Detailed Project Report

ITS Solutions, Transit Signal Priority, and Automated Fare Collection System

Congestion has been named the number one frustration with the roadway network all around the world. Effectively addressing the congestion issue means not only adding new lanes (capacity) to the roadway system, it also means finding ways to make the existing roads work better. Combining communications strategies and technology to accomplish this is known as Intelligent Transport Systems, or ITS. The City of Indore is looking at comprehensive transportation improvements with emphasis on public transport and technologies. This document provides a detailed project report of the ITS solutions proposed for Indore.

TMS

TRAFFIC MOBILITY SOLUTIONS

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1 Introduction

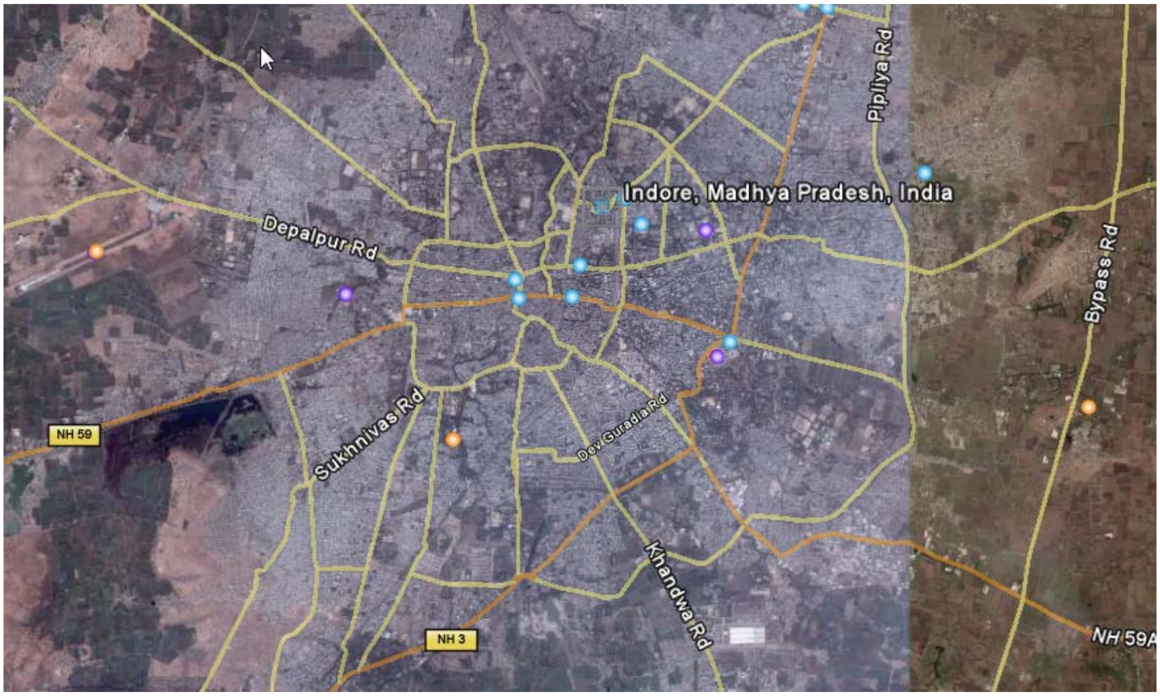
Entering the 21st century, the Indian transportation system has been rapidly expanding, still it has not been able to keep pace with the congestion in our cities which continues to grow at an alarming rate. This increased congestion is adversely impacting our quality of life and increasing the potential for accidents and long delays. To fight and mitigate congestion, transportation professionals in India are working towards increasing the productivity of existing transportation systems through the use of advanced technologies. Intelligent transportation systems (ITS) encompass a broad range of wireless and wire line communications-based information and electronics technologies. When integrated into the transportation system's infrastructure, and in vehicles themselves, these technologies relieve congestion, improve safety and enhance productivity.

1.1 Background

Indore, a historical city situated on the banks of rivers Khan and Saraswati, is the largest city of 'Indore Agro Industrial Region' of Madhya Pradesh. It is almost centrally located on the fertile Malwa Plateau at latitude 220 43' North and longitude 760 42' East and is the nerve centre of the economic activities of the state. Indore is the most populous city in Madhya Pradesh with population of about 1.6 million according to the 2001 census. It is likely to rise to 2.5 million and 3.6 million by 2011 and 2035 respectively. The average annual growth rate of population is around 40% as per the statistics of census 2001. Indore has an average literacy rate of 72%, higher than the national average of 59.5%: male literacy is 78%, and female literacy is 65%.

Indore is one of the fastest growing Tier II cities in India. It already is the commercial capital of central India. The rapid industrial and commercial development coupled with the rise in population in the recent past has contributed to a large scale increase in traffic on the city roads. This increasing intensity of traffic has resulted in the manifestation of a number of problems like congestion, delay, accidents, pollution etc. which pose a potential threat to the economic vitality and productive efficiency of the city.

Figure 1-1 Layout of Indore



1.2 Objective and Scope

The objective and scope of this detailed project report are as follows:

1. The DPR details the system, functional, and operational architecture and design to implement the intelligent transportation solutions in the city of Indore.
2. The DPR documents the recommended technological improvements to improve operational performance of the pilot (A-B Road) BRT corridor.
3. The DPR scope is limited to implementation of field and centralized equipment and software to the A-B Road corridor.

1.3 Intended Audience

This document describes the ITS solutions that are proposed for the city of Indore, with emphasis on Transit Signal Priority (TSP) and Automated Fare Collection System (AFCS). This report's intended audience is the various stakeholders involved in the Indore City Transportation Projects Development.

The scope of TSP and AFCS, bus priority, ticketing process and architecture and other important items of the project are described in this document. The costing and procurement process are also documented.

1.4 Abbreviations and Acronyms

Acronym	Description
AFCS	Automated Fare Collection System
BCTU	Bus Control and Ticketing Unit
BCV	Bus Card Validator
BIM	Bulk Initialisation Machine
Non-BRTS	Simple buses with two doors
BRTS	Bus Rapid Transit System
CCS	Central Computer System
CPD	Card Personalisation Device
CSC	Contact less Smart Card
DCS	Depot Computer System
GPS	Global Positioning System
ICTSL	Indore City Transport Services Limited
ITS	Intelligent Transportation System
OTS	Off The Shelf
PIS	Passenger Information System (on BRT station)
SC	Station / Site Computer
SCP	(BRT) Station Card Processor
TOT	Ticket Office Terminal
TMC	Traffic Management Center
TSP	Transit Signal Priority
CCHS	Central Clearing House
ETM	Electronic Ticketing Machine
IVR	Interactive Voice Response

CRM	Customer Relationship Management
PIMS	Passenger Information management System
LCD	Liquid Crystal Display
MTTReplace	Mean Time To Replace

1.5 Navigating the Document

This document includes 9 chapters that are organized to introduce you to the current condition of the Indore transportation system, summary of ongoing transportation projects, and the proposed ITS solutions to be applied to the city of Indore to provide long-term transportation improvement.

Here is a breakdown of the 10 chapters and what you will find in each:

Chapter 2: Outlines the urban transport development strategy and plan for city of Indore

Chapter 3: Prepare base line urban transport scenario relevant to the project

Chapter 4: Description of the Indore BRT network

Chapter 5: Description of services development plan

Chapter 6: Detailing of the ITS Operations Plan

Chapter 7: Detailing of the Automated Fare Collection System

Chapter 8: Project execution methodology

Chapter 9: Benefits and Costs

2 Urban Transport Development Strategy and City Plan

In 2006, the City of Indore put together the Indore Development Plan (IDP) 2021 which provides a comprehensive account of Indore's demographic and economic characteristics, land-use, infrastructure, environment, and housing and slums. Some of the salient features of the CDP are[1][2]:

1. The plan documents the demographics of the City of Indore:
   a. According to the 2001 census, Indore's population growth is a whopping 40% with a similarly high population density of 1028 persons per hectare in Indore planning area
   b. The City consist of skewed spatial distribution-dense pockets with high densities in the CBD area and in the slums coexisting with sparsely populated areas mostly near the fringe.
2. The Plan identifies the gaps and deficits in city's infrastructure:
   a. Water supply is available for only 45 minutes on alternate days, covering 54% of the city population. Average water supply is 80 lpcd. 50% of water is unaccounted for (UFW), including 40% transmission and distribution losses.
   b. Only 55% population has access to sewerage network and 80% of sewers are underutilised for want of maintenance
   c. Only 20% of roads have storm water drainage
   d. Solid waste collection suffers from poor handling and management
   e. Narrow road widths, high vehicular ownership, and a heterogeneous mix of transport modes resulting in traffic congestion problems and a high accident rate.
3. The Plan identifies environmental pollution and lack of green cover as critical problems faced by the city:
   a. According to the CDP, the main cause of air-pollution is vehicular traffic. The suspended particulate matter (spm) in the city is in excess of the threshold of 200 ug/cum by Indian standards (p. 55-

[1] http://www.skyscrapercity.com/showthread.php?t=263611&page=5

[2] http://jnnurm.nic.in/nurmudweb/cdp_apprep_pdf/CDP_Appraisals_Nipfp/CDP-Indore.pdf

56). Discharge of untreated domestic and industrial wastes has resulted in pollution of the surface water bodies in the city.

b. The city has very limited green areas and recreational spaces.

4. The Plan presented the state of housing shortage:

    a. Informal housing form 50% of residence of Indore's population in the form of squatters and unauthorised colonies. 35% people live in slums and squatter settlements and another 15% in unauthorised colonies, with inadequate infrastructure facilities.

5. The Plan also detailed the inner city congestion:

    a. The CBD has heavy population pressure and is suffering from congestion in terms of traffic, building intensity, and parking. Most of the buildings in the CBD area are said to have completed their life span.

6. The Plan addressed critical limitations in the governance process such as Institutional multiplicity, lack of co-ordination and overlapping jurisdiction

    a. The CDP makes specific references to the areas of fragmentation between the Municipal Corporation and development related agencies like IDA, MPTNCP, and MPHB.

    b. Lack of co-ordination is said to be the principal reason behind the many problems that Indore City is faced with, particularly regarding the utilisation of land. Issues pertaining to governance and institutional set-up are separately highlighted in the CDP, but these are not linked to their impact on service provision or land development.

7. The Plan seeks to improve the city's existing infrastructure with "minimum basic services to the underprivileged" to ensure functional, sustainable development and further growth towards becoming a "world class commercial city".

8. Keeping long-term growth in perspective, the City Development Plan has strategies to provide the city's entire population with round-the clock water supply by 2010 and efficient solid waste management using modern and scientific systems by 2011.

9. The CDP envisages a well-organized public transport system which would include a metro rail, flyovers and elevated road intersections by 2012, and an environment friendly Indore by 2021.

10. It provides information on the city's institutional set-up, with particular reference to the role of Indore Municipal Corporation (IMC) vis-à-vis other agencies involved in the provision and maintenance of infrastructure and services.

11. The Plan details the role of agencies involved in urban development, these being the Indore Development Authority (IDA), Madhya Pradesh Public Works Department (MPWD), Madhya Pradesh Housing Board (MPHB), District Urban Development Authority, Madhya Pradesh Town and Country Planning Department, and Krishi Upaj Mandi Samiti.

12. Special agencies are identified in the plan for the provision and management of city's transport. These are the Indore Development Fund limited which is owned by IMC and had been formed to mobilize funds for repair and construction of roads in the city and Indore City Transport Services which is a fully government owned company, set up to provide an efficient transport system in the city. The CDP has provided a detailed account of the finances of the Municipal Corporation of Indore.

