Transactions

o High personage convoys and military convoys are exempted from paying a toll.

o Therefore, as the toll operator enters the transaction type as convoy by pressing the key "HPMC", the auditor authorizes the transactions transaction upon checking the validity of the transaction.

o As the toll collector presses the HPMC key, the zero toll fare amount will be displayed on the TC, the traffic light is made green, the barrier is kept open continuously and the vehicle is allowed to exit the lane.

o All the transactions are marked as "HPMC" transactions, with toll amount as '0' (zero), and No receipt is printed.

o The vehicle class is not entered by the toll collector, while the class determined by the AVC for each vehicle will be recorded.

o The sequence is terminated by pressing the same key i.e., "HPMC" followed by an "Accept" key when the last vehicle arrives at the level of the toll collector.

o The system will close the barrier after the passage of the last vehicle. Upon termination of the HP & MC sequence, the traffic light is made red & the system is then initialized to perform normal transactions.

4.2.13   Receipt Printing

o The Receipts will be issued automatically for each transaction, except those 'EXEMPT', 'HPMC', 'EMERGENCY', and 'ETC' is used instead of payment on the registration of completed payment. However, the printing of receipts is an optional facility.

o The receipt is printed with the barcode for the details of the transaction. The receipt with barcode will be used for a refund at Shivajinagar and no payment at mainline tollgate for an eastbound vehicle coming from Shivajinagar.

o Activation and deactivation of receipt printing is a settable parameter. Further, the printing of the receipt can be configured as "on-demand" so that the receipt is printed only when the user demands it.

4.2.14   Maintenance Mode

o The lane application enters maintenance mode when a maintenance user logs in. This activates reporting and testing of equipment reserved solely for maintenance. In maintenance mode, all the

lane peripherals are active and allow performing the transactions as in normal mode. The only exception is the OHTL is set to red and the manual lane barrier is kept closed.

- o The transactions performed by the maintenance user, are flagged and are not included during calculating the shift summary. Any traffic processed in this mode is not included in the traffic count records but is identified as performed in maintenance mode.

- o The maintenance user is facilitated to perform a special test that assists in routine testing or fault diagnosis. These facilities will allow verification of the correct operation of the following:

  a) full functioning of the lane as a whole
  b) operation of the TCT and its various sub-parts
  c) operations of the AVC
  d) operations of the loop detector
  e) operations of bar code reader
  f) operations of RFID antenna
  g) output interfaces for all equipment,
  h) data communication with TPS,
  i) Input from and output for all the lane equipment

- o These tests will be initiated using either the portable laptop computer with appropriate software in place of the lane controller or using the existing lane controller with the keyboard (TCK) and display (TCD) forming part of the TCT. It will be possible for each of the functions to be checked separately and independently.

4.3 ETC System

o The proposed ETC system is based on the FASTag operation proposed by the National Highway Authority of India (NHAI), implemented and operated by Indian Highway Management Company Limited (IHMCL), and managed by the National Payment Corporation of India (NPCI). The requirements for and operating procedure of the system will comply with the Procedural Guidelines of NETC - ICD manual version 2.5 release on 29th August 2017.

o The proposed ETC system uses 2 main components i.e., RFID antennas and readers installed in the lanes and the RFID tag fixed on the windshield of the vehicles from inside. The RFID antenna will communicate with the RFID tag using radiofrequency waves of specified frequency in the range of 865 MHz to 867 MHz.

o The proposed ETC equipment can detect, read, write the data with the vehicle running at a maximum of 60km/h. The communication between lane application, RFID reader, and tag is designed in such a way that the transaction completes tag detection, validation, and computation within available read / write time.

o The ETC system proposed with the ETC software avoids dual detection of Tag in the reading zone. This means once the tag is read, the software ensures avoiding double deduction from the user's account, with the help of settable pass-back time (pass-back time is the time set by the application - period for which subsequent detection of the tag is ignored.)

o The toll lane controller receives the following data from the TPS:

1) Receives configuration data from the Toll Plaza System at start-up.

2) Receives blacklist and reload data from the Toll Plaza System at start-up, and the blacklist and reload list will be updated whenever the Toll Plaza System sends data to the lane controller.

4.3.1 ETC Lane Operation

o The proposed hybrid system will be equipped with ETC facilities. The RFID reader & antenna will be installed in each lane to read the RFID FASTag installed on the windshield of the vehicle.

o The following sequence of the transaction will be followed:

1) The RFID reader & antenna will be installed near the pay axis. The presence loop installed near pay-axis triggers the RFID reader & antenna to check and detect the presence of the RFID tag in the vehicle.

2) The RFID reader & antenna will read the RFID tag. On this, the system fetches & displays the information stored in the tag memory on the TCD. The LPIC camera captures the image of the vehicle registration number.

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3) The system checks the detected tag ID against the blacklist. Information read from the Tag memory will include:

   a) Tag ID

   b) EPC Memory details and information stored in the same

4) **If the ETC FASTag is valid,**

   a) The valid tag message along with the vehicle registration number is set in the RFID tag. The traffic light will turn green & the exit barrier will open automatically.

   b) As the vehicle drives out of the lane, it will cross the automatic vehicle classification (AVC) system, which will automatically classify the vehicle according to the defined vehicle classes. The exit barrier will then automatically close. The lane will be in a ready state for the next transaction.

   c) The TLC will compare the AVC classification with the registered ETC FASTag class, and if different, send a class discrepancy message to the toll control room. A class discrepancy will trigger the incident capture camera to capture the image of the exiting vehicle.

   d) The images captured by the ICS & LPIC camera together with details of the class discrepancy message, corresponding transaction number, date and time of the transaction, and lane number are verified by the supervisor.

   e) AT the TPS sever, the system will send the data of ETC transactions to the acquirer bank for further processing by NPCI.

5) **If the RFID antenna fails to read the RFID tag,**

   a) The traffic light remains Red & the exit barrier remains closed. An alarm will be displayed on the TCT & auditor's console of the TPS. The toll collector will use the Handheld RFID reader to read the ETC FASTag.

   b) The toll collector will attempt to read the ETC FASTag, which if successful, will initiate the electronic payment routine as described above. In case this method also fails the toll, the collector will attempt to enter the ETC FASTag manually into the system by pressing the manual entry key and keying in the ETC FASTag number via the numeric keypad.

   c) If the handheld RFID reader fails to read the RFID tag, the RFID tag will be judged to be defective. The toll collector will inform the driver that the RFID tag is defective, and the vehicle use will be required to pay the toll with a penalty in cash, QR code, or credit/debit card. After completion of the toll payment, the normal operation will resume.

6) If the RFID tag is judged invalid, the following sequence will be taken:

   a) The traffic light remains Red & the exit barrier remains closed. An alarm will be displayed on the TCT & auditor's console of the TPS.

b) The toll collector present at the tollbooth will inform the driver that the RFID tag is invalid, and the vehicle will be required to pay the toll and penalty in cash, QR code, or credit/debit card.

c) After completion of the toll payment, the normal operation will resume.

4.4 Technical Specifications

The proposed technical specifications for the Lane level equipment will be as per the "1.1 Division 5A ITS Part-1 -27.08.21".

Anticorrosion treatment of LC & AVC cabinets:

The LC & AVC cabinets will be made of hot-rolled mild steel plate having a thickness of 2.3t. They will be treated with abrasive blasting before zinc thermal painting. Then two or more layers of coating of polyurethane resin enamels and varnishes will be applied before they are painted in the final color. Active cross ventilation will be provided to dissipate heat & minimize moisture condensation.

5 Data Communication

5.1 Type of Data Communications

1) In the proposed TMS, the data communication will be performed by three communication modes i.e.,

   a) Between lane controller and toll plaza system

   b) Between toll plaza system and toll management center system

   c) Between toll management center system and acquire bank

2) The toll lane controllers will be interfaced with the local TPS installed in each interchange plaza building via a local area network (LAN). Data will be transmitted from and stored by the lane equipment at various times for transaction recording, data transmission, operation parameter updating, and equipment operation monitoring.

3) The proposed toll lane controller system is designed in such a way that interruption of the data communication link between Toll Plaza System and toll lane controller will not stop the toll collection operation and normal operation of toll lane will be possible.

4) The Toll Plaza System will send the toll collection operation data of normal operation to the toll management center system at the 5 minutes interval. The incident data including insufficient balance, unreadable RFID tag, detection of blacklisted RFID tag, vehicle class discrepancy, and the exempted vehicle will be transferred immediately to the traffic management center system.

