Phased Development of ITS System Architecture for Traffic Management in India

Dr. Mandar Khanal, P.E., Boise State University, Boise, Idaho, USA 83713

Prof. Vinay Maitri, Ph.D., School of Planning and Architecture, New Delhi,

Prof. Pradip Sarkar, Ph.D., School of Planning and Architecture, New Delhi

Why TMS?

it reduces

- traffic congestion,
- journey time,
- waiting time at signals,
- pollution etc

It can also be postulated that TMS combined with an efficient public transport system can induce modal shift.

But the selection of the right mix of TMS tools is not simple

It depends on various characteristics of the area, such as geography, population, land use, socio-economic conditions, traffic characteristics, travel behavior, network characteristics, vehicle ownership, etc

which can be collectively denoted as City Characteristics

Traditional TMS plan

was concerned with optimizing the capacity of road network by alternation of traffic flow.

- diversion of traffic,
- conversion of two-way streets to one-way,
- closure of streets,
- banning of movement of selected type of traffic.,
- traffic calming,
- coordination of traffic signals,
- conversion to pedestrian malls,
- traffic control measures include signaling and traffic regulatory measures include restrictions on speed, parking, and size of the vehicles.

Challenges and issues in Indian cities

- Rapidly increasing number of vehicles on the network
- Narrow roads, close intersections, encroachment on roads and haphazard on-street parking
- High density city - not built according to master plan
- Chronic congestion on major roads specially in the CBD and the old city area
- Heterogeneous traffic, old (poorly maintained) vehicles
- Non availability of proper maps and network inventory
- Non availability of traffic data

- Inadequate power supply to traffic signals – manual management of traffic at corridor, area level – lack of coordination due to manual system
- Lack of coordination among related agencies
- Vehicles not following lane discipline and traffic rules
- Vehicles coming from wrong direction
- Poor intersection geometry, roadside obstructions
- Lack of public awareness, driver behavior
- Lack of proper signage, information display system

- Misuse of service lane and uncontrolled side roads
- Lack of facilities for pedestrian, pedestrian crossing, poor maintenance of foot over bridge, and footpath
- Poorly located and maintained traffic control, detection and surveillance infrastructure on road side
- Overloaded vehicles,
- faulty number plates on vehicles,
- Poorly designed road side infrastructure that is unable to handle weather events such as heavy rains.

All of these challenges cannot be addressed completely using ITS tools alone for traffic management system. ITS tools can definitely contribute a lot, maybe more that the other solutions, but educating road users combined with other engineering interventions can together create a successful traffic management system plan for any city in India or anywhere else in the world

Some of ITS tools for TMS

- Intelligent signaling system
- Automatic vehicle location system
- Automatic fare collection system, electronic parking charge payment system and electronic ticketing system, electronic road pricing system
- Emergency and accident response system
- Electronic toll collection system
- Multimodal transportation logistics support system
- Transportation monitoring system (fleet monitoring system-public transport, taxies, Jal (Water) board vehicles, bank vehicles, school buses, ambulances, government vehicles, etc.)

- Police patrol monitoring system
- e- Challan (ticketing) system
- Automatic incident detection system
- Pedestrian/biker detection system
- Passenger information system – Advanced Traveler Information System (ATIS)
- Smart card based driving licenses issue system
- Smart card based permit and registration certificate issue system
- Parking management and information system
- Parking guidance system

- Intelligent parking lot management system
- Traffic control maintenance services system
- Traffic – transport information system– traffic flow monitoring system
- Ramp metering system
- Automatic speed detection system
- Automatic number plate recognition system
- Automatic vehicle detection system (Image processing)
- Automatic air pollution capturing system – meteorological sensors
- Journey time monitoring system

- Goods vehicle weight monitoring system
- Vehicle tracking system
- Distress call response management system – emergency road side telephone system
- Area traffic control system
- Red light violation detection system
- Smart tracking and distress alert system for automobiles
- Car navigation system – vehicle information and communication system (VICS)
- Route guidance system – dynamic route guidance
- Automatic traffic counter and classifier
- Wrong way vehicle detection system
- Towing system

No doubt everybody wishes to use as many tools as possible to get the best result.