13. The development plan of the city is proposed to be conducted in two phases with the first phase to be implemented from the year 2007. Under the first phase of development 5,400 hectare of land would be acquired and an investment of Rs 500 crore, and another Rs. 1,930 crore will be spent on its development. Around 70 per cent of the land acquired would be used to developed new roads and for the maintenance of old ones.

14. In summary, the CDP has been prepared keeping a view the deficiencies and requirements till 2021. It focuses on the first phase of the target for sustainable and harmonious development by 2021. The CDP relates to the entire planning area of Indore for a period of seven years from 2006-2011. The Vision identified in the CDP for the city is:

    "Indore shall enter an era of prosperity with spatially restructured environment, improved urban infrastructure to achieve better lifestyle, minimum basic services to the underprivileged with functionally sustainable development and dynamism of growth which will pave the way for it becoming a world class commercial city".

    The vision consists of the following elements:

a. Healthy community life

b. Improved mobility

c. Housing for all

d. Sustainable city

e. Heritage and inner city area Conservation

15. The goals identified in the CDP are:

a. Strategies are formulated after identification of sector-wise goals for the year 2021.

b. Water supply 100% population coverage and 24 hour water supply by 2010

c. Sewerage 100% population and area coverage by 2020

d. Solid Waste Management Development of a comprehensive system with modern and scientific methods by 2011

e. Transport Efficient public transport, introduction of metro-rail, elevated road intersections and flyovers to remove congestion Slums Slums less city by 2012

f. Environment Clean and environment friendly Indore by 2021

g. Slum less Indore by 2015, through construction of dwelling units for EWS and LIG category on 20% of land of its Town Development Schemes.

3 Indore – Urban Transport Scenario

As with all Indian cities, Indore has very few existing studies depicting the quality of service in the city. This chapter documents the studies that have been conducted till date in the city[3].

3.1 Traffic & Transportation – Draft Development Plan for Indore (1974)

Some of the principle findings for draft development plan of 1974 were:

1. An estimated 500 passenger buses move into and out of Indore everyday
2. An estimated 1200 trucks move into and out of Indore daily while 430 trucks were through in nature
3. The peak hour volume on some of the important city roads like A B Road and M G Road, Subhash Marg and Jawahar Marg varied between a minimum of 275 PCU to a maximum of 1132 PCU
4. Central area road network exhibited a higher traffic density in comparison to the network capacity

The study highlighted the following problems and issues:

1. Central area suffered from inadequate circulation pattern
2. Inter-mixing of traffic
3. Misuse of road space and narrow width
4. Accidents
5. Lack of traffic regulation and enforcement
6. Parking problems

The document presented the following recommendations to alleviate the problems were:

1. Relocation and rearrangement of various activities which generate parking
2. Recommended or conceptual circulation plan comprising of system of ring roads and approach roads for central area

[3] Comprehensive Traffic and Transportation Study for Indian Urban Area, CES in association with ICF Kaiser and Anil Varma Associates, 2004

3. Preparation of traffic operation plan

3.2 Traffic Flow Study for Indore City (1997)

In 1997, the Indore traffic police commissioned a traffic flow study that was carried out by Sh. G S Institute of Technology & Science, Indore. The study aimed at understanding the traffic issues and recommending improvements to facilitate smoother traffic flows. Population growth, vehicle ownership, socio-economic characteristics, and public transport facilities were among the parameters analyzed in the study. The study identified the following as contributing issues to the traffic problem:

1. mixed traffic conditions
2. encroachment resulting in reduction of capacity of roads
3. lack of enforcement measures
4. lack of engineering measures
5. inefficient and inadequate mass transport system

The broad recommendations emerging out of the study included:

1. Planning should focus on reduction of the traffic load on existing road network through various travel demand management measures.
2. Emphasis should be placed on mass transport system
3. Concerted efforts are needed in removing encroachments, bottlenecks, improving traffic signal, road condition and geometrics at intersections.

3.3 Vehicle Data

Vehicular studies from 1975 are shown in Table 1 below. The volumes show rapid increase in all modes of transport in the past decade.

Table 1. Vehicle Data From 1975 to 2004.

No.	Year	Scooter	Truck	Taxi, Car & Auto	Car	Bus	Other	Total
	1975	10783	4360	5110	Not Classified	929	3569	24751
	1980-81	29850	6785	9222	-do-	1452	2276	49585
	1985-86	72449	10022	14983	-do-	2070	4101	103625
	1990-91	162414	15757	27090	-do-	2230	6383	213874
	1995-96	241737	22835	34442	-do-	2660	23066	324740

	2000-01	395908	30380	10900	43829	12855	23654	517530
	2001-02	425094	30793	11035	45953	11913	25600	550388
	2002-03	460131	32148	11965	49223	14643	24243	592353
	2003-04	513456	32725	13185	55542	18975	34721	658604

3.4 Comprehensive Traffic and Transportation Study (2004)

A Comprehensive Traffic and Transportation Plan for Indore (CTTPI) have been prepared in 2004 by CES in association with ICF Kaiser and Anil Varma Associates. The study area was over 214 sqkm and covered Indore Municipal Corporation and 16 other adjacent villages and settlements. After evaluating the existing traffic and travel characteristics of the Indore city, the study: (1) provided projections of travel demand up to the horizon year 2025, (2) identified short term transport improvement measures, (3) prepared medium and long term transport improvement plans, (4) developed a plan for Integrated Mass Transport System (IMTS) that included economic and financial analysis, and (4) suggested implementation mechanism and organisational structure for the CTTSI recommendations.

The following are some of the findings for the base year (2004) of the CTTPI[4]:

1. In the base year, on an average, 88423 vehicles move in and out, daily, at the outer cordon while 5,28,558 vehicles enter and exit, daily, the inner cordon.

2. An estimated 2,84,161 passengers enter and exit the city daily by various modes. Minibuses and buses put together contribute to a share of 60 percent of passenger trips.

3. Majority of trips are made for the work, business and education purpose together accounting for nearly 76% of total trips performed.

4. An estimated 20,321 freight vehicles move into and out of study area daily.

5. On an average, 31,056 tonnes and 26,676 tonnes move into and out of the city daily. Apart from building materials, foodgrains and vegetables are the major commodities moving in and out.

6. The speed distribution reveals that 71 percent of road length in central area had speeds less than 20 kmph.

[4] Comprehensive Traffic and Transportation Study for Indian Urban Area, CES in association with ICF Kaiser and Anil Varma Associates, 2004

7. The average journey speeds on A B Road and Ring Road were observed to be 32.2 kmph and 40.1 kmph respectively.

8. The study area is presently being served by an estimated 300 minibuses along with estimated 150 tempos, with minibuses carrying the most passengers

9. An estimated 61,192 rail users use the station daily. In all, 49 trains service the rail movement needs.

10. Analysis of household socio-economic data reveals that the average household income in Indore is Rs. 7524.

11. The average vehicle ownership rate in the study area is 0.88 vehicles per household with two wheelers and bicycles being the most commonly owned vehicles.

12. An estimated 22.7 lakh trips take place in the study area of which central area contributes 19.4 percent, while the rest of Nagar Nigam area contributes 76.4 percent and extension area's share being 4.3 percent only.

13. The overall per capita trip rate (PCTR) was 1.49 while the vehicular PCTR (excluding walk) was 1.09.

14. The shares of personalised vehicles (cycles, two wheelers & cars) and public/IPT transport in the total trips were 51.1 percent & 16.4 percent respectively.

15. Work /Business trips accounted for maximum share (38.1 %) followed by education trips (37.6 %). Shopping trips share was 28.4 percent.

16. The average trip lengths observed were 3.8 km and 4.4 km including and excluding walk trips respectively.

The following are some of the estimated findings for the horizon year (2025) of the CTTPI:

1. A population size of 42 lakhs was estimated for the city by the year 2025.

2. The forecasted estimate was 62,85,950 passenger trips for the year 2025, comprising 55,03,000 intra-city trips while the rest comprise of inter-city passengers. An estimated 27,51,825 trips by public transport have been forecasted for the horizon year.

3. Nearly 416 km of road network is proposed to be developed in phases by 2025. Of this, 133.8 km would be 2 lane roads, 13.1 km – 3 lane roads, 122.7 km – 4 lane roads and 146.3 km – 6 lane roads. Eight railway over bridges (ROBs) have been proposed all over the city.

4. By year 2025, at modal split of 50% and with an estimated average trip length of 6.02 km, it is estimated that 16.5 million passenger km would be performed daily by public transport.

5. According to traffic estimates, a total of 5.5 million person trips would be generated every day by 2025, of which the share of public transport trips would be 2.75 million trips.

6. In all 478 buses are required to service the demand of 1.22 million passengers in the year 2025.

CTTPI proposes financially viable integrated mass transit system (IMTS) comprising of 44.75 km length with 27 stations. The study's recommendations for the ITMS were:

1. The Indore Mass Transport System (IMTS) was proposed to include 277 km of bus network and 44.75 km of rail network (IMTS) comprising three corridors:

   a. Green Corridor (East-West Corridor) comprising of 12.3 km, having eight stations along it, starting from Khazrana in the east and terminating at Namod in the west.

   b. Red Corridor (A B Road) comprising of 15.25 length, having nine stations along the corridor, starting from Niranjanpur in the North and terminating at Rajendra Nagar.

   c. Blue Corridor (Ring Road – W) comprising of 17.20 km length, with 10 stations along it, starting from Niranjanpur and terminating at Rajendra Nagar running along the Western Ring Road.

3.5 Traffic and Travel Pattern in Indore City (2008)

V R Techniche Consultants Pvt Ltd5 conducted a study in May 2008 to establish the baseline traffic data before the implementation of the BRT corridor. The study is intended to evaluate the improvements in traffic flow and modal-shift of road users by establishing a baseline scenario of traffic parameters. VR Techniche consultants conducted the following surveys:

[5] Traffic and Travel Patterns in Indore City, V R TECHNICHE Consultants Pvt Ltd, 2008

1. One-day classified traffic volume counts at 15 locations: The VR study concluded that two wheelers are predominant mode in Indore City with a share in the range of 40 to 70% at various locations. Cars (big and small put together) are the next significant mode with generally 15 to 30% share. Since the cycle traffic is quite significant in Indore City, the VR study recommended providing cycle lanes to enhance the safety of cyclists as well as enable smooth flow of vehicular traffic.

2. Vehicle occupancy surveys at all the above 15 locations on 7 corridors: In the study, for private vehicles the vehicle occupancies were observed along with classified traffic volume counts. For buses and minibuses, vehicle occupancies were estimated by boarding and alighting counts of buses. Rough estimates of occupancy show that the car occupancy is 1.6, scooter occupancy is 1.4, auto rickshaw occupancy is 4.0, minibus occupancy is 22, and bus occupancy is 38. According to the study, buses carry about 26% of the total passenger trips.

3. O-D surveys at 13 locations: The study identified the major corridors in Indore City that service the maximum passenger trips by Public Transit and private vehicles. These include:

    a. A.B. Road Corridor (Mangliya to Rau)

    b. Eastern Ring Road Corridor

    c. M.R.10 Corridor (Bypass to Ujjain Road)

    d. River Side Road Corridor

    e. Western Ring Road Corridor

    f. RW-2 (Ujjain Road to Airport)

    g. M.G. Corridor

4. Bus boarding and alighting counts on all existing bus corridors: About 26% of the person-trips is being carried by mini and regular buses.

3.6 Operations Plan for BRT Corridor Along AB Road

EMBARQ developed an operations plan for corridor in August, 2008. The Plan provides a detailed plan for running operation's along a route that included size of fleet, service planning, route planning, and financial modeling. The recommendations included: (1) installing single operator for the BRT route, so that competition to get to bus stops among competing operators do not deteriorate the service, (2) reorganizing mini-buses and maruti vans, (3) terminating intercity and all-india permit buses outside the city limits, and (4) providing intermediate terminals at Naulakha and Vijay Nagar junctions.