5) The Toll Plaza System will receive a blacklist, exception list, and other operating data and parameters immediately as they are updated.

6) The toll management center system will communicate with the acquirer bank to obtain the system parameters including such as blacklist data, exception list to process the toll payment process efficiently. The communication will be encrypted to prevent eavesdropping and other malicious attempts by unauthorized organizations or persons.

5.2 Data From Toll Lane Controller to TPS

1) The communication between the toll lane controller & TPS server will be performed in both directions. The toll lane controller will send data to the TPS in batch mode[1]. In case of failure of the data communication link between TPS & lane, the toll lane controller will store operation data for a minimum of seven (7) days for later transmission to the TPS.

2) The following information will be stored by the lane equipment on an individual event basis and transferred to the TPS in real-time under normal operating conditions:

   a) Log in and log out of toll collector.

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[1] The batch timings are configurable in the toll management system software.

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    b)   Individual transaction details

    c)   System status and operational status

    d)   Lane opening and closing events.

    e)   Operating shift statistics.

    f)   Images of incidents

3) The following data will be transferred to the TPS in real-time & also stored on an individual event basis by the lane equipment:

    a)   Alarms and incidents

    b)   On-demand messages

5.3   Data from TPS to Toll Lane Controller

1) The lane equipment will receive data relating to operational parameters from the TPS.

    a)   Current and future fare tables for each vehicle classification with date and time of implementation for future tables

    b)   List of authorized collectors, lane supervisor, auditor, and maintenance personnel with ID.

    c)   Violation alarm time out period

    d)   Blacklist of RFID tags

    e)   Parameter values for equipment alarms

    f)   All toll plaza codes, and lane codes included in the network

    g)   Codes to be used when manual log-on of collector is necessary

2) Downloading of all operational parameters will be completed within 10 seconds under all circumstances. The operating parameters received from the TPS will be stored in a non-volatile storage device of the lane controller in a secured way.

3) Fare tables for each type of journey for each vehicle class will be stored in two formats i.e., one current and one future. These tables will be stored in the database of the toll lane controller along with the time of implementation of the future table.

4) The violation alarm time-out period will be started at the determination of a violation by the lane equipment. In the event of the alarm being acknowledged by input to the monitoring console of the TPS within this period, the alarm will be canceled immediately. All alarms generated in the system will be recorded by the LSDU.

5.4   System Time

1) A software utility is installed on each machine and used for time synchronization between the plaza server and the lane controllers. The utility controls the time setting of all the clients over LAN. All lanes

are synchronized with the plaza server. Any change in the server's timing automatically updates the lane timings.

2) The lane equipment will include an internal real-time clock that receives data and time synchronization from the TPS regularly and on any event no less than once every hour. The equipment will use data from its real-time clock to drive the clock display on the TCT and for time flagging of events and data.

3) In the event of TPS failure, the lane controller will continue to update its internal clock from the last synchronization data received. The accuracy of the lane equipment clock under such conditions will be within 15 seconds per month. When data communication with the TPS is restored, the lane equipment will assume the date and time next advised by the TPS. The authorized personnel can set up and adjust the time assumed by the lane controller in the event of data communication with the TPS not being possible. An alarm will be generated if any gap is found between the lane controller and the TPS server after the communication is restored.

4) The TPS also has an integrated real-time clock that will be used for the timing of all reports, printouts, data transfer, and the like. The real-time will be automatically synchronized with the real-time clock of the toll management center server. Authorized personnel can set the current date and time. Once set the clock will remain accurate to within 15 seconds in one calendar month. In the event of power failure to the TPS, the real-time clock will be maintained to the same degree of accuracy for not less than a week. The TPS will send its currently assumed date and time to the lane controller and the lane controller will use this data for their time synchronization purposes.

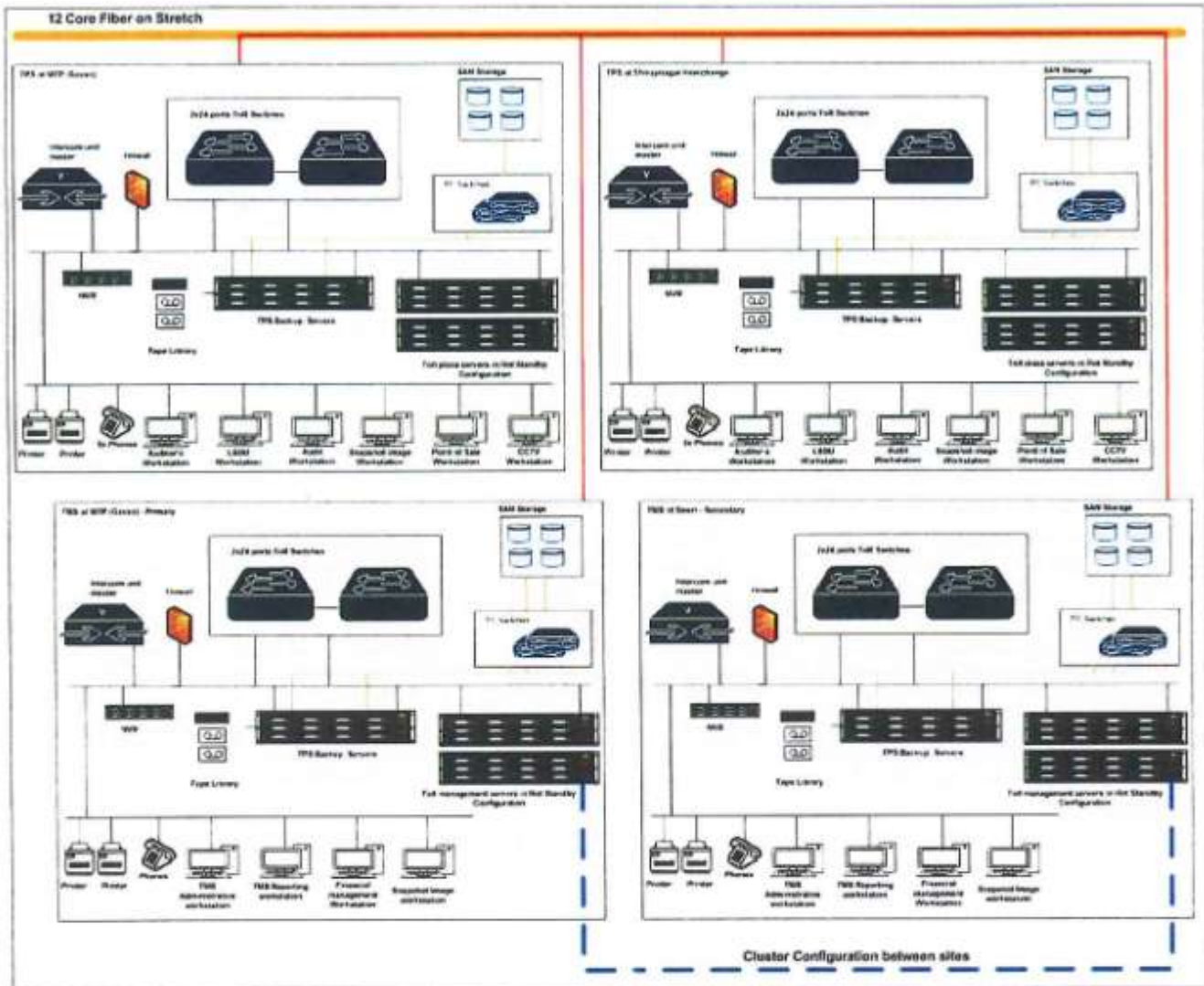| STRABAG	TECHNICAL PROPOSAL – TOLL MANAGEMENT SYSTEM	एम एम आर डी ए MMRDA

5.5 Network Architecture

Figure 5:1 – Network Architecture

5.6 Technical Specifications

The proposed technical specifications for the Data Communication equipment will be as per the "1.1 Division 5A ITS Part-1 -27.08.21".

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6 Toll Plaza System (TPS)

6.1 System Outline

1) The Toll Plaza System will be installed in the plaza building for each interchange. The system imposes a central control over the overall functions of the toll plaza. The system's principal functions are:

   a) Provide real-time monitoring facilities

   b) Correlate data from lane equipment into audit and statistical reports and files

   c) Serve as an alarm monitoring and acknowledgment system

   d) Transmit operational data to the toll management center System (TMS)

   e) Receive data (relating to the operation of that plaza) from the TMS, and download it to lane equipment, parameters relating to the operation of that plaza.

   f) Serve as a time recording system for the attendance of toll personnel at the site

   g) Provide traffic data to the TMS system

   h) Allow input of Bank-in Data

   i) Produce backup files for security and further offline processing.