The proper selection of the above stated tools depends on available funds and ITS policy.

The ITS policy defines or specifies the ITS architecture at national, regional, or state level and then at city level

But it also depends on available funds and the city characteristics.

In India there is no defined ITS policy yet.

In absence of ITS policy

Some states and cities are implementing ITS tools independently for TMS (without integrating with other states or regions within the state also)

Here we attempted to suggest system architecture for TMS in phased manner

It is not expected that any city in a developing country can use all possible tools of ITS in one go due to lack of funds, experience, and expertise.

So the TMS measures need to be implemented in a phased manner so that the experience from the earlier phases can be utilized in the later phases.

Thus based on funds, available expertise along with the severity of the problem and the ground reality the following suggested phases can be altered and adapted to suit the prevailing conditions in a city

Phase I

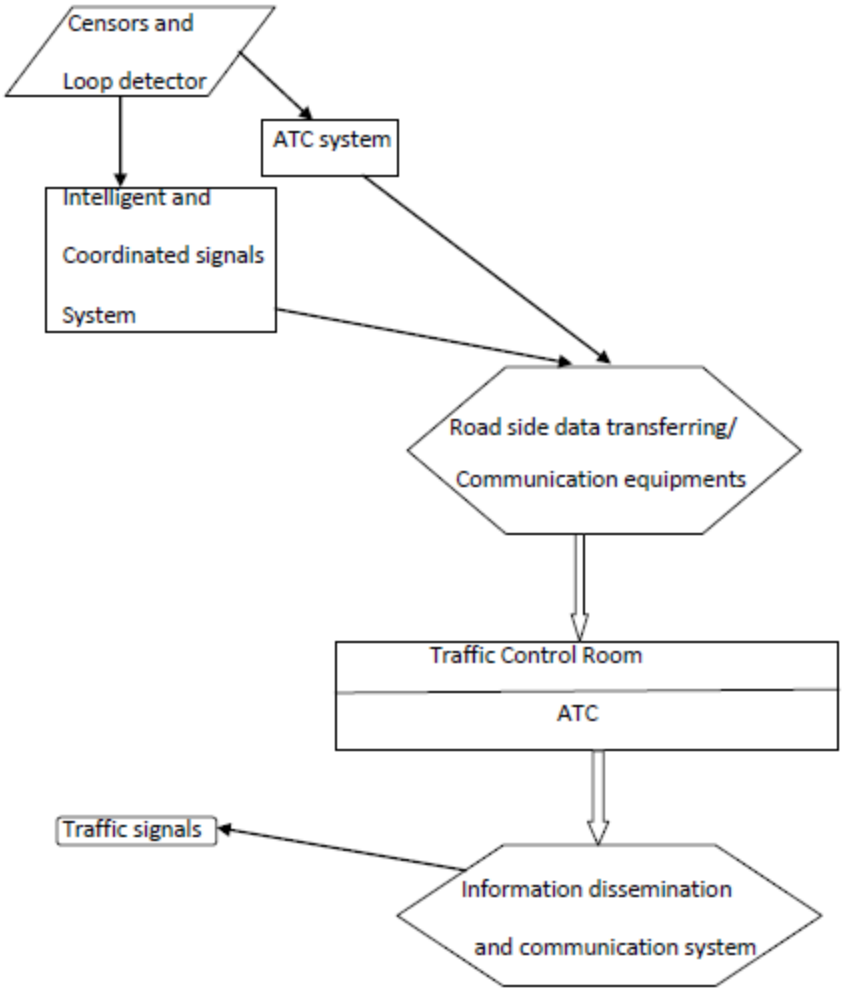
The first phase applies to cities where the problem of traffic congestion has not become very big, congestion is just starting to spread beyond the peak hours, and funds or staff may also be a constraint. This phase is ideal to understand the benefits of ITS. It also constitutes the first steps towards learning about the experiences or issues related to implementing and maintaining TMS in a city.