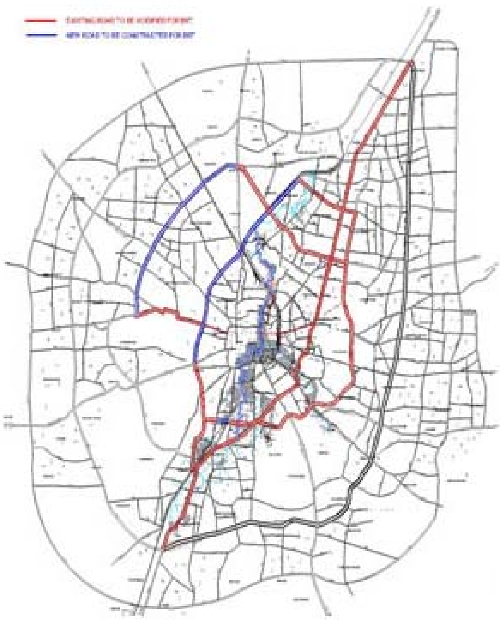
4 BRT Network Description

The studies in Chapter 3 show the rapid growth that Indore City is experiencing and it effects in increasing congestion in central business district (CBD). The studies show that by 2025, Indore has to cater for 5.5 million person trips with about 50% of person traffic to be carried by transit. From Environmental, economic and social impacts perspective, transit (buses) always provides the best alternative among the various road infrastructure development alternatives. The CTTPI analysis also provided a detailed, feasible, Indore Mass Transit System (IMTS). Based on extensive studies and evaluation of a number of alternate development scenarios in the detailed project report, the Bus Rapid Transit System for Indore has been identified. This includes the High Capacity Bus Based Rapid Transit System and the Standard Bus Service System planned, operated and managed as an integrated system. The Indore Bus Rapid Transit System comprise of 306.5 km of Bus network and 109 km of High Capacity Bus Based Rapid Transit System (BRTS). In this chapter a brief description of the BRT system that is to be implemented in Indore is provided. This network description sets the stage for the ITS technologies, in the next chapter, that will best improve the operations in the corridor.

4.1 High Capacity Bus Based Rapid Transit System (Indore BRTS)

The Indore Bus Rapid Transit System is in-principal approved with an estimated cost of 868.15 Crs, by the Central Sanctioning and monitoring Committee through sub- mission Urban Infrastructure and Governance under Jawaharlal Nehru National Urban Renewal Mission (JNNURM). On the basis of Travel Characteristics, Travel Impedance Matrices, Trip Assignment Transport Plan 2025 Proposals in CTTS Indore 7 corridors were identified for developing the Bus Rapid Transit System within the city, which can be developed in Phases. Other Public Transport Routes, which would serve as Feeder Routes to BRTS, were also been identified as per the Comprehensive Mobility Plan. Figure X below presents the identified corridors:

Figure 4-1 Indore Proposed BRT Corridors



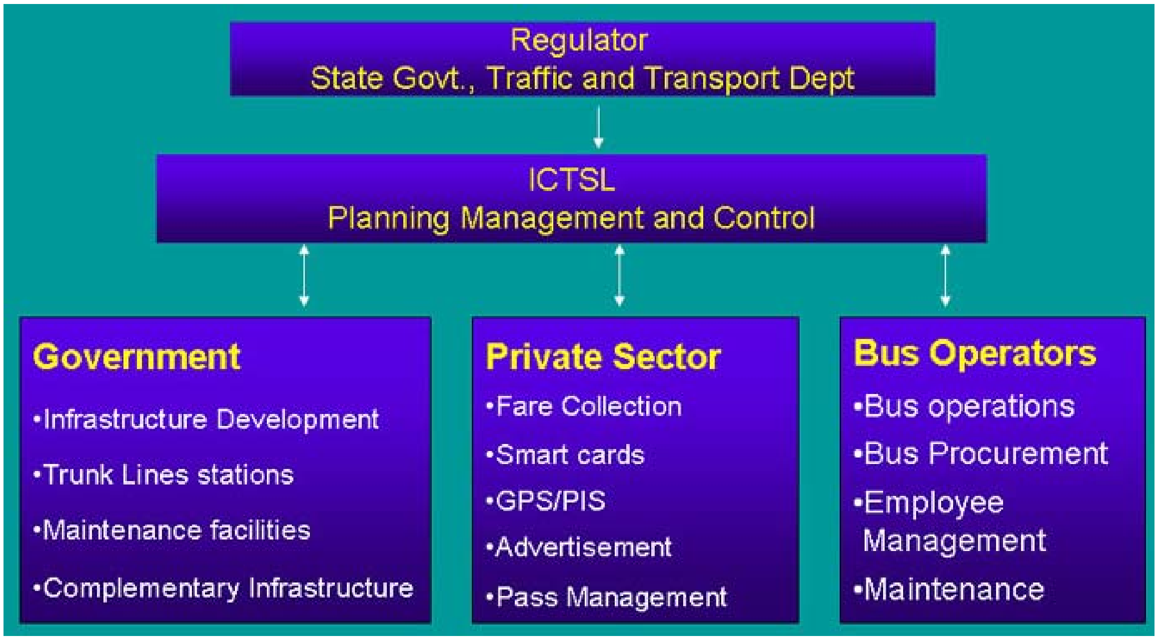
Corridor	Distance
•AB. Road Corridor	23.80 Kms
•Eastern Ring Road Corridor	23.65 Kms
•M.R.10 Corridor	8.71 Kms
•River Side Road Corridor	14.50 Kms
•Western Ring Road	15.90 Kms
•Badaganpti To airport	5.30 Kms
•RW2 Ujjain Road to airport	9.50 Kms
•Other road(M.G., RNT , YN.)	19.10 Kms
Total	**120.46KMs**

Indore developed a systems approach to implementing the BRT system consisting of planning, management, and control through the establishment of Indore City Transport Services Ltd (ICTSL). The agency's approach is shown in Figure X.

Figure 4-2 Systems Approach to BRT Implementation in Indore

The organizational structure of stakeholders for successful implementation of the BRTS projects is shown in Figure X. The established structure is expected to make the work flow between the various organizations involved in the implementation of the BRTS system, smooth and efficient.

Figure 4-3 Organizational of Stakeholders



4.1.1 The Pilot Corridor - AB Road (Mangliya to Rau)

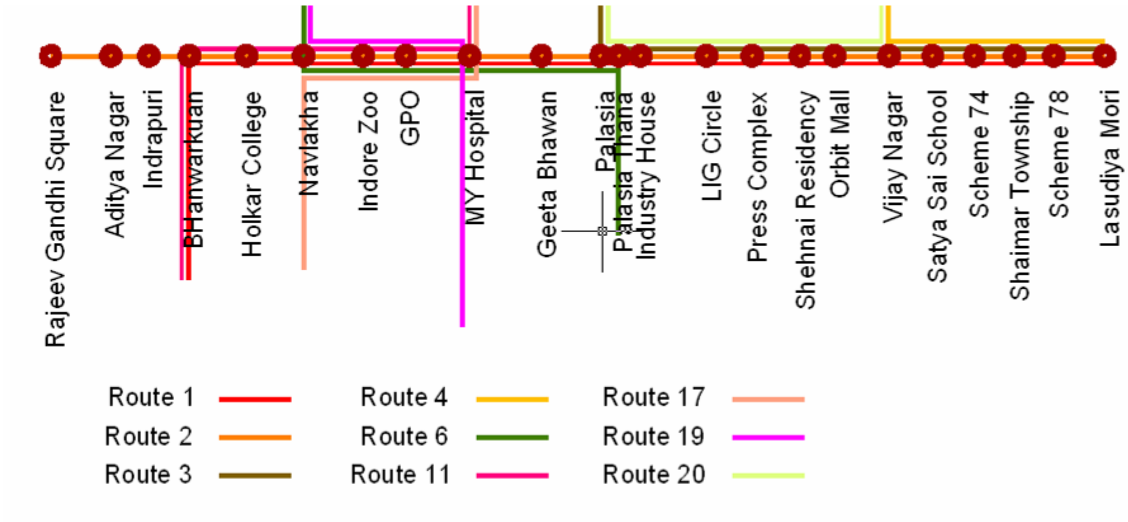
The A B Road pilot project is being implemented in the first year. The AB Road Corridor starts from Bypass Junction on AB Road at Mangliya, it runs through the Northern Suburbs of Indore City crosses other BRTS corridors Eastern Ring Road Corridor at Niranjan pur Square and MR-10 (East West Corridor) at Vijay Nagar forming a BRTS Interchange Station. From there on it runs along the AB Road itself with densely Developed Mixed Use Development up to the MG Road BRTS Corridor forming another Interchange Station at Palasia. It continues further along the AB Road with institutional areas Commercial Establishments up to the Rajeev Gandhi Square where it forms a BRTS interchange with Eastern Ring Road BRTS Corridor. It continues to run along AB Road, and crosses Western Ring Road BRTS Corridor at Rajendra Nagar forming the Last BRTS interchange along this AB Road, further it enters the newly Developing Southern Suburbs of Indore and Ends at Bypass Junction at Rau.

The Length of the Corridor is 27.50 Kms with 55 Bus Stops and 5 BRTS Interchange Stations identified along the corridor. The Stretch 1 from Mangliya to LIG Square and Stretch 3 from Navlakha to Rau has Right of Way of 60 Mts, thus facilitating Development of two dedicated Bus Lanes, four lane main Carriageway, segregated Cycle Track, Pedestrian Paths and two lane Service

Roads on either side, while the Stretch 2 from LIG Square to Navlakha has Right of Way of 30 Mts thus only facilitating Development of two dedicated Bus Lanes, four lane main Carriageway, segregated Cycle Track, and Pedestrian Paths on either Side.

ICTSL Buses are currently running on the AB Road Corridor. Generally 30 buses move on various sections of the corridor during the day. The number of bus routes and buses presently entering and leaving the Corridor are shown in Figure X below.

Figure 4-4 ICTSL Bus Operations along the AB Road Corridor



It is envisaged that the AB-Road Pilot Corridor will become operational in the First quarter of 2009. It is proposed that the Current Routes operating on the Pilot Corridor will continue Operating with increased Frequency as per the growing Demand.

While the Route 2 will be converted to BRTS A1 Route to make it Closed BRT Option with Up-Down Movement along AB- Road. ICTSL will run High Capacity semi articulated/articulated Buses for the BRTS A1 Route. The Routes Proposed for BRT and Non BRT operations on the AB Road pilot Corridor is shown in Fig 3.2.

It is proposed that 82 Non BRTS ICTSL Buses will run along the AB Road Corridor, While 30 High Capacity Semi-Articulated/Articulated Buses will run along the Pilot Corridor up and down.

The Peak Hour PT Passenger Trips per Direction demand on the Pilot Corridor will vary from 1000-6000 passengers on various links in 2009 with a modal PT share of 30%. The same is estimated to be increased up to 2500-10,000 by 2012 with a modal PT share of 42%, while it is expected it to be 6000-25000 by 2021 with a modal PT share of 50%.

5 Services Development Plan - Intelligent Transportation Systems (ITS)

The city of Indore is developing an integrated infrastructure development plan for the city through the comprehensive development plan. One of the main developments is the implementation of the seven BRT corridors. In this section, the associated services are identified that will enhance and enable the effective utilization of the infrastructure development.