2) The TPS will support multi-task, multi-operations functions so that the various requirements of the system can be carried out simultaneously with no perceivable delay to persons making inputs to the system. In the event of power failure, the system will restart automatically on the restoration of power without the need for intervention with no loss of data or reduction in security.

3) The system will be provided with diagnostic software for immediate loading and running to allow tests to be performed on all TPS system equipment, interfaces, and peripherals. These tests will be performed in the off-line condition and have no adverse effects on the operation of the toll lane equipment.

4) Any fault of one software module of the server will be recorded and alarmed by the system. The system has an inbuilt watchdog facility as part of the processor system with an alarm being given at the LSDU console in the event of any fault of the TPS.

5) The TPS will process the data received from the lane equipment into the files for storage and further processing these to achieve the operating requirements of the system. Details of all printouts, toll collector duty records, revenue data, incident reports, and the like that are compiled by the TPS will be stored as uniquely identified files as well as made available for transfer to the TMS system. Sufficient storage capacity will be provided within the TPS to allow all such files to be stored for a minimum of 5 years of operation under the design criteria specified.

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6.2 CPU Utilization

1) The CPU utilization is maintained well below 50% by applying best practices of design and development to improve performance and scalability. Key areas where the reviews and tests are carried out are the following:

   a) Coupling and Cohesion

   b) Communication (Across remote machines, Queuing, etc)

   c) Concurrency (Symmetric multithreading)

   d) Caching, state management

   e) Resource management (Resource sharing, DISK I/O, Memory I/O, Hardware interfacing, etc)

   f) Best practices of the language and architecture in use

   g) Multithreading with optimizing usage to reduce unnecessary context switching

2) Environmental Factors that are taken into consideration

   a) Network Configuration

   b) Network Security

   c) Authentication across network

   d) Firewalls (Allowed ports etc.)

Tool Name	File Name	Function
Trace Capture, Processing, and Command-Line Analysis tool	Xperf.exe	Captures traces, post-processes them for use on any machine, and supports command-line (action-based) trace analysis.
Visual Trace Analysis tool	Xperfview.exe	Presents trace content in the form of interactive graphs and summary tables.
Windows performance monitoring tool	Perform.exe	

3) To test the CPU utilization following tests need to be carried out:

   a) For simulation advanced test scripts and tools are incorporated which randomly generate lane transactions and can be configured to generate various toll transactions as per the size and volume required to stress test the server.

   b) XPERFVIEW would be executed simultaneously to trace the CPU usage.

   c) The number of virtual lanes would be gradually increased to full load with all lanes active at one time generating normal and discrepant transactions as per the estimated load.

   d) Data transfer agents would be launched on all virtual lanes.

6.3 Disk Capacity

1) The disk capacity of the TPS is calculated considering the need to store the operating system, the application software and other software packages necessary for the operation of the system, and the data generated by the system and to adhere to the manufacturer's recommendations on usable disk capacity for the efficient running of programs.

2) All transaction records will be kept for five years in the disk connected with TPS online. The calculation is provided in Section 3.15.

6.4 Failure of TPS

Case 1: TPS Server Failure

If the TPS server is failed, the records are kept manually and entered into the system once the server is recovered. These records include attendance, Cash up entries, cash transferred to the bank, etc.

Case 2: Workstation Failure

If any of the workstations is failed, the system facilitates to access the same functionality from a different workstation. E.g., if the TOD workstation is failed then the Cash up entries can be made from the POS workstation.

6.5 Proposed Application Software Licensing

The application software developed and customized for the Hybrid Electronic Toll Collection System consists of various modules performing defined functionality. The Plaza Level application software package consists of the following architecture.

EFKON TOLL MANAGEMENT SOLUTION

PLAZA PRODUCT KEY COMPONENTS

- Audit
- Super Audit
- LSDU
- Cash-up
- Sundry Payment
- Admin
- Account Reconciliation
- MIS
- Dashboard Modules
- Transaction Module
- CCH Interface
- FASTag Manual Upload Utility
- Vehicle Status Alert Master
- Vault Management
- ETC Monitoring Tool
- NHAI EDI

- **Platform**: Windows/Web
- **Technology** Microsoft DOT NET Winforms,WPF C#, MVC4,
- **External Interfaces**
- **Crystal Reports**
- **Database**: Oracle

LANE PRODUCT KEY SUB-COMPONENTS

- Transaction Module
- Bleed-off
- Events/incidents
- Menu based Access
- Media Module (RF)
- AVC
- MIS Reports
- Shift management
- Maintenance Module
- Lane ETC Recharge

- **Platform**: Windows
- **Technology** Microsoft DOT NET Winforms C#,
- **External Interfaces** C/C++
- **Database**: Oracle

KEY SUPPORT PRODUCT COMPONENTS

- Service layer for platform diagnostic interface
- LOG module (Activity, Errors)
- Data completeness at all levels
- Data transfer (WCF, DBLINKS, Restful services)
- App Monitoring agents
- Secure manual Export/Import
- Data backup module

REMOTE PRODUCT COMPONENTS

LOCAL APPS

- Reconciliation

- **Platform**: Windows
- **Technology** Microsoft DOT NET Winforms C#
- **Database**: Oracle/SQL Server

WEB BASED OFFERINGS

- Web based Monitoring for toll collection, operation & management

- **Platform**: Web Enabled
- **Technology** ASP.NET,C# NET Winforms C#, MVC4
- **Database**: Oracle/SQL Server

Figure 6:1– Plaza TMS System Architecture

Figure 6:2 – High-Level Lane design

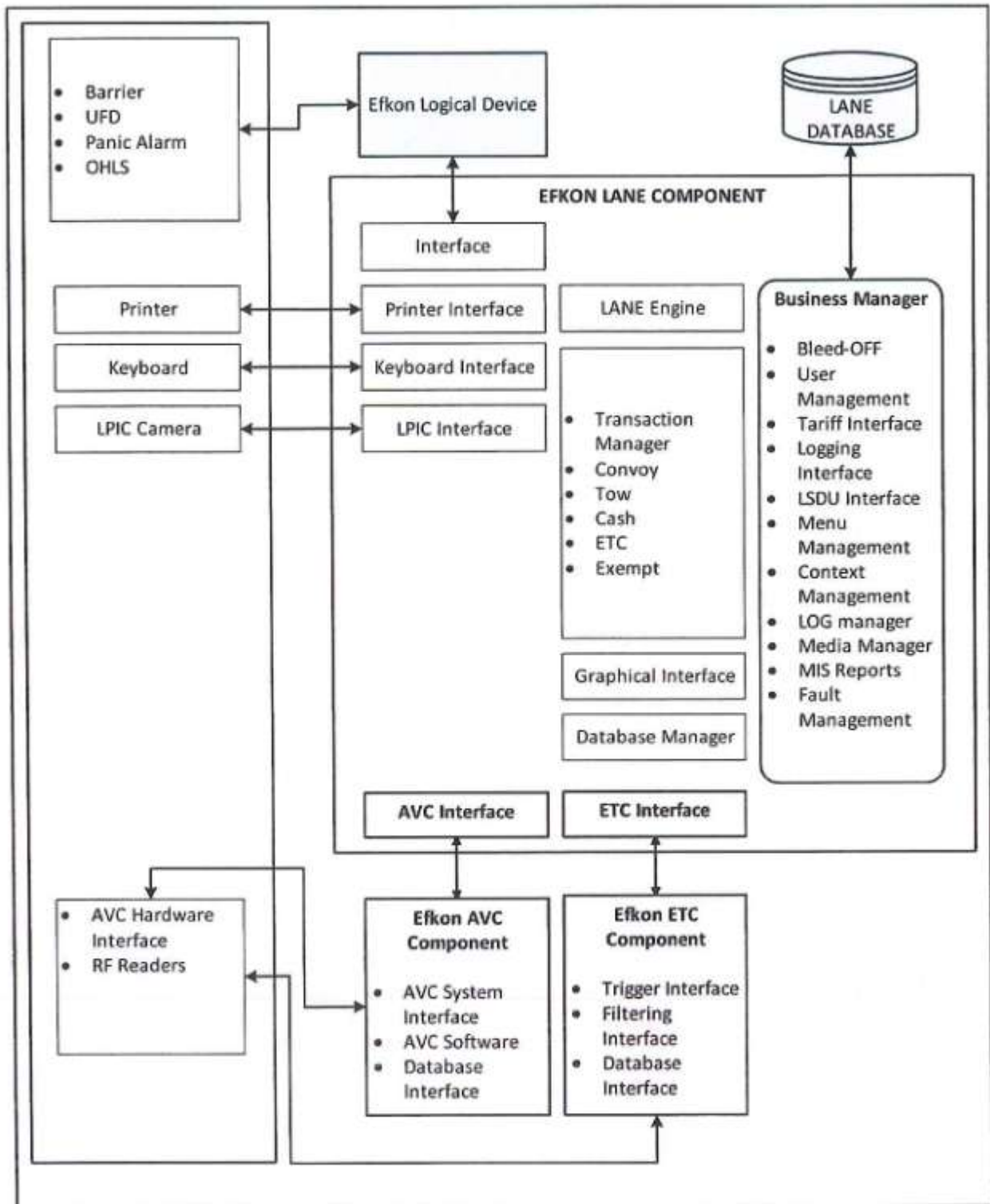| STRABAG	TECHNICAL PROPOSAL – TOLL MANAGEMENT SYSTEM	एम एम आर डी ए MMRDA