This phase does not require a sophisticated control room or advanced level of infrastructure. Once cities understand and sort out the implementation and maintenance issues related to TMS and ITS, and become capable of analysing the field data on their own, then they can graduate to higher phases. Cities like Vizaywada, Amritsar, Pathankot, Karnal, and Meerut are examples of cities that can start with Phase I immediately

PHASE I

SYSTEM PROPOSED	AIM
Intelligent signals/ coordinated signals	For smooth discharge of traffic at intersection / smooth flow of traffic on corridor
Area traffic control system (ATC)	Smooth flow of traffic in implemented network, minimum overall delay at red lights, throughout green signal for emergency vehicles.

System Architecture for Phase I



Phase II

When a city is ready with a computerized database of vehicle owners/driving licenses/commercial vehicle permits and also starts implementing smart driving licenses/ permits /registration certificates, etc., the city is prepared for Phase II. Further, if the road network in the city is also used by lot of through traffic and traffic violations show increasing trends (and disposing of the traffic violation cases takes more time), then that city should turn to Phase II.

This phase also assumes that the city has some basic infrastructure such as a traffic police control room and is ready to expand in terms of trained/skilled staff, infrastructure, and advanced communication systems.

Cities like Dehradun and Jammu are example cities where this phase should be implemented

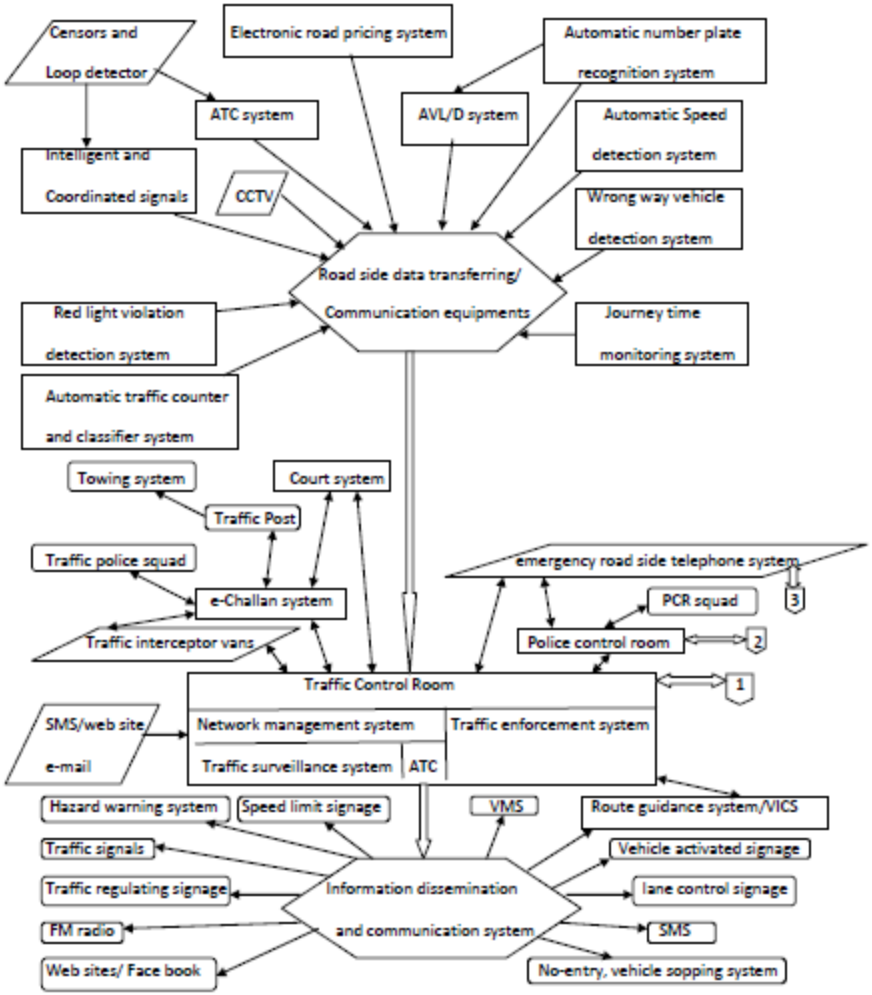
ADDITIONAL SYSTEMS PROPOSED FOR PHASE II