5.1 ITS - Why?

Current day demand for mobility is increasingly confronting economic, social, and physical constraints on transportation infrastructure. These constraints include funding limitations for transportation projects, social and environmental impacts of infrastructure expansion, limited physical space to devote to such projects. Rapid advances in information processing and communications technology have created new opportunities for transportation professionals to deliver safer and more efficient transportation services, and to respond proactively to increasing demand for transportation services in many areas and mounting road user expectations. Promotion of mass transit and implementation of traffic, event and incident management tools are emerging as solutions. One of the most effective roadway improvement solutions is the improvement of public transit service so that more travelers will utilize transit freeing up space on the streets, diminishing dependence on fossil fuels, and improving air quality.

While a BRT corridor improves the safety and performance of the traffic flow, in arterial corridors the BRT system is limited by the efficiency of the signalized junctions on the arterial. The Delhi BRT system is a good example of the limitation of a BRT system without the signal control technology to efficiently move buses through the junctions. ICSTL recognizing this early, has commissioned the usage of various Intelligent Transport System (ITS) components to further make the BRT transportation mode attractive to the road users. Indore is planning the application of ITS to improve the safety, efficiency, dependability and cost effectiveness of the city's transportation system. The sections below discusses the elements of Indore's ITS System.

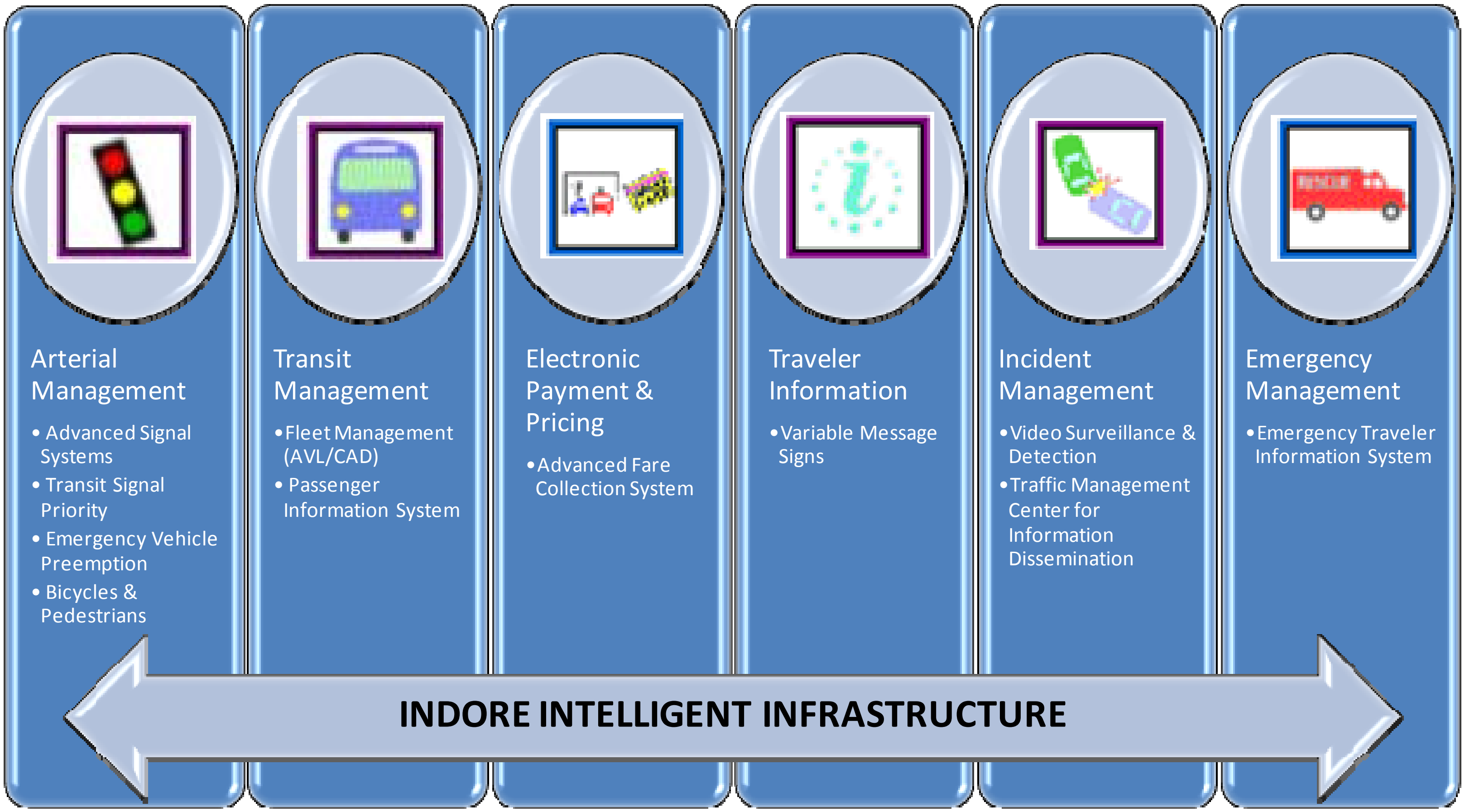
5.2 Indore ITS System Overview

Indore's proposed ITS system borrows elements from FHWA's ITS Applications[6] that fit into the cities development plan.

[6] http://www.itsoverview.its.dot.gov/

Figure 5-1 presents the infrastructure application for Indore's transportation system. Indore ITS elements consists of Arterial Management, Fleet Management, Electronic Payment & Pricing, Traveler Information, Incident Management, and Emergency Management.

Figure 5-1 Intelligent Infrastructure Applications - Indore



Potential benefits of the proposed ITS system include[7]:

- Increased productivity: If the transit rider can be told when the coach will be at their stop in real time, they are less likely to leave their work site earlier than necessary to allow for the perceived wait time needed to assure catching the coach of their choice.

- Reduced stress: If the transit user can be assured that the coach she/he is planning to ride has not passed their chosen stop and that it will be arriving in a timely manner, the stress level associated with the lack of information will be reduced Increased public safety: Providing timely information to transit riders will allow them to spend less time in potential dangerous waiting situations.

- Increased ridership and mode change: The above benefits would lead to a perception that transit is responsive to public needs and that transit is an attractive alternative to SOV travel. This would reduce congestion as well as have a beneficial impact on environmental pollution.

5.3 Arterial Management

In Indore, the elements of arterial management that are proposed are adaptive signal control, Transit Signal Priority (TSP), and Emergency Vehicle Preemption (EVP).

- Advanced signal systems include coordinated signal operations across neighboring jurisdictions, as well as centralized control of traffic signals which may include some necessary technologies for the later development of adaptive signal control.

- Transit signal priority systems use sensors to detect approaching transit vehicles and alter signal timings to improve transit performance. For example, some systems extend the duration of green signals for public transportation vehicles when necessary.

- Signal preemption systems for emergency vehicles use sensors to detect an approaching emergency vehicle and provide a green signal to the vehicle.

- Specialized pedestrian and bicycle treatments for markings and signaling are used to improve the safety of all road users at signalized intersection and unsignalized crossings.

[7] http://www.its.washington.edu/pubs/wc94.pdf

5.3.1 Arterial Management – Why?

The benefits of the elements of Arterial Management are listed below[8]:

5.3.1.1 Advanced Signal Systems

- Across United States of America, traffic signal retiming programs have resulted in travel time and delay reductions of 5 to 20 percent, and fuel savings of 10 to 15 percent.
- Installing new traffic signals in Japan reduced crash frequency by 75 to 78 percent and upgrading existing traffic signals reduced accidents up to 65 percent.
- The Institute of Transportation Engineers (ITE) estimates that traffic signal improvements can reduce travel time by 8 to 25 percent.
- In Los Angeles, central signal control systems improved travel time by 13 percent, decreased stops by 31 percent, and reduced delay by 21 percent.
- Traffic signal coordination among two jurisdictions in Arizona resulted in a 6.2 percent increase in vehicle speeds; optimization of the coordinated timing plans was predicted to reduced AM peak period delay by 21 percent.

5.3.1.2 Transit Signal Priority

- In the literature, TSP is defined as "an operational strategy that facilitates the movement of buses through traffic-signal controlled intersections." TSP is deployed to improve transit operations and service quality and eventually promote more ridership, improve person mobility, reduce traffic congestion, and reduce mobile-source emissions and fuel consumption rates.
- On time arrival of buses improved between 11% to 60% in various countries across the world
- A transit signal priority system in Helsinki, Finland reduced delay by 44 to 48 percent, decreased travel time by 1 to 11 percent, and reduced travel time by 35,800 to 67,500 passenger-hours per year.
- In Arlington, Virginia, carbon monoxide emissions reduced by 5.6 percent and nitrogen emissions reduced by 1.7%

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[8] http://www.itsoverview.its.dot.gov/AM.asp

- Implementing traffic signal priority for a light-rail transit line in Toronto, Canada allowed system operators to remove one vehicle from service and maintain the same level of service to passengers.

- A bus priority system in Sapporo City, Japan reduced bus travel times by 6 percent, decreased the number of stops by 7 percent, and reduced the stopped time of buses by 21 percent.

5.3.1.3 Emergency Vehicle Preemption

- Modeling indicated that emergency vehicle signal preemption at three intersections on a Virginia arterial route increased average travel time by 2.4 percent when priority was requested.

- An emergency vehicle signal preemption system in Houston, Texas reduced emergency vehicle travel time by 16 to 23 percent.

- In Denver, Colorado emergency vehicle signal preemption reduced response time by 14 to 23 percent.

- The emergency vehicle crash rate fell by 71 percent after deployment of emergency vehicle signal preemption systems in St. Paul, Minnesota.

5.3.1.4 Bicycle & Pedestrian

- Automated pedestrian detection at signalized intersections tested in three U.S. cities reduced the number of pedestrians who began crossing during the steady DON'T WALK signal by 81 percent.

- Vehicle-pedestrian conflicts were reduced by 89 percent in the first half of the crossing and 43 percent in the second half with automated pedestrian detection at intersections in Los Angeles, California; Rochester, New York; and Phoenix, Arizona.

5.4 Transit Management

Fleet Management, and Passenger Information System (PIS) are two elements of Transit Management that are part of the Indore ITS configuration. These two items are already in various stages of implementation in Indore.

Fleet management systems improve transit reliability through implementation of automated vehicle location (AVL) and computer aided dispatch (CAD) systems which can reduce passenger wait times. These systems may also be implemented with in-vehicle self-diagnostic equipment to automatically alert maintenance personnel of potential problems. For Indore, the bus fleet has been equipped with AVL technology. In this project, the CAD system will be implemented.

Information dissemination websites allow passengers to confirm scheduling information, improve transfer coordination, and reduce wait times. Electronic transit status information signs at bus stops help passengers manage time, and on-board systems such as next-stop audio enunciators help passengers in unfamiliar areas reach their destinations. Electronic signs already form part of the Passenger Information System (PIS) for Indore. In this project the web broadcasting capability of bus locations will be developed.

5.5 Electronic Payment and Pricing

Electronic payment systems employ various communication and electronic technologies to facilitate commerce between travelers and transportation agencies, typically for the purpose of paying tolls and transit fares. Pricing refers to charging motorists a fee or toll that varies with the level of demand or with the time of day.

An automated fare collection (AFC) system on the Chicago Transit Authority rail and bus systems facilitated fare policy changes that lowered the price of several multi-day passes. The study estimated that 70 to 80 percent of a 3.6 percent increase in system ridership was the result of AFC-facilitated fare policy/pricing. AFCS provides convenience for passengers and reduces travel times.

In Indore, Automatic Fare Collection System for buses will be installed on the corridor. A detailed description of the AFCS architecture and operations plan is provided in later chapters.

5.6 Traveler Information

Traveler information applications use a variety of technologies, including Internet websites, variable message signs (VMS), telephone hotlines, as well as television and radio, to allow users to make more informed decisions regarding trip departures, routes, and mode of travel.