6.6 Integration with External Applications

- Toll System Application consists of many modules that are largely relevant to toll operations. As a result, there will be huge data accumulation at varying levels within the database. For example, the following types of information will be present:

Module	Information	Usability
User Management	All personnel information	Attendance, etc.
Transaction Management	Financial Data	Accounting
Master Data	TAG's hardware equipment	Inventory
Traffic Data	Traffic count according to required classification	Data ware-housing

Table 6:1– Modulewise Information

- While the proposed application does not inherently handle all this usability, the application is transparent enough to provide information for external sources in the following manner:
  - o The proposed application uses Crystal Reports for all its reporting. One of the output formats of crystal reports is ".pdf".
  - o Based on the requirement, the application can be enhanced to give the required output in the desired format as a ".pdf" file.

6.7 Toll Auditor Console

An auditor's console is provided and installed in the toll control room in such a position to allow an auditor seated at the console to have the best possible view of the toll plaza. The auditor's console encompasses the following:

1) Lane status display workstation
2) Audit workstation
3) Snapshot image & incident workstation
4) CCTV monitoring workstation
5) Booth intercom system master unit
6) Alarm buzzer and indicator

6.7.1 Lane Status Display Unit (LSDU) Workstation

1) The LSDU workstation will be installed in the toll control room to monitor the lane system status, sitting in the control room, in real-time. The LSDU performs the following functions:
   a) The user interface (UI) of the LSDU workstation displays all lane equipment' status as they change while performing the real transactions,

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b) Generates visual alarms for defined incidents on the UI

c) Facilitates acknowledgment of alarms and canceling them

d) Displays the data input by an operator such as vehicle class, MoP, vehicle's registration number, etc.

e) Displays class identified by the AVC system

f) Displays transaction status normal, class discrepancy, violations, exemptions, etc.

g) Displays toll booth emergencies i.e., activation of footswitch by the operator.

2) The above data is displayed lane-wise facilitating quick acknowledgment and service from the control room during emergencies. After verifying, the LSDU shows, whether the equipment is connected/disconnected, the actual status of equipment, and the error message in case the equipment are not functional. The change in status of the equipment is shown by changing the color and the events are shown by blinking the icon.

3) e. g. receipt printer connected is shown in Green color and in case it is disconnected it is shown in the Red Color.

4) e. g. In case of any reading/writing error while using the card with the reader the read / write failure event is generated and is shown by blinking the smart card icon of the respective lane on LSDU.

5) The real-time status update is done by sending messages instantly to the LSDU module via LAN.

6) The LSDU also shows a list of events (including error and failures only) along with their location and time of occurrence on the same user interface. Each time an event is generated it is added as a top row in the list. The operator sitting in the plaza control room acknowledges the events and takes appropriate actions to rectify them. Once rectified the event is removed from the list automatically.

Equipment	Status	Alarm
TLC with Industrial PC	Connected / Disconnected,	Disconnected
Receipt Printer	Connected / Disconnected	Failure / Out of paper / Cover open
Smart card reader	Connected / Disconnected	Reader failure / Reading error
User Fare Display	Connected / Disconnected, Display Contents	LED Failure
Traffic Light	Connected / Disconnected, Red / Green	LED Failure
Overhead Traffic Light	Connected / Disconnected, Red Cross / Green Arrow	LED Failure
Incident capture camera	Connected / Disconnected	Failure
AVC System	Connected / Disconnected, AVC class received	Sensor Failure
Automatic Lane Barrier	Connected / Disconnected, Open / Closed	Failure

2000 81

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Equipment	Status	Alarm
Manual Lane Barrier	Connected / Disconnected, Open / Closed	Failure
Panic alarm & buzzer indication	Disable / Enable, Activated	Failure

6.7.2   Audit Workstation

1) The audit workstation allows authorized staff to access various traffic, revenue, and management-related data, including operational data in the form of equipment and operating parameters, both in real-time and from archive data files.

2) The data is displayed in graphical and tabular format as selected by the supervisor. The auditor is facilitated with the following features available to him.

No	Main Menu	Activity
1.	Traffic menu	Traffic volume by location (lane, plaza, interchange), time base (hour, day, month), direction (in, out), direction (eastbound, westbound)
		Graphical presentation of above
2.	Plaza activity menu	Current toll collector assigned
		Toll collector assignment schedule
		Transactions
		Lane events reports
		TOD reports
3.	Revenue menu	Revenue by vehicle class
		Revenue Report
		Collector Revenue
		Bag Bank Transfer
		Return Bank Slip
		Revenue Updating
4.	Maintenance menu	Alarm Criteria
		Alarm Log
		Alarm Summary
		Fault History
		Accuracy of the AVC per class
5.	System menu	Backup TPS Data
		Restore Data

No	Main Menu	Activity
		Backup Parameter
		Restore Parameter
6.	Incident menu	Incident notice
		Incident acknowledgment

3) The auditor gives commands to view the information related to traffic, revenue, and other events. Once the request is given, the data is filtered based on the selection and displayed on the screen. The data is frozen once the display command is given. The auditor is facilitated to print the data he has generated.

6.7.2.1 Revenue Reconciliation

1) The daily collected revenue is the corresponding sum of the toll paid by each of the various methods of payment of ETC, QR code, credit/debit card, and manual options. Cash is collected only through manual payment.

2) The cash collection and cash collection discrepancy will be compiled for each toll collector. The tours of duty (TOD) of a collector will be closed when the end of shift report is consistent and all discrepancies due to exceptional transactions have been duly acknowledged by the auditor and there is no outstanding transaction that requires the auditor's acknowledgment.

6.7.2.2 Audit Detail Specification

6.7.2.2.1 Accessing Audit Functionality

1) To be able to access the audit functionality, the user must be logged on to the Transaction Review Module and must have the required privilege for this functionality. The application must be started by clicking on the "Transaction Review".

2) The first audit will be performed by a Cashier whereas the final audit will be performed by the Supervisor.

6.7.2.2.2 Query Screen

1) After accessing the application, the user must be presented with a "query" screen.

2) The query screen must give the user the facility to specify the criteria by which the incidents will be filtered for display.

3) Selection criteria must be given in a user friendly way.

4) The following is the minimum criteria that must be selectable by the user:

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Item	Description	Special Conditions
Plaza	Current Plaza name	Current Plaza name
Lane	A list of all the lanes available for the plaza	If no lanes are selected, the system must default to "all". (where "all" refers to all the lanes available for the selected plaza) The user must have the ability to select any (one lane.
From date and time	Calendar date. All data from this date forward (including this date) must be included in the selection criteria. Calendar time. All data from this time forward (including data at this time) must be included in the selection criteria.	A user-friendly "date picker" must be used. The default date must be the current date ("today"). A user-friendly time input mechanism will be used.
To date and to time	Calendar date. All data up to and including this date must be included in the selection criteria. Calendar time. All data up to and including this time must be included in the selection criteria	A user-friendly "date picker" must be used. The user will not have to type the date. The default date must be the current date ("today"). A user-friendly time input mechanism will be used.
Incident type	A list of all the incident types available on the system.	The incident description must be shown. If no incident type is selected the default value will be "all". The user will select the appropriate incident type (it will not be necessary for the user to manually type in the incident type). The user will only have the facility to select any combination of incidents.
Transaction number from For audited Data	The start number for a range of transaction numbers for audited data.	The number must be typed by the user. The start number must be included in the search. A quick search tab will be available for audited data.