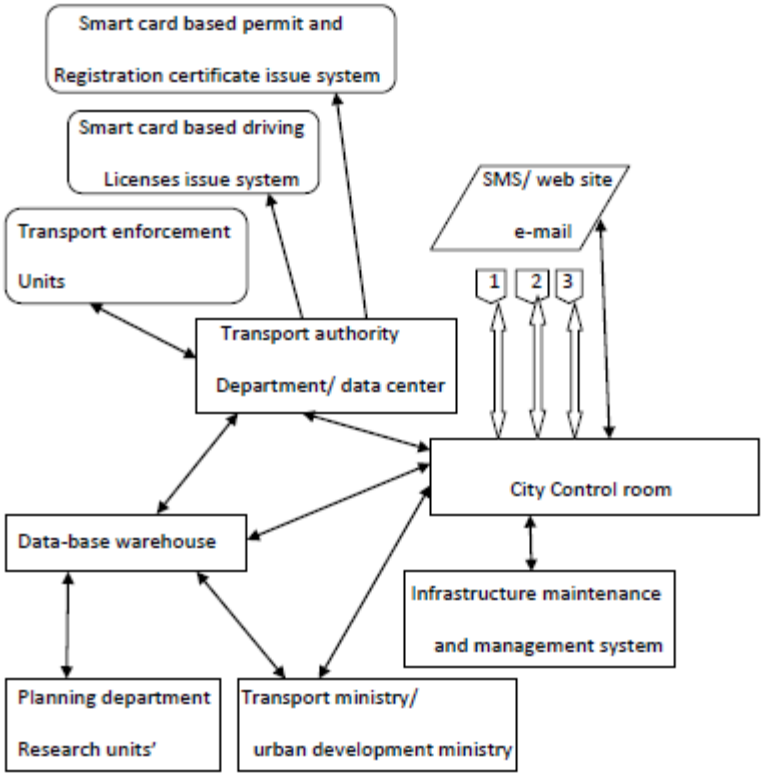
SYSTEM PROPOSED	SUB-SYSTEM	AIM
Traffic Surveillance System	Automatic vehicle location (AVL) system Route guidance system VMS Hazard warning system Speed signage No-entry, vehicle sopping system GIS maps - 3D GIS system	To assist driver and other road users on network for smooth flow of traffic and for their mobility Decrease congestion on network Reduce journey time

Traffic rules enforcement system	Automatic Speed detection system Automatic number plate recognition system Red light violation detection system Wrong way vehicle detection system e- Challan system Smart card based driving licenses issue system Smart card based permit and registration certificate issue system Police patrol monitoring system electronic road pricing system	To capture traffic rules offender, and collect fines from them To book the traffic rules offenders, violation of permit rules, fake driving license holders, fake permits and RC holders, stolen vehicles in the law of court Maintain the records of traffic rules offenders for giving severe punishment in law of court Reduce accidents and increase safety To collect the congestion charges

Infrastructure maintenance and management system	Maintain and manage road side ITS and non-ITS based infrastructure Maintain roads, footpath, FOBs, junctions Maintain and manage communication system, control room Maintain traffic signals, VMS, signage of different types	To provide maintained road network for all road users for smooth flow of traffic and road users mobility. To provide un-interrupted platform for ITS functioning
Data-base warehouse	Automatic traffic counter and classifier	To maintain data of traffic, vehicles for forecasting, planning etc. For demand management