In Indore, VMS will be installed at a few locations to provide travel time information to the public. Information dissemination of any type was found to reduce stress level for commuters and improve the travel experience.

5.7 Incident Management

Incident management systems can reduce the effects of incident-related congestion by decreasing the time to detect incidents, the time for responding vehicles to arrive, and the time required for traffic to return to normal conditions. Incident management systems make use of a variety of surveillance technologies, often shared with arterial management systems, as well as enhanced communications and other technologies that facilitate coordinated response to incidents.

Benefits of incident management are chronicled all over the world. Here are some examples:

- The delay reduction benefits of improved incident management in the Greater Houston area saved motorists approximately $8,440,000 annually.
- Advanced traffic management systems in Amsterdam and Germany reduced crash rates by 20 to 23 percent.
- In Paris, France, incident management resulted in a nine-minute reduction in response time
- In Georgia, call boxes installed on a 39-mile section of I-185 were estimated to eliminate one injury per year, and one fatality every five years.

Surveillance through CCTV cameras on the corridor and a centralized information dissemination location will be part of the Indore Incident Management System. Details of the architecture are provided in later chapters.

The other element of Incident Management system, that is also part of Arterial and Emergency Management is the Central Control Room (Traffic Management Center). The Traffic or Transportation Management Center (TMC) is the hub of a transportation management system, where information about the transportation network is collected and combined with other operational and control data to manage the transportation network and to produce traveler information[9].

It is the focal point for communicating transportation-related information to the media and the motoring public, a place where agencies can coordinate their responses to transportation situations and conditions. The TMC links various elements of Intelligent Transportation Systems such as variable message signs, closed circuit video equipment, roadside count stations, etc., enabling decision makers to identify and react to an incident in a timely manner based on real-time data. TMCs can help reduce incident response times, lower incident rates (mainly secondary incidents), disseminate traveler information and hence reduce congestion and enhance safety.

TMCs provide a number of potential benefits. The main benefits are:

- Faster incident response and reduction in incident rates.

[9] http://www.calccit.org/itsdecision/serv_and_tech/Traffic_management/TMC/tmc_summary.html

- By broadcasting traveler information and coordinating their activities with the police, etc, TMCs have been successful in reducing congestion on arterials.
- Increases traffic safety by effective incident response and clearance techniques. By providing traveler information regarding incidents it minimizes the likelihood of secondary incidents.
- Enhanced communication in all aspects of transportation management (planning, design, implementation, operation, maintenance).
- Monetary savings by sharing responsibilities between fewer staff, achieved by co-location of participating agencies at the center.
- Agencies working closely together in a TMC typically produce a more consistent, unified response to a situation, increasing the overall effectiveness of the transportation resources.

5.8 Emergency Management

Integration with traffic and transit management systems enables emergency information to be shared between public and private agencies and the traveling public. This communication and cooperation also enables the use of the variety of ITS information dissemination capabilities to provide emergency traveler information.

Emergency management helps with emergency medical services, and route planning and evacuation in cases of manmade and natural disasters.

6 Intelligent Transportation Systems Operations Plan

This section will describe the architecture and ITS implementation plan for Indore. As mentioned in Chapter 5, various management systems are included in the vision of Indore's development with the express objective of alleviating congestion, improving air quality, and reducing fuel consumption. Since the hardware and software from the various ITS component systems are generally integrated at the Traffic Management Center, this section provides the integrated architecture of the system.

Many of the ITS management plans are integrated at the Traffic Management Center (TMC), hence the TMC architecture is first provided and then the other ITS systems are described.

6.1 Central Control Room/ Traffic Management Center

The central control room serves as the hub for all ITS system activities. The objectives of the TMC are to:

- Maximize the number of vehicles the corridors can handle.
- Minimize congestion.
- Provide traveler information.
- Manage incidents and special events.
- Provide aid to stranded motorists.

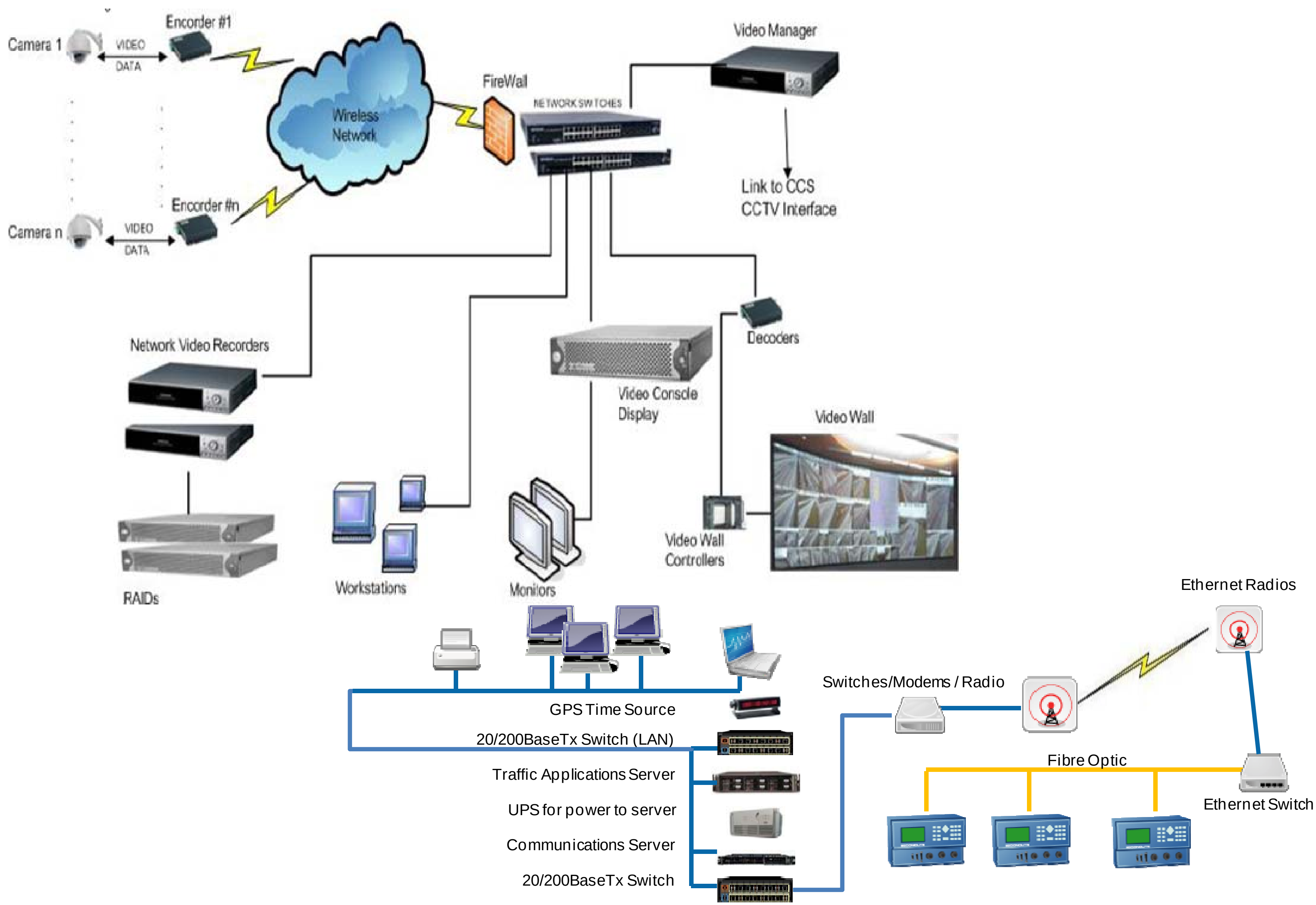
The various elements of TMC are:

- Hardware
  - Video Wall
  - Workstations
  - Servers
  - Monitors
  - Satellite TMC Locations
  - Communication
- Software for Center
  - Advanced Traffic Management Software

        - Traffic Signal Operations Software
        - VMS Linking Software
        - CCTV Linking Software
    - Microsimulation Software
    - Signal Optimization Software

The cost of implementing TMCs vary depending upon the size and functions of the TMC. Overall costs involve:

- Conception, design and implementation of TMCs.
- Yearly operational costs including the cost for co-hosting the number of agencies present.
- Implementation and Operational Challenges
    - The challenges that a modern transportation management center face are not confined to implementation alone, equally challenging is its operation and maintenance.
    - The TMC planning, design, and implementation involve not only several departments within the implementing agency (or agencies), but also the efforts of a variety of private sector product and service providers. This requires both significant coordination and ongoing effort to build and maintain consensus.
    - The TMC may be in planning, design, and implementation several years, requiring it to deal with multiple technology generations. The agency owning the TMC faces a daunting challenge of implementing, operating, and maintaining not only a complex transportation environment, but a mass of complex and rapidly evolving technology.


Camera 1
VIDEO
DATA
Encoder #1
Wireless Network
FireWall
NETWORK SWITCHES
Video Manager
Link to CCS CCTV Interface
Camera n
VIDEO
DATA
Encoder #n
Network Video Recorders
Decoders
Video Console Display
Video Wall
RAIDs
Workstations
Monitors
Video Wall Controllers
Ethernet Radios
Switches/Modems / Radio
GPS Time Source
20/200BaseTx Switch (LAN)
Traffic Applications Server
UPS for power to server
Communications Server
20/200BaseTx Switch
Fibre Optic
Ethernet Switch

6.2 Advanced Signal Systems

In India, many new signal systems are being run in the adaptive mode. Adaptive implies that the signal will automatically find signal timing parameters that will improve the traffic flow on the corridor. The applicability of adaptive control for heterogeneous traffic is still unproven, hence it is not recommended for Indore. The controller is still proposed to be an adaptive capable controller so that in the next few years when adaptive technology matures for Indian conditions, the AB corridor in India can be put on an adaptive system.

Currently, an Advanced Signal System consisting of Area Traffic Control (ATC) from a centralized location is proposed for the AB Road corridor. The signals in the corridor will be run in the actuated coordinated mode. This will allow skipping or truncating minor street phases based on demand, and providing progression on AB road. Transit signal priority will be placed in such a manner that it does not impact the coordination of the signals.

6.3 Transit Signal Priority & Emergency Vehicle Preemption

Transit Priority is a form of preferential traffic signal control strategy that facilitates the passage of transit vehicles. Transit priority requests are often conditional and may, for example, be granted on one or more conditions such as the absence of a pedestrian phase, the presence of a green interval, and a prescribed level of bus occupancy or degree of bus lateness.

Emergency Vehicle Preemption on the other hand is generally unconditional except for the safety requirements (i.e., pedestrian phases are not preempted, minimum greens are provided) of the junction. While both TSP and EVP utilize similar equipment, signal priority modifies the normal signal operation process to better accommodate transit vehicles, while preemption interrupts the normal process for emergency vehicles and heavy-rail. Emergency vehicle preemption results in reducing response time to emergencies, improving safety and stress levels of emergency vehicle personnel, and reducing accidents involving emergency vehicles at intersections. Provision of transit signal priority leads to improved schedule adherence, improved transit efficiency, contribution to enhanced transit information, and increased road network efficiency[10].