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Item	Description	Special Conditions
Transaction number for audited Data	The end number for a range of transaction numbers for audited data.	The number must be typed by the user. The end number must be included in the search. A quick search tab will be available for audited data.
User	A list of all the users on the system. This will refer to the user who was logged into the lane when the incident was generated. (Typically, the collector)	The user must be able to select a specific user from a list of all the users on the system. If no selection is made, data for all the users on the system will be included in the selection. (This must be the updated SVC – after incident control. This might have to be found in the transaction table).
Shift	A list of all the Shift available for the plaza	If no shift is selected, the system must default to "all". (where "all" refers to all the shifts for the selected plaza)

Once the user has entered all the search criteria, it must be possible to request that this search be done. Upon starting the query facility from the MIS Audit menu, the default values will be shown. The system is optimized to perform the query in a reasonable time.

6.7.2.2.3   *Output Screen*

1) After performing the query as specified by the query parameters in the query screen, the system will display the output on a screen similar to the current incident acknowledgment screen.

2) Minimum following fields will be displayed:

   a) Plaza

   b) Lane

   c) Date

   d) Time

   e) Incident type

   f) AVC

   g) MVC

   h) SVC

   i) User (Toll collector)

   j) Transaction number

   k) The user who did the acknowledgment (if this incident was acknowledged)

l) An acknowledgment entered by the user (e.g. comment etc.)

m) Action applicable for the incident

3) It will be possible to order the output by any combination of the following:

a) Time

b) Lane

4) One of the output rows will be active at any time. If the user "double clicks" on the image, the image will be enlarged to the size of the incident query window.

5) Upon clicking on the enlarged picture, the user will return to the output screen with the thumbnail pictures.

6) The auditor gives commands to view the information related to traffic, revenue, and another event. Once the request is given, the data is filtered based on the selection and displayed on the screen. The data are frozen once the display command is given.

Figure 6:3 – Toll Transaction Review Screen

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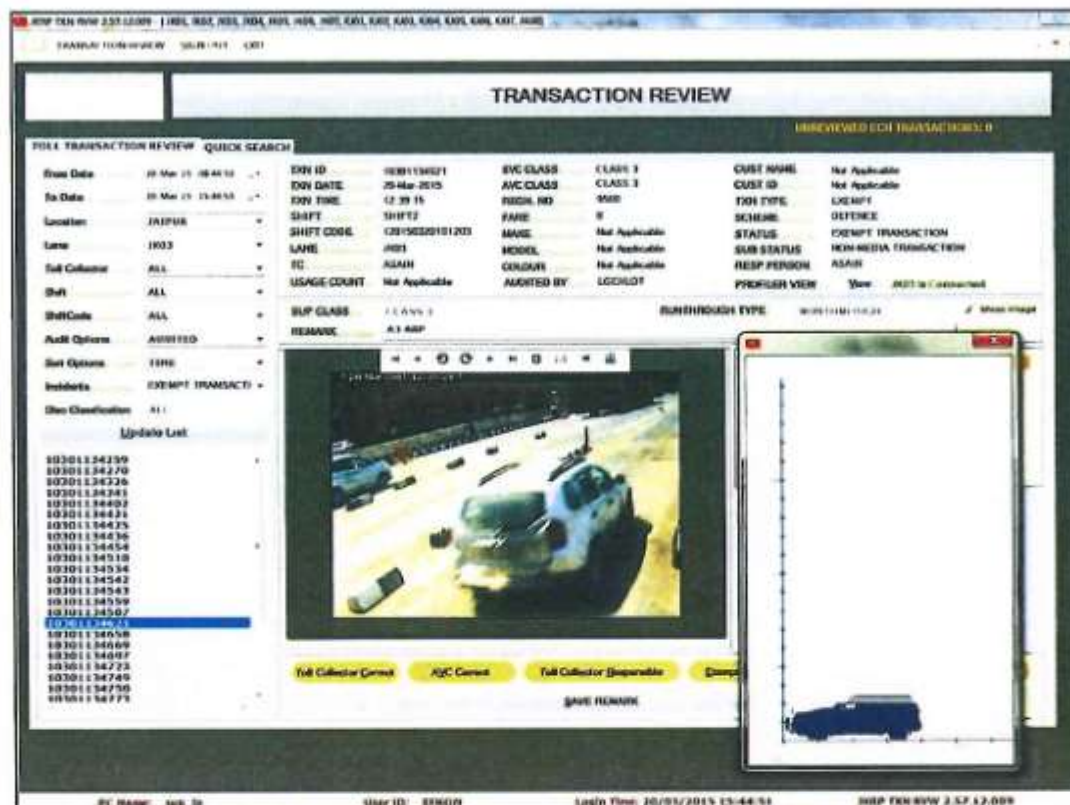
Figure 6:4 – Toll Transaction Review Screen with Vehicle Profile Image

6.7.2.2.4   Quick Search Screen

1) The quick search screen is helpful to view all audited transactions based on the below-mentioned filters.

Item	Description	Special Conditions
Plaza	Current Plaza name	Current Plaza name
Lane	A list of all the lanes available for the plaza	The system by default selects 'all' lanes if no particular lane(s) is selected.
From date and time	Calendar date. All data from this date forward (including this date) must be included in the selection criteria. Calendar time. All data from this time forward (including data at this time) will be included in the selection criteria.	The default date is the current date. A user-friendly "date picker" is available to select the required date. A user-friendly time input mechanism will be used.

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Item	Description	Special Conditions
To date and To time	Calendar date: All data up to and including this date will be included in the selection criteria. Calendar time: All data up to and including this time will be included in the selection criteria.	The default date is the current date. A user-friendly "date picker" is available to select the required date. A user-friendly time input mechanism will be used.
MoP	A dropdown list is provided for all MoPs.	By default, "All" MoPs are included in the criteria if no particular MoP is selected

Table 6:2 – Audit Detail Specification

2) After selecting the criteria, the user clicks on the "Update list" button, thus populating the transactions in the transaction pane. Users can select a transaction to view the details along with the image. By default, the first transaction of the list is selected.

3) Apart from the above-mentioned criteria, the user can set transactional criteria based on the following: viz. transaction number, customer name, customer ID, and vehicle registration number. The user will then click the "Update list" to display the transactions.

4) After selecting a particular transaction, the details are shown on the output screen.

6.7.3 Snapshot Image Workstation

1) The snapshot image workstation is used to monitor and store the snapshot image of the vehicle that has caused an incident. The workstation has two main functions namely:

a) Real-time viewing of image & video

b) Search and retrieval of images from & video from the archive

2) The operator views the transactions as they get recorded in the system and performs a transaction review by verifying the incidents, images, and video. If an incident occurs, snapshot image & Video will be sent immediately and shown on the display in a new window irrespective of the operation is executed on the workstation. The image & video will be attached with the date, time, interchange name, lane ID. For the image & video of the vehicle class discrepancy, category input by the toll collector and category judged by the automatic vehicle classification system will also be attached.

3) For each defined incident, an image & video is captured and saved with transaction details imposed on them. This image is referred to using the transaction number and displayed on the snapshot image workstation, while the operator is performing the transaction review.

4) The transaction is marked as an incident and an image is captured, if the transaction is

    a) a class discrepancy is found i.e., a mismatch between the toll collector class and AVC class,

    b) an exempt transaction or a convoy

    c) a violation

5) The supervisor sitting in the control room reviews these transactions in real-time during the shift. While review he verifies the transaction with the image & video taken while the vehicle is exciting. Based on the visual inspection, the supervisor judges the toll collector's decision. In case a fraud is found, the respective toll collector is charged. All snapshot images & videos will be stored in the storage device and at the same time, they will be sent to the toll management center system.

6.7.4 Tour of Duty (TOD) Workstation / Cash up Workstation

1) TOD Module is installed on the TOD workstations at each plaza for attendance recording and input of cash collection data by toll collectors following completion of a toll collection duty using manual lane equipment. A smart card reader is provided and installed adjacent to each TOD workstation, which is used for attendance recording. The TOD workstation facilitates tour of duty planning i.e., shift scheduling, attendance recording, vehicle classification discrepancy statistics, and exceptional transaction statistics.