In India, currently, preemption is being used by transit in the guise of priority. Emergency vehicle preemption requests, on the other hand, are usually only conditional on the absence (or completion) of the pedestrian phase and may involve either a green extension or a red truncation. A trend taking place is to coordinate the planning and deployment of emergency vehicle preemption and

[10] http://www.itsa.org/itsa/files/pdf/finaltspoverviewupdate.pdf

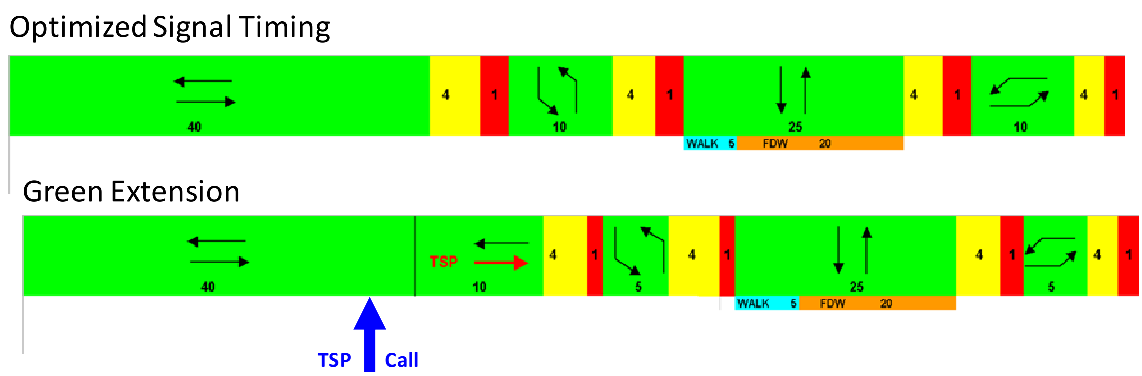
transit priority strategies for the purposes of developing a single, integrated traffic signal control system.

6.3.1 Transit Signal Priority – Strategies

Priority can be provided by applying various strategies at a traffic signal. Some of the strategies are signal controller specific. A description of some of the common strategies are provided here:

6.3.1.1 Green Extension

In green extension, if a TSP request is received within a certain time before the yellow onset, the green will extended. This is the most effective TSP strategy since buses do not have wait a whole cycle before getting the green.



6.3.1.2 Early Green (Red Truncation)

In early green, if a TSP call is received after the TSP phase is timed out, the non TSP movements are provided only minimum green to provide early green to the bus movement.

6.3.1.3 Phase Swapping

In Phase Swapping, the transit phase can be introduced immediately after the current phase is time out. The disadvantage of this strategy is that road users have an expectation of phase sequencing once they get acclimatized with the location, which might result in accidents.

6.3.1.4 Phase Skipping

In this strategy, in response to a TSP call the minor phases will be skipped to provide green to the transit vehicle. This is generally not a preferred strategy since all the minor street vehicles have to wait another cycle to get a green.

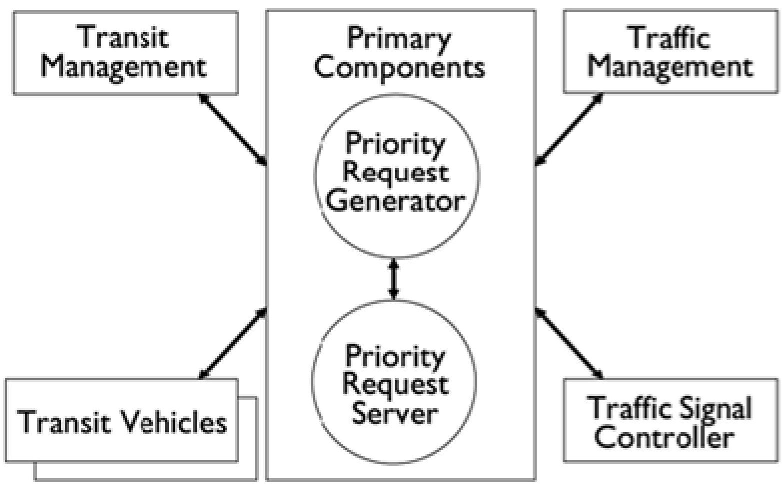
6.3.1.5 Conditional Priority

Since granting TSP interrupts the normal operations of the corridor, in this strategy TSP is granted only when a bus is behind schedule by a certain amount of time. This is usually a preferred strategy for TSP.

6.3.2 Transit Signal Priority - Concept of Operations

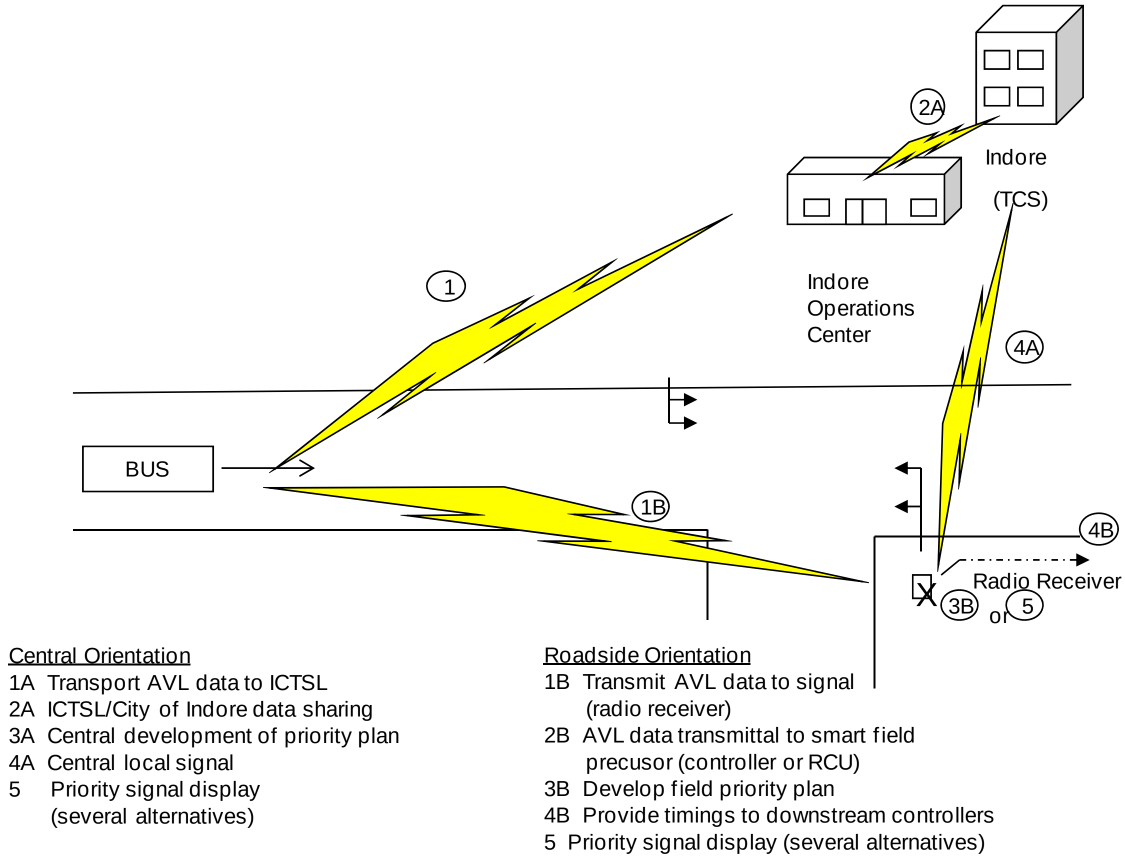
TSP Operations is generally comprised of two primary elements, the Priority Request Generator (PRG) and a Priority Request Server (PRS). The transit vehicle (bus in Indore), through its agent, the PRG, submits a request for priority to the PRS. These two elements can be thought of as a logical process that could be physically implemented in more than one way, as discussed further in the document. The two primary interfaces are (1) between PRG and PRS and (2) between PRS and the traffic signal controller coordinator, which implements special coordination operation. Another element TSP operations which directly relates to the traffic signal software, is the concept of granting priority while maintaining coordination with adjacent intersections.

Figure 6-1 Logical Structure of TSP System (from NTCIP 1211)



Since the buses in Indore are equipped with AVL system, it is logical to use the technology for granting transit signal priority. An AVL based TSP system is shown in figure below.

Figure 6-2 AVL based TSP Scheme for Indore[11]



To have the outlined system to work, the following elements are needed:

- Transit signal priority and actuation of selected traffic movements
- Ability to adjust nature of transit priority movements
- Ability to detect presence of transit vehicles
- Communications between the vehicles, central control room dispatch, and traffic signal system

7 Traveler Information, Incident Management, and Emergency Response Systems

Incidents such as vehicle breakdowns or accidents can impact traffic congestion immensely. The best practices for Incident Management are quick response for removal of the affected vehicle(s) and person(s); and demand management on the corridor

[11] Extracted from spider.apta.com/lgwf/**transit**ech/2001/columbus.ppt

through broadcasting the information through Traveler Management Systems (radio, VMS, web, etc.). Quick response also helps save lives in emergency situation.

7.1 Overview of AFCS

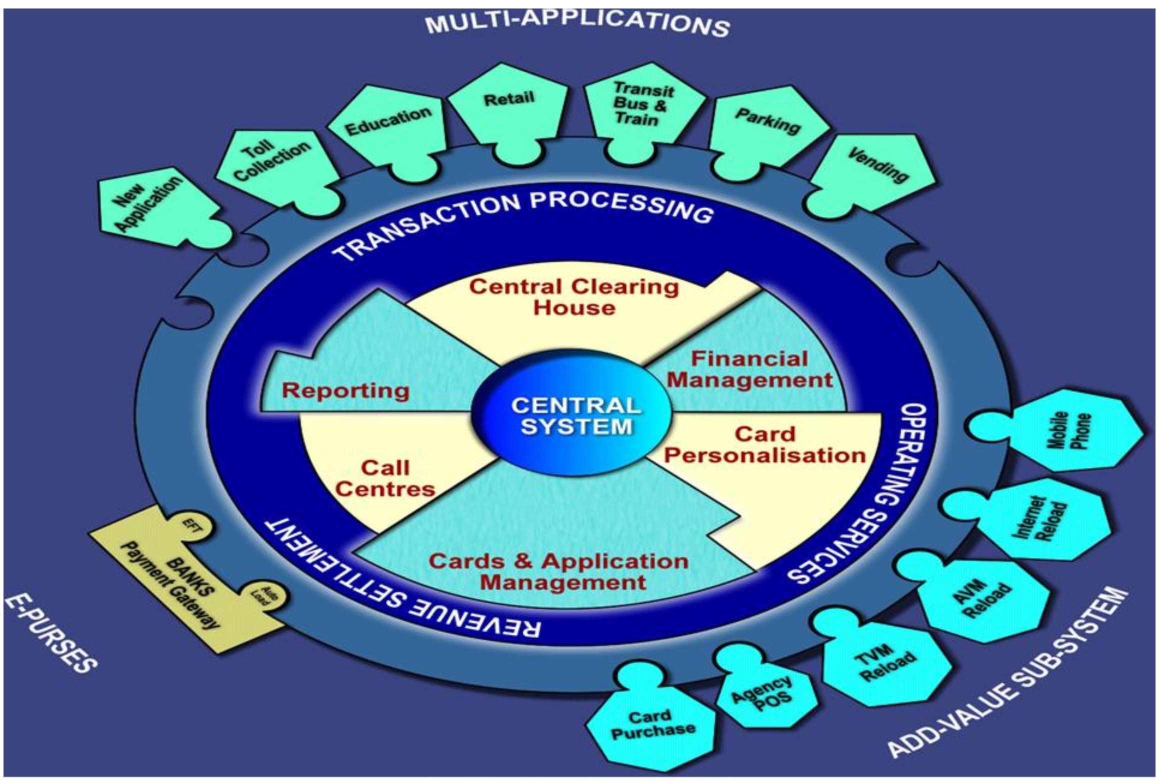
In Indore, it is proposed that the entire AFCS project will be implemented in two phases:

7.1.1 Functional Architecture

It is proposed that phase 1 will comprise installation, commissioning and making operational the on-bus equipment. Along with the same the depot computer system, central computer system and other back-ends will also be installed and made operational. TOT's will be installed at appropriate places.

The phase 2 of the project will involve installing the off-bus equipments on the stations and setting up TOT's on the stations. It is proposed that both the system will have common back-end. The back-end for the second phase will be integrated with back-end for the first phase.

The overall system modules are shown below:



Application Functionality
With Provision for Scalability to add new applications/features

7.1.2 Broad Scope For Phase 1

- Design, supply, installation and operations & maintenance of all AFC equipments and services for the non-BRTS system along with one Bus Control Unit and validator in each Non-BRTS bus.
- Setting up of Data Centre, along with ancillary equipments and operating it.
- Setting up and operating a helpdesk
- Setting up and operating TOT's at some of the main stations.
- Performing other activities to operate and maintain the AFC system.

7.1.3 Broad Scope For Phase 2

- Design, supply, installation and operations & maintenance of all AFC equipments and services for the BRTS system.
- Supply of Turnstiles at both entry and exit at each BRTS bus station. Optionally we can also opt for Turnstile at entry and Validator at exit. The final option will be decided by client during final discussions.
- Setting up and operating TOT's at stations.

Performing other activities to operate and maintain the AFC system.

7.1.4 Common Facilities

- The help desk will be common for Phase 1 and Phase 2.
- There will be common operations Staff for Phase 1 and Phase 2.
- It is assumed that space for data centre will be provided by ICTSL.
- It is assumed storage space for equipments during project execution before start of operations will be provided by ICTSL.
- Please refer the "Third party Interface" document (attached as part of Appendix 4 of the main proposal) for details of scope.
- For roles and responsibilities during project execution, please refer section 6.6.2 in the Technical Proposal.
- Facilities/Outlets/Franchises to issue Personalised Smart Cards

7.2 AFCS Selection And Component Identification

7.2.1 Phase-I (Non-BRT)

Proposed System:

- Entry validator (conductor console) – 1(One) per bus
- Number of Non-BRT buses – 100
- Number of Depots - 1
- Exit Validator (near exit gate) – 1(One) per bus
- Full function TOTs
- Hand held ticket checking units
- Depot Computer system
- Central Computer system
- Networking and software arrangement

7.2.2 Phase-II (BRTS)

Proposed System:

- Entry Gate – 1 per bus-stand located on the station
- Number of BRTS bus-stands – 46
- Exit Gate – 1 per bus-stand located on the bus stand
- Full function TOTs – (at Main Bus-stands)
- Simple function TOTs – (at remaining Bus-stands)
- Hand-held ticket checking units
- Depot Computer system
- Upgrade of Central computer
- Networking and software arrangement

The number of entry gates/turnstiles is subject to final discussion between client and Bidder Consortium.

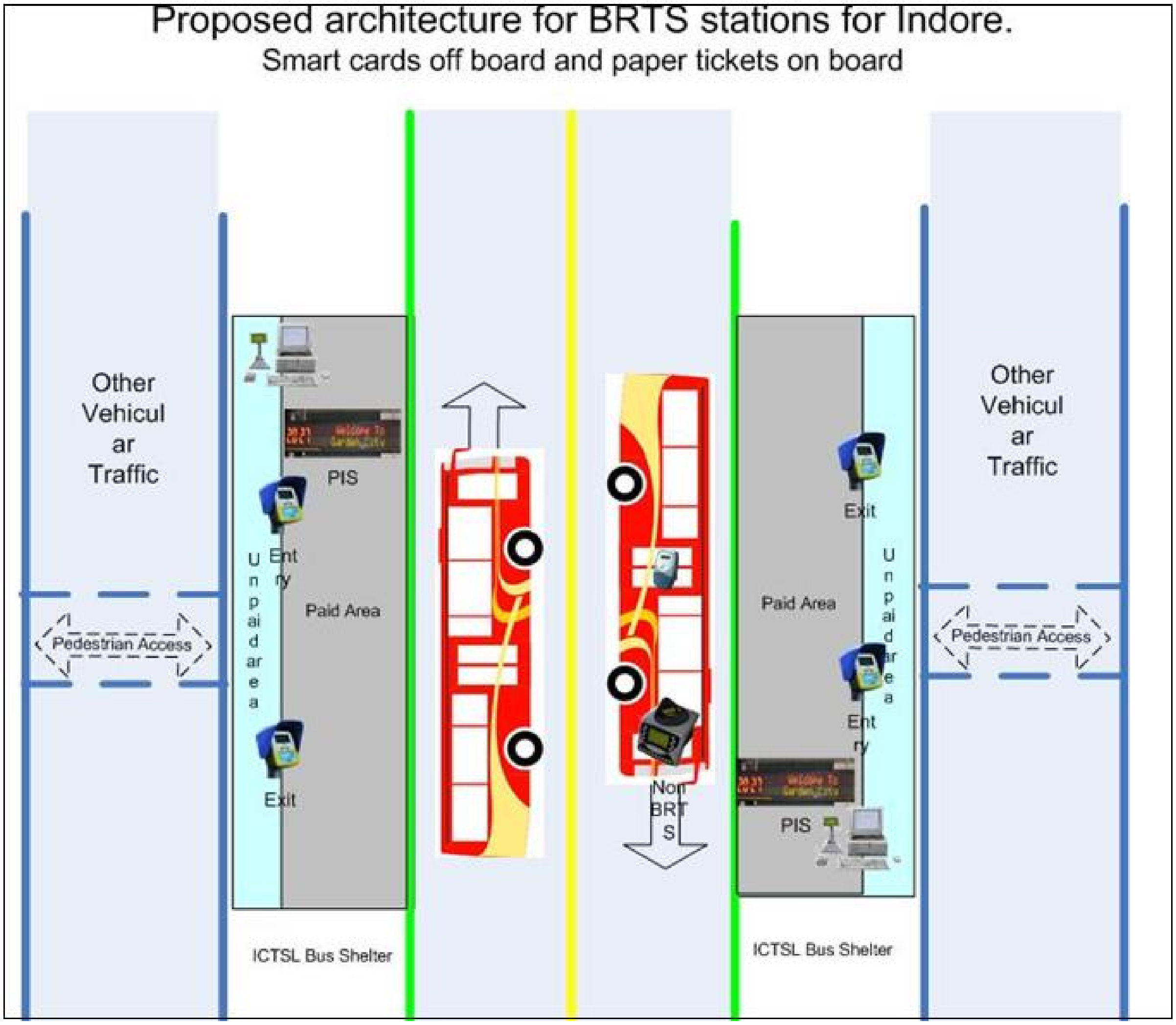
7.3 Architecture and Ticketing Process

7.3.1 System Architecture

System description:

Each BRTS bus-stand will have two gates installed (acting as the entry and exit gates for the paid area). The same can be changed to one gate and one validator also depending on Client's preference and final negotiations. The passenger would enter the station through the unpaid area and then either show his smart card and enter the paid area or take a paper ticket from the TOT and enter the paid area.

At the destination station, the passenger would show the smart card again and exit the paid area.



7.4

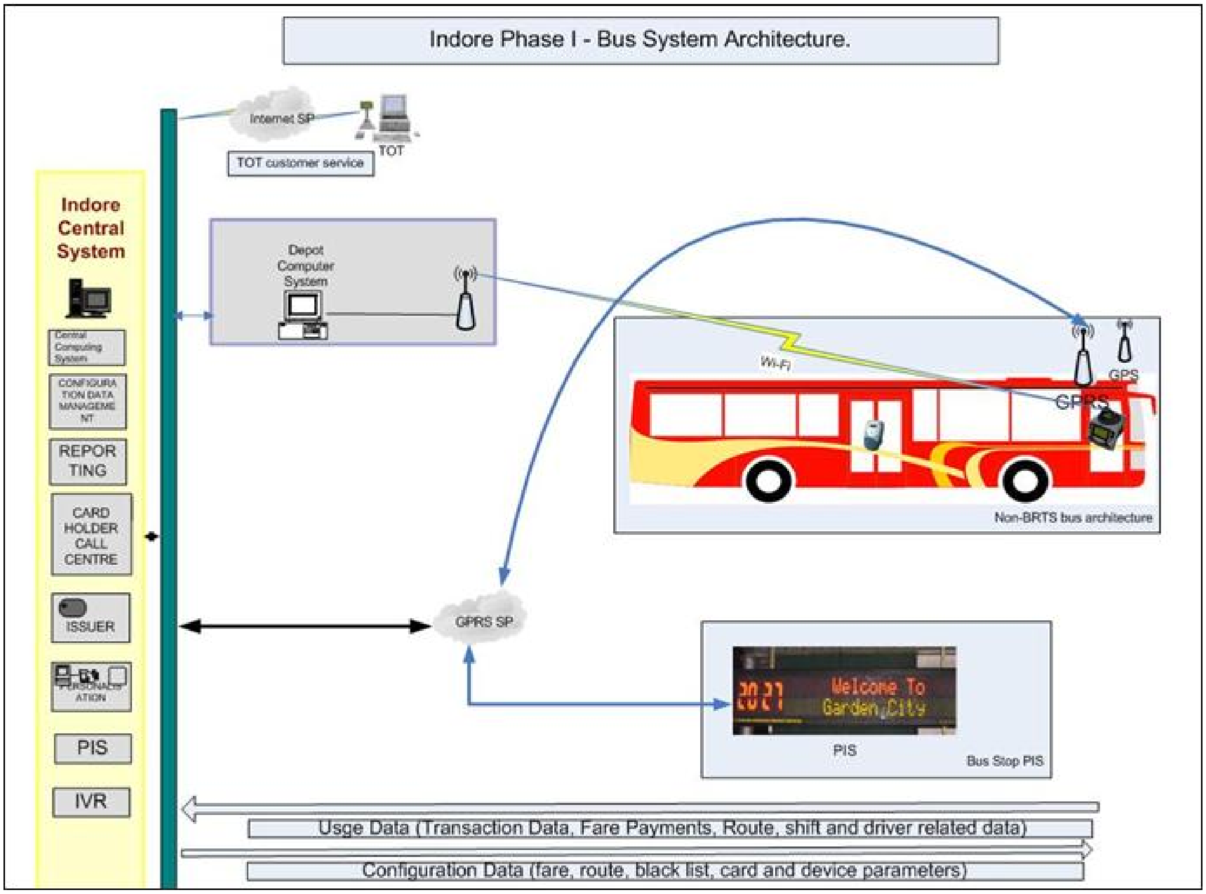
7.4.1 Main System Components and their Roles

Main Components For AFC System

The following diagram depicts the main functional components of the system and its important interactions during operations for Phase 1

- Ticket Operating Terminals (TOT)
- Passenger Information System (PIS)
- GPS/GPRS

- Smart Cards



7.5

7.5.1 Passenger WorkFlow Process

WorkFlow of Passenger using Smart card:

- The user needs to buy the smart card and fill the required amount from the TOT.
- The user needs to show the smart card at the entry gate or turnstile and enter the paid area.
- The scanning process in gate would automatically deduct the entire amount for the longest possible journey in that route.
- When the passenger exits the bus, the card needs to be shown at the exit gate or turnstile in the bus-stand, and the difference amount would be loaded onto the card.

WorkFlow for Passengers using Paper ticket

- The passenger needs to tender the money and buy a paper ticket from the TOT at the bus-stand and then enter the paid area.
- While exiting the bus, the passenger needs to show the paper ticket at space close to the exit gate or turnstile of the destination bus-stand and exit the paid area. The checking/validation of the paper ticket is manual.
- Instead of single journey paper tickets, the TOT can be used to print return tickets and one-day passes also.