2) **Attendance Recording**

    a) Before the start of the duty, each toll collector reports to the plaza and marks his attendance in the system. To mark the attendance, the toll collector selects the "Sign on/off" menu". Then presents its finger on the fingerprint scanner to gather the user identification information. The TOD workstation will display the identification number of the user as per the fingerprint reader, together with an indication of whether the action is for arrival or departure, and the name of the person.

    b) Based on the login status the module automatically records, operators' sign-in or sign-off attendance. When the operator places his finger on the fingerprint scanner, the system checks for the previous records. If the system finds that the sign-on is already done, then it enters the record as sign-off.

    c) The Toll Plaza System will compile attendance records and will make these records available for transfer to the TMS system together with other data.

3) **End of Duty records**

    a) After completing the duty, the toll operator again reports to the plaza and marks his End of duty. The operator opens the sign-in of the menu, presents his thumb to the associated fingerprint reader, which in turn records as end of duty.

STRABAG	TECHNICAL PROPOSAL – TOLL MANAGEMENT SYSTEM	एम एम आर डी ए MMRDA

b) The operator then declares the cash collected during the duty. The operator declares the cash in denominations by entering a number of each type of note and coin. The system allows the collector to enter a bag or seal identification number which will be used as part of the "cash transferred to bank" facility. The collector will acknowledge correct input or amend incorrect entries if required.

c) Once declared, the system compares the cash declared and cash expected and warns the operator in case of a mismatch. The operator can verify his entries and correct his errors if any. The cash is received by the cashier, an acknowledgment is printed and which is preserved with toll operator's and cashier's signature.

6.8 Data Exchange

Data exchange with toll lane equipment, toll management center system, and the peripherals attached to TPS will be arranged in such a way that failure of any one device or communication link does not render any other data exchange inoperative.

6.8.1 Data Exchange with Toll Management Centre System

1) The L2 network switches are provided for the data communication between TPS & TMS. All data transmission will be validated. The errors that occur during the data transmission will be automatically detected and retransmitted. Under no circumstance, the data integrity of the data exchanged between TPS and the TMS system will not get affected.

2) Data exchange from toll management center system to TPS will include the following:

Data	Contents
Operating parameter table	Valid interchange and lane codes, access control password, alarm setting
Staff ID number table	ID number, name, access level
Vehicle classification table	Vehicle classification parameter, number of vehicle classes
Fare table	Current, future, date, and time of implementation
Blacklist	Complete blacklist and differential blacklist

3) Data exchange from TPS to toll management center system will include the following:

Data	Contents
Lane operation	Time open and time closed, etc.
Traffic data	Lane traffic volume by class, etc.
Transaction	Date and time, interchange, lane, vehicle class, toll collector class, payment Method (manual, QR code, credit/debit card, ETC), amount of toll collected, exemption, etc.

Snapshot image & Video	Image & Video of the vehicle taken by incident capture camera together with date and time, lane
Alarm	Date and time of alarm, etc.
Revenue	Revenue by payment mode (manual, QR code, credit/debit card, ETC), by toll collector, bank-in amount with date and time, etc.
Toll collector	Time reported time sign in, time sign off, time left, etc.
Equipment malfunction	Date and time occurred, date and time recovered, etc.

4) In case of communication failure with the toll management center system, operating parameters data will be transferred & loaded into the TPS using removable media or a USB drive. It will be possible for the implementation of amended inputs to be included and for the data to be checked for correct configuration before execution in sequence.

6.8.2 Data Collection from Lane Controller

1) All data generated by the lane equipment and stored by the TPS will be secured against failure of the lane equipment, failure of the TPS, breakdown of the data communication link between the lane and the TPS or the TPS and the TMS system, and failure of the TMS system itself.

2) All the data sent from the lane equipment to the TPS will contain a unique identification number. This number will be supplemented by the plaza code and lane number for tracking. All incident notices will be individually stored by the lane controller for seven (7) days.

3) The TPS will monitor all the data received. The mechanism to detect the loss of data & automatic recovery of lost data will be implemented in the system. On the restoration of data communications between the TPS and lane equipment or disk capacity becoming available at the TPS, all essential data messages stored by lane equipment that have not been previously transferred to the TPS will be transferred automatically to the TPS. The received data will be similarly processed by the TPS to that received in real-time and once this has been completed, a display and printout of the data will be available.

4) The primary aim of the system is to ensure that all reports and data files are correctly compiled, data is available for print out, display, and files are available for transfer to the TMS system, and that no data is lost.

5) A portable external storage drive will be provided for extracting data stored by the lane equipment under conditions of TPS failure. Such equipment will be used when the limit of available data storage

`004055`

in the lane equipment is being reached and the intention is to provide a means of continuing operation of the system with no long-term loss of audit and statistical data.
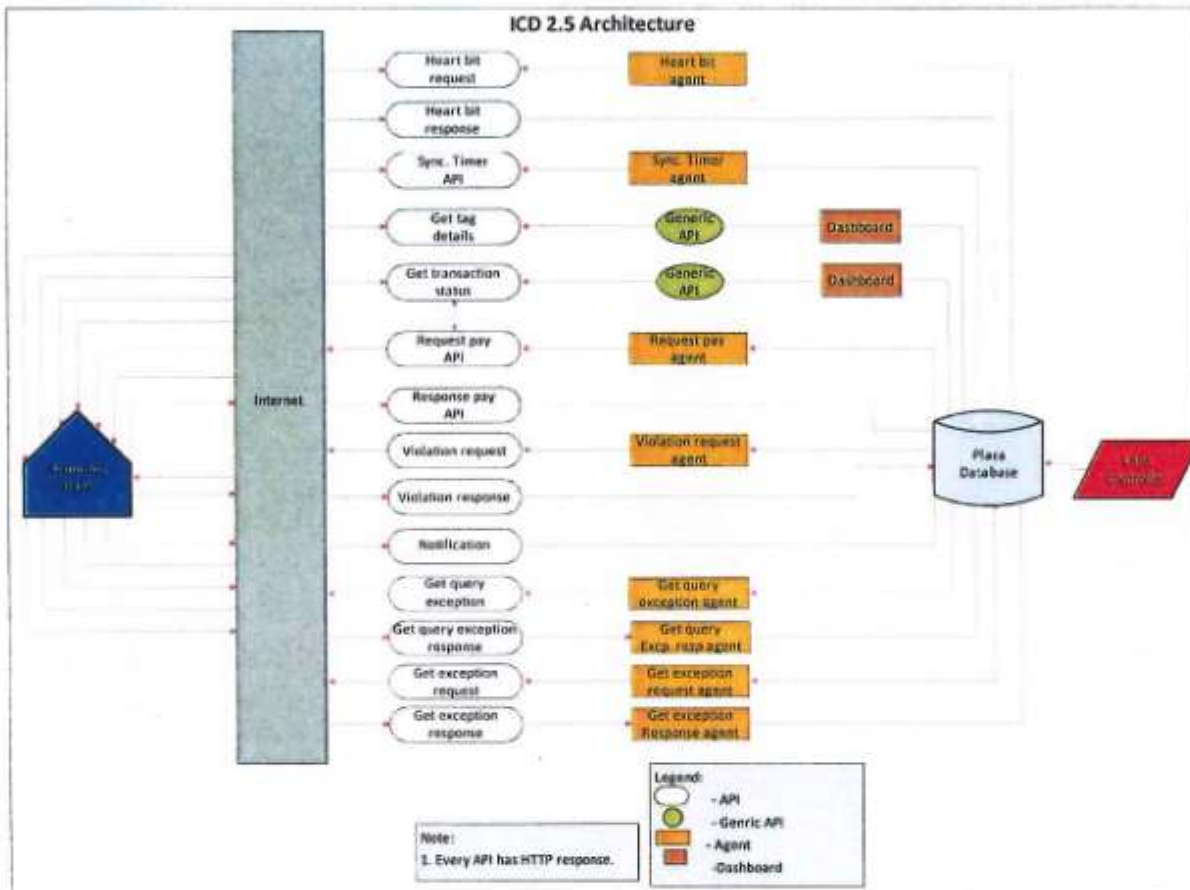
6.9 ICD 2.5 Architecture

Figure 6:5 – ICD Architecture

1) **Toll plaza Heartbeat:**

   This API will be initiated by Toll Plaza to report the availability status of each lane of the plaza & the acquiring bank will consume the API & store it in their database.