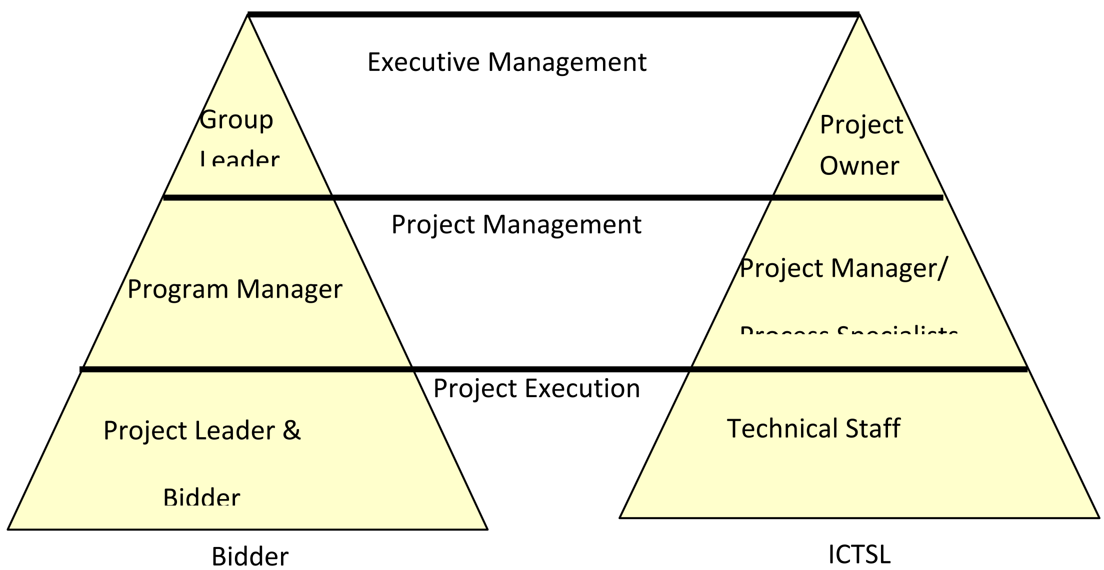
Over-lapping of BRTS and non-BRTS systems

- In case a passenger carrying a smart card boards a non-BRTS bus from a BRTS bus-stand and exits in a non-BRTS bus-stand, then the following workflow would exist.
- The passenger would display the smart card at the entry turnstile of the BRTS bus-stand to enter the paid area.
- The passenger would board the non-BRTS bus without displaying the smart card.
    - The passenger would exit the bus at the non-BRTS bus-stand by displaying the smart card at the exit validator of the bus.

8 Project Execution

The Indore ITS project will be executed through a bidder consortium whose expertise should include system integration. The bidder consortium must have capabilities in all the ITS solutions listed in the document, and have prior experience in operationalizing an Advanced Traffic Management System for a similar or bigger sized city than Indore. Detailed project plan will be finalized between bidder consortium and ICTSL at time of signing the contract. The proposed project organization structure and milestones are discussed in sections below:

8.1 Project Organization Structure



The consultant recommends a Project Organization structure, which shall involve ICTSL management's total involvement in Project management, partnering with the Bidder Consortium. The proposed organization structure for the project team from ICTSL and TCS and the roles and responsibilities are described below.

8.1.1 Project Organization Structure

The Bidder Consortium proposes the project team's organization structure as below.

8.1.1.1 ICTSL Team:

The consultant proposes that ICTSL should formulate a project team as under:

- ICTSL Project Owner

- Project Manager / Project Specialists
- Technical Staff
- Project Management Office (PMO)
- Business functional / logistics team.

In addition to the above, ICTSL can identify suitable representatives to ensure that required information and details are made available to Bidder Consortium as and when required.

8.1.1.2 Bidder Consortium:

Bidder Consortium will have the following associates working in the team during various stages of the project:

- Group Leader/ Project Manager
- Engineering Manager
- Test Manager
- Developer
- DBA
- Business Architect
- BCP/RCP Customization Developer

Roles and Responsibilities

The Bidder Consortium envisages lot of work to be done by subcontractors. Effort will be made include all the existing contractors into the new system.

Following are the broad roles envisaged by the Bidder Consortium in execution and operation of the system:

Role	Responsibility
Project Manager/Group Leader,	Interaction with ICTSL management Serve as last Level escalation and resolution mechanism for ICTSL Management

Role	Responsibility
Test Manager	Arrange Internal quality test, unit testing, integration testing, regression testing and arrange test plans and test cases Coordinate user acceptance testing, bench marking of application software, etc.
Database Administrator (DBA)	The DBA would be responsible for maintenance and changes (if any) in the database.
Developer	Would be responsible for customisation and development (if any) of ICTSL specific features.
PMO	The PMO would be a joint activity between Bidder Consortium and the ICTSL. The Project manager from ICTSL and Program Manager from TCS would jointly be responsible for the PMO activities. The various other leads described above would also be members of the PMO and coordinate activities related to the project. PMO members should meet regularly to plan the activities vis-à-vis the project plan.
Business Architect	Would be responsible for understanding the functional architecture and to design an appropriate software architecture which optimally meets the functional and technical requirements.
BCP/RCP Customization Developer	Would be involved in the customisation of existing system to meet ICTSL functional requirements.
System and network Administrator	Would be involved in ensuring the system and network availability at all times.
Back office Developer	Would be responsible for developing the back office system and associated interfaces.
Back Office Team Leader	Would be responsible for leading the back-office development team.
Data Management Team Member and Team Leader	Would be responsible for the management of Configuration data and Usage data.
Device Deployment Technical Specialist	The device Deployment technical specialist is responsible for the deployment of the field devices, depot computers and back office systems.

Role	Responsibility
Front Office Architect	Responsible for architecting the front office framework of the solution.
Front Office Developer	Would be responsible for the development and implementation of the front office part of the solution.
Hardware Test Engineer	Is responsible for the testing of the field units and other hardware devices
Product Architect	The primary role of the product architect is to analyse and understand the usage requirements and to architect/customise the product to suit the requirements.
Operations Staff Roles	
Operations/Engineering Manager	Project Owner for communication with Project Manager and across different department Project champions. Responsible for getting project resources, coordinating logistics for the project with ICTSL Responsible for reporting for controlling all the technical resources in the Bidder Consortium
Hardware Maintenance Specialists	The primary roles for performing preventive and workshop maintenance on AFC equipment
TOT Operators	The primary role is man the TOT's and perform operations like smart card topping up, card personalization, and other operations on BRTS stations
Help Desk Specialists	The primary role would be manning the helpdesk and attending customer/passenger calls

8.2 Major Project Milestones

The following are the milestones:

Milestones	Deliverables
Contract Sign Off	

Preparation of project plan including risk and resources	Project Plan
Acceptance of system design by ICTSL.	Bidder Consortium will submit functional requirement documents and acceptance of the same by ICTSL will mark the culmination of this milestone.
Ordering of Hardware and Other Equipment	-
Software Procurement and Customization	-
Acceptance Test Plan, Acceptance test Schedule	Acceptance Test Schedule as approved by ICTSL
System Integrated Testing/Field Testing of all installed modules	Acceptance testing reports against requirements
Deployment of ITS systems	Completion Report
Train the Trainers	Training plan and training schedule.
Selected Public trials	Trial report
Final Introduction to Public	

8.3 Project Execution Strategy

The project execution strategy will include following parts:

1. Hardware Equipment Procurement
2. Installation and Commissioning
3. Systems and Software Integration
4. Operations.
5. Managing staff during development/installation and Operation phases.

It is proposed that the entire project will be handed over to on agency through a process of competitive bidding. The agency would be responsible for all the activities specified above.

The sourcing of staff for operations will be done locally and the profiles for same are specified in section X.1.1. The strategy for their hiring and managing are specified in Section Y.1.

8.4 Benefits And Cost Benefit Analysis

A tabular view of the benefits of the various ITS systems are provided below.

ITS System	Benefit Explanation	Quantified Benefits*
Arterial Management		
Advanced Signal System	Reduces cycle lengths, and improves coordination leading to reduction in: • motor vehicle delays at junctions, • End-to-end travel times in the corridor, • Stops/vehicle, • Fuel consumption, • Emissions, etc.	Expected to reduce delays by around 15% at junctions Expected to reduced end-end travel time on AB Road by around 20 percent Reduce stops/vehicle by 15% Reduce fuel consumption by 2 to 5 percent Reduce emissions up to 10%
Transit Signal Priority	Provides priority to buses, hence greatly reducing the person-delay of the corridor Improve the performance of the BRT corridor by reducing junction delays for buses	Person-delays on the corridor for all modes of traffic are expected to reduce by around 7 percent. Due to priority and increased reliability, the fleet size can be reduced by one or two buses, which translates to 18 lakhs/bus in capital costs.
Emergency Vehicle Preemption	Provides preemption (immediate green) to emergency vehicles (ambulances, fire trucks, etc.), greatly improving the safety of traffic all round during emergency vehicle traveling through junctions.	Expected to see minor reduction in accidents during emergency events.
Transit Management		
Fleet Management	Indore has already implemented fleet management with AVL and has been reaping benefits of controlled bus service operations	Vastly improved service quality is being provided to the commuters. Fewer larger buses are being used, leading to fewer stops and adverse effects on other motorized traffic. The AVL system provides location information to the operators who can use it to improve scheduling.
Passenger Information Systems (PIS)	Indore is working on implementing a PIS system at the new bus shelters. This	The PIS system once implemented on a large enough region, with BRT on

	provides realtime location information of buses to passengers	congested stretches is expected to provide 10 to 20 percent modal shift from two wheelers and cars. It also improves the usability and stress level for commuters
Electronic Payment and Pricing		
Automated Fare Collection System (AFCS)	• AFCS system reduces the time to ticket • Less cash handling • Helps rapid transportation of passenger through quicker service times. • Helps online automatic data capture and data classification	Smart card system (AFCS) in Indore is expected to increase ridership by 5% based on similar experiences in other cities around the world. AFCS is expected to decrease fare evasion in Indore, marginally. In the long run, AFCS is expected to reduce administrative costs by 5 to 10 percent.
Traveler Information		
Variable Message Signs (VMS)	• VMS can be used to provide vital information in emergencies • VMS can be used to provide congestion data to commuters, which can help them decide on alternate routes	Slight improvements in length of congestion are expected due to the broadcasting of enroute information to commuters.
Incidence Management		
Video Surveillance & Detection	CCTVs help in identifying stalled vehicles and accidents immediately. Computer Aided Dispatch (CAD) can be used then to alert the responsible agencies.	Congestion duration can be reduced by 20 to 30 minutes in Indian conditions due to a stalled vehicle. Accident related congestion duration can also be reduced by about 5 to 10 minutes (for small accidents). As is well known time is of vital importance for people who sustain life threatening injuries in accidents. Hence, benefits of alerting and dispatching emergency

		personnel immediately can be quantified as 5.5 lakhs/person (fatalities), to 5,000 rupees for a minor accident.
Traffic Management Center (TMC)	TMC is the brain center for the ITS operations and is an essential part for realizing the benefits listed for the above ITS infrastructure elements.	• TMCs world over offer wide benefits by providing integrated operations and support to the locality. These benefits can range anywhere from 10% to 30% in cost savings in various costs (reduce number of buses, mode shift, emergency response, etc.). • TMC can be nerve center at which all the stakeholders in Indore (Police, Municipality, Transit Operators) can come together and share data and information leading to more efficient usage of resources and improved planning for the city as a whole.
Emergency Management		
Emergency Traveler Information System	Helps in evacuation of localities/cities in times of man-made and natural disasters	Benefits of proper planning can lead of saving of thousands of lives.

*Note: the quantification is based on data from similar implementations around the world, length of the corridor, and local conditions prevalent on the AB corridor.