2) **Heartbeat Response:**

   In case of the request, the message is accepted by Acquirer then it will respond with the result "SUCCESS", if there is any technical or business validation failure then the acquirer will send a response with the result "FAILURE".

3) **Sync time:**

   This API is initiated by the toll plaza operator to sync its system's time with the Acquiring bank host or through the NTP server.

4) **Sync Time Response:**

This response is generated by Acquirer bank in request to sync time request API.

5) **Request tag details:**

   This API is called by the toll plaza operator to get details of the vehicle passed through its toll plaza from the acquirer bank

6) **Response Tag Details:**

   This API is the response of Request Tag Detail API and is always issued by Acquirer Bank. If the request is initiated with TID, in response TID, a Tag ID and vehicle registration number will be part of Vehicle Element, and if the request is initiated with and vehicle registration number, in response vehicle detail, a Tag ID and TID will be part of Vehicle Element.

7) **Request Pay API:**

   This API is called by the toll plaza operator to either perform the debit or credit leg of a transaction. The toll plaza operator passes this request to Acquirer bank. Acquirer bank will validate this request pay message and if valid, then, Acquirer bank will process this request pay message with Issuer bank via NPCI to get the toll fee requested by toll plaza.

8) **Response Pay API:**

   The Response Pay API is initiated by Acquirer Bank to respond to Request Pay. The transaction id will be the same for the entire leg of the transaction. Acquirer bank will pass the response to the toll plaza server based on the success, failure, and/or in-process transaction.

9) **Check Transaction status:**

   This API is called by the toll plaza operator to get the status of the transaction from Acquirer bank. Toll plaza operator can use this API to check transaction status before reconciliation which are "In-process" or for which no response is received by the toll plaza operator.

10) **Check Transaction Status Response:**

   This API is the response of check transaction status API issued by Acquirer bank. The toll plaza operator will receive the status of the requested transaction before reconciliation which is "In-process" or for which no response is received by the toll plaza operator.

11) **Request Query Exception List:**

   This API is called by the toll plaza operator to get an incremental exception list from the acquirer bank. The exception list will contain the latest status of the Tag IDs requested as an exception type.

12) **Response Query Exception List:**

   This is the response of Request Query Exception List API to provide the incremental exception list on request by toll plaza operator, i.e., from the last exception list fetch time.

13) **Notification:**

The Notification API is initiated by Acquirer Bank to provide detailed status of "In-Process" transactions which were generated by the acquirer bank in the Response Pay message. Acknowledgment for Notification API will be generated by Toll Plaza.

14) **Violation API Request:**

This API is called by toll plaza to raise violation to acquirer bank.

15) **Violation API Response:**

Once validation of violation request is completed, this API is initiated by acquirer bank to provide the result of violation raised by toll plaza.

16) **Get Exception request:**

This API is called by the toll plaza operator to get the consolidated exception list, at the time request is raised to Acquirer bank. The exception list will contain the latest status of the Tag ids requested as an exception type.

17) **Get Exception Response:**

This API is initiated by Acquirer bank to provide the consolidated exception list on a request raised by the toll plaza operator. The exception list will contain the latest status of the Tag ids requested as an exception type.

6.10 Technical Specifications

The proposed technical specifications for the TPS equipment will be as per the "1.1 Division 5A ITS Part-1 - 27.08.21".

7 Toll Management Centre System (TMS)

7.1 System Outline

1) The TMS system will be provided to monitor and supervise the operation of both the TPS at Mainline toll (at Gavan) and at Shivajinagar interchange and to provide audit control and statistical data relating to the toll collection operation at each toll plaza.

2) The system's principal functions are:

   a) Receive transaction data, incident data, operation monitoring data, and equipment monitoring data from all TPS systems

   b) Correlate transaction data from TPS and bank-in into summary and statistical reports and files

   c) Process traffic data and produce a statistical summary

   d) Process incident data and prepare blacklist to be added and send it to central clearing house

   e) Produce archive disks containing data files that may be further processed off-line

   f) Receive blacklist of FASTag from the acquirer bank portal or in turn from a central clearinghouse and download them to the TPS

   g) Update and revise operation parameters and download them to TPS

   h) Search FASTag data of vehicles, find a pair of data of the same FASTag unit, and adjust the net amount to be charged

3) The TMS will be configured as a two-node high availability with a primary & a secondary node. The primary node will be located at the Main toll management center at the mainline toll plaza (at Gavan) & the secondary node will be located at the sub toll management center at Sewri interchange. In the event of serious hardware or software problem at the primary node, the secondary node becomes active. On rectification of faults, the primary node becomes active again. The servers will form a cluster to support continuous system operations.

4) The TMS performs data analysis, system administration, and report generation. The traffic analysis module collects traffic volumes at each plaza. It maintains vehicle class-wise traffic count on a daily, weekly, monthly, and yearly basis. The data is displayed in graphical and/or grid format as requested by the operator. The module also shows traffic trends on a daily, weekly, monthly, and yearly basis by calculating the average traffic count.

7.2 CPU Utilization

Please refer to Section 6.3.

2014

7.3 Disk Capacity

1) The disk capacity of the TMS server is calculated considering the need to store the operating system, the application software and other software packages necessary for the operation of the system, and the data generated by the system and to adhere to the manufacturer's recommendations on usable disk capacity for the efficient running of programs.

2) All transaction records will be kept for five years in the disk connected with TMS online. The snapshot images & video of the incident will be kept for the same period for all types of transactions. The images of all vehicles that have passed through the toll lane without any incident will be stored for three (3) months regardless of the payment mode.

3) The calculation of disk capacity is provided in Section 3.15.

7.4 System Time

A software utility is installed on each machine and used for time synchronization between TMS servers and TPS Server. The utility controls the time setting of all the clients over the provided network. All TPS servers and the secondary TMS server timings are synchronized with the Primary TMS Server. Any change in the Primary TMS server's timing automatically updates the other server timings. The synchronization of the clocks is maintained accurately within two seconds in one calendar month. The synchronization is also dependent on the availability of the network.

7.5 TMS Functions

The TMS system application facilitates the following functionalities:

1) Parameter management
2) Traffic management
3) TMS activity
4) Revenue statistics
5) System administration
6) Report generation
7) Organization of data
8) Transaction matching and pairing

7.5.1 Parameter Management

1) The functions available in this module are:

   a) Inquiry / Reporting

   b) Maintenance of parameter tables

2) The parameter tables managed under this module are:

   a) Access level setup

   b) Automatic print out

   c) System constant

   d) Exemption criteria listing (such as ambulance, police, government, etc.)

   e) Staff list

   f) Fare tables

   g) Versions (in case of change of tables such as changed toll fare table, etc.)

   h) AVC parameters

   i) Acceptable bank for a bank in transactions (list of banks for bank-in processes)

   j) Parameters related to blacklist management

   k) Remarks (optional)

3) Whenever the administrator makes entries of the above parameters a version number is assigned to the entire set. E.g., the user makes fare table entries in the TMS server, valid from 1st January 2022. The user also makes fare entries which will be valid from 1st June 2022. The system automatically maintains the two sets of fare tables by assigning a unique version number. The system does not allow editing of parameters table.

4) The parameter values are maintained separately for each plaza. The parameters for each plaza include many lanes, fare applicable, users, etc.

5) The enquiry/ reporting function allows the display/ printing of parameter tables for the selected range of dates and revision numbers.

7.5.2 Traffic Data Management

1) The system will collect the traffic volume data at the mainline toll plaza and Shivajinagar interchange from the Toll Plaza System and process them into the summary format. It will generate:

   a) Traffic volume at section and on/off ramp statistics

   b) Origin – destination (OD) traffic volume statistics

2) Traffic volume statistics

   a) The system will collect traffic details from the TPS server and generate a summary report on request. The summary report gives the traffic volume handled by each plaza during the selected time frame and classified under the defined vehicle classes.

   b) The report is generated for the day(s), week(s) and day of the week, month(s), and year and shows details of average traffic on a daily, weekly, and monthly basis.

3) OD traffic volume statistics

004061

a) The data collected from the TPS server is processed further to generate the traffic details on an origin and destination basis. The data is processed separately for each type of vehicle classification and aggregate of all types of vehicles.

b) The summary report is generated for monthly total, daily average, and day of the weekly average.

c) The processing of the transaction will be carried out by the toll plaza server and the toll management center system to compile the data from each Toll Plaza System into overall data covering the entire MTHL.

7.5.3 TPS Activity

1) The primary functions available in this module are:

    a) Enquiry/reporting

    b) Audit reporting of maintenance activities

    c) Status

    d) Enquiry/ reporting function performs the display and printing of the following:

    e) List of toll collectors on duty

    f) List of toll collectors who have finished their duty in a day

    g) Details of transactions specified

    h) Criteria for filtering transactions for display including the discrepancy types

    i) Plaza revenue summary

    j) Plaza TOD summary

    k) Plaza traffic volume summary

    l) Collection performance summary for a specified period (with both text & graphics)

    m) Exceptional transaction summary

2) The display of End of Duty for lane includes the possibility to zoom into the individual transactions of the same duty or to the list of duties where another duty can be selected. The enquiry/ reporting function allows the display/ printing for the selected date, plaza, lane, duty, bag no, transaction number, transaction time, as applicable.

3) The plaza activity display criteria screen will provide additional selection filters for the lane individual transaction screen. The additional selection filters are based on two criteria namely the observation of events at lanes and payment type. The logical control between the two criteria may also be specified as an 'OR' or 'AND' function. The logical control between the three categories under the observation of events namely payment monitoring, sequence, and passage will be an 'OR' function.

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7.5.4   Revenue Statistics

1) The functions available in this module are:

   a) Revenue by vehicle class

   b) Revenue by payment method type (Cash/QR/Card/ETC)

   c) Period wise Revenue

   d) Computed Revenue Summary (Computed by the system)

   e) Declared Revenue Summary (Declared through TOD)

   f) Cash Reconciliation (Difference in Computed and Declared)

   g) Bank-in history

   h) Bank-in reconciliation

   i) Revenue recovered/refunded

   j) Miscellaneous revenue

2) The entry of data for bank-in reconciliation consists of the following:

   a) Data entry of bank-in slip/total bank-in for a collection date

   b) Zooming into cash collection facility

   c) Zooming into plaza TOD declaration

3) The following data is entered:

   a) The amount bank-in by the bank for each collector daily

   b) The total bank-in per bank-in slip

4) If a discrepancy occurs between declared and bank-in, an appropriate message is displayed. If the auditor proceeds, he writes a remark to indicate the reason for the discrepancy.

5) The revenue outstanding amount recovered/refunded screen will provide a facility to record and print revenue recovered or refunded during the operation of the toll management system.

6) The miscellaneous revenue screen will provide a facility to record and print other sources of revenue from other services such as towing and repairing other than a collection of toll.

7) The data entered, deleted, or edited will not affect all other reports or screens provided in the TMS system.

7.5.5   System Administration

1) This module will allow the auditor to administer the TMS system through the management of data and parameters including verification of data. It is expected that the TMS system will receive data via a digital data transmission system periodically and on an ad hoc basis from all plazas and provide completed statistical data at the end of every operational day.

2) This module has the following functions:

a) Copy Parameter for TPS

b) Load TPS Data to TMS system

c) Parameters for ETC communication with the acquirer bank

d) Backup TMS Data

e) Restore TMS Data

f) Backup TMS Parameter

g) Restore TMS Parameter

h) Data upload verification

i) System data verification

3) If under unforeseen circumstances the digital data transmission system gets fail to allow transmission of data, the 'Copy parameter for TPS' function will enable the auditor to transmit parameter data manually via removable media to every TPS. Similarly, the "Load TPS data to TMS system" function will enable the auditor to load data from every TPS to the TMS system.

4) The TPS and TMS systems will be capable of segregating and distinguishing newly inserted data from other data already located in the database and files to avoid duplication or deletion of data.

5) Using the "System data upload verification" screen, the TMS auditor can check and verify the status of data uploaded at the TMS. The number of duties for the lane will be determined at the plaza level and will be transmitted as "data" to the TMS system.

6) Using the "System data verification" screen, the TMS auditor can verify the status of the summary data at the TPS and the TMS. The summary of data will be determined at the plaza level and transmitted as processed data to the TMS system.

7) The information on this screen will be updated automatically at least once daily on every operational day.

7.5.6 Report Generation

The modules facilitate the generation of the following types of reports:

Sr. No.	Report Type	Description
1)	Transaction Reports	The report shows each transaction in detail for the selected criteria. It is used when a particular transaction needs to be traced. The report is generated after giving the selection for plaza, duration, shift, lane, user, type of transaction.
2)	Revenue Reports	The report shows the revenue summary for the selected criteria. The report is generated for plaza (one / multiple / all) and duration. The revenue is displayed for each plaza with a total.

Sr. No.	Report Type	Description
3)	Traffic Reports	The traffic report shows the traffic volume as per the vehicle class. The report is generated for plaza (one / multiple / all) and duration. The traffic count is displayed for each plaza, for each vehicle class with a total.
4)	Incident Reports	The incident report shows the transaction count which is treated as an incident. The incidents include class discrepancy, violations, and exempt transactions. The report can be generated by a selected plaza (one / multiple / all) and duration.
5)	Event Reports	The report shows the list of events captured by the TPS and/or TMS system. The TPS events include lane equipment events, data transfer events,
6)	AVC Reports	The AVC report shows the traffic count, detected and classified by the AVC system. It also shows the comparison of AVC classification and auditor's classification and the percentage of AVC accuracy concerning the auditor's class.
7)	Fare Detail Reports	The report shows the fare applicable for each type of transaction which includes QR, Credit/Debit card system, ETC payment.
8)	User Reports	The report gives the user details including user name, login ID, status, etc.

7.6 Technical Specifications

The proposed technical specifications for the Toll Management System equipment will be as per the "1.1 Division 5A ITS Part-1 -27.08.21".

STRABAG	TECHNICAL PROPOSAL – TOLL MANAGEMENT SYSTEM	एम एम आर डी ए MMRDA

8 Constraints

RFP reference	RFP requirement	Justification/ Considerations	Remarks
1.1 Division 5A ITS Part-1 - 27.08.21, PDF pg. no. 80	**8.1.3 Lane computer (LC)** Design Criteria: 8th Generation Intel® Core™ i5-8365U **(NUC8v5PN)** 1.6 GHz to 4.1 GHz Turbo, 4 Core, 8 Thread 6MB Cache, 25W Intel® UHD Graphics 620, 300 MHz – 1.10 GHz	The part number **(NUC8v5PN)** provided in RFP is a commercial-grade box PC. Hence, we have not considered the same model number. Instead, we have considered a fanless industrial computer, which is 100% compatible with the requirement. **2.9 Environmental** Table 30 lists the environmental specifications for the board. **Table 30. Environmental Specifications**	We are providing better
1.1 Division 5A ITS Part-1 - 27.08.21, PDF pg. no. 105	**8.15 Automatic vehicle classification system (AVC)** Design Criteria: 8th Generation Intel® Core™ i5-8365U **(NUC8v5PN)** 1.6 GHz to 4.1 GHz Turbo, 4 Core, 8 Thread 6MB Cache, 25W Intel® UHD Graphics 620, 300 MHz – 1.10 GHz	The part number **(NUC8v5PN)** provided in RFP is a commercial-grade box PC. Hence we have not considered the same model number. Instead, we have considered a fanless industrial computer, which is 100% compatible with the requirement. **2.9 Environmental** Table 30 lists the environmental specifications for the board. **Table 30. Environmental Specifications**	We are providing better
1.1 Division 5A ITS Part-1 - 27.08.21, PDF pg. no. 105	**8.8 Overhead traffic light (OHTL)** Material and finishes:Polycarbonate	We have considered MS material.	We are providing better

RFP reference	RFP requirement	Justification/ Considerations	Remarks
1.1 Division 5A ITS Part-1 - 27.08.21, Pg. 95	**8.8 Overhead traffic light (OHTL),** 7) It should be possible to control OHTL from LSDU even if the lane computer is not working or power off and when the lane is connected to the network.	The OHTL is connected with the lane controller through I/O card & if lane controller is powered OFF or not working, Or not in network then it is not possible to control the same through LSDU.OHLS switching is based on TC login and logout hence it should be connected to lane controller only.	
-	General	Consumables like printer headers, cutters, boom arms, damaged components by vehicle hits, accidents or act of Gods, printer cartridges, dg fuel, recurring power charges, printing papers etc. shall be in customer scope during DLP & AMC period.	