System Architecture for Phase II




Smart card based permit and
Registration certificate issue system
Smart card based driving
Licenses issue system
Transport enforcement
Units
SMS/ web site
e-mail
1
2
3
Transport authority
Department/ data center
City Control room
Data-base warehouse
Infrastructure maintenance
and management system
Planning department
Research units'
Transport ministry/
urban development ministry

Phase III

When road accidents and road rage become everyday affairs and fatalities increase, then the city must immediately adopt Phase III. It is recommended that the city should not wait for increase in fatalities but begin to prepare for Phase III immediately after implementing Phase II

If the pollution level increases at a faster rate than stipulated, the city should also commence implementing phase III. Phase III requires that the city have a trauma centre and ambulance system.

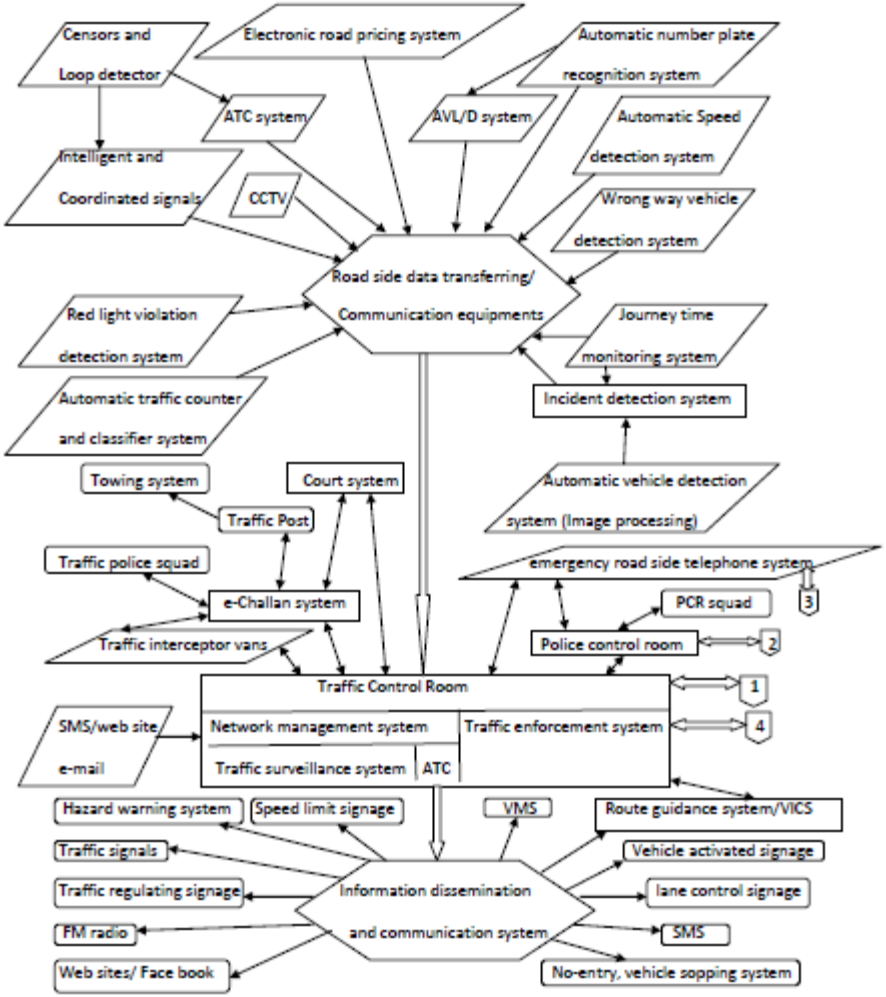
All metropolitan cities and state capitals should proceed directly to Phase III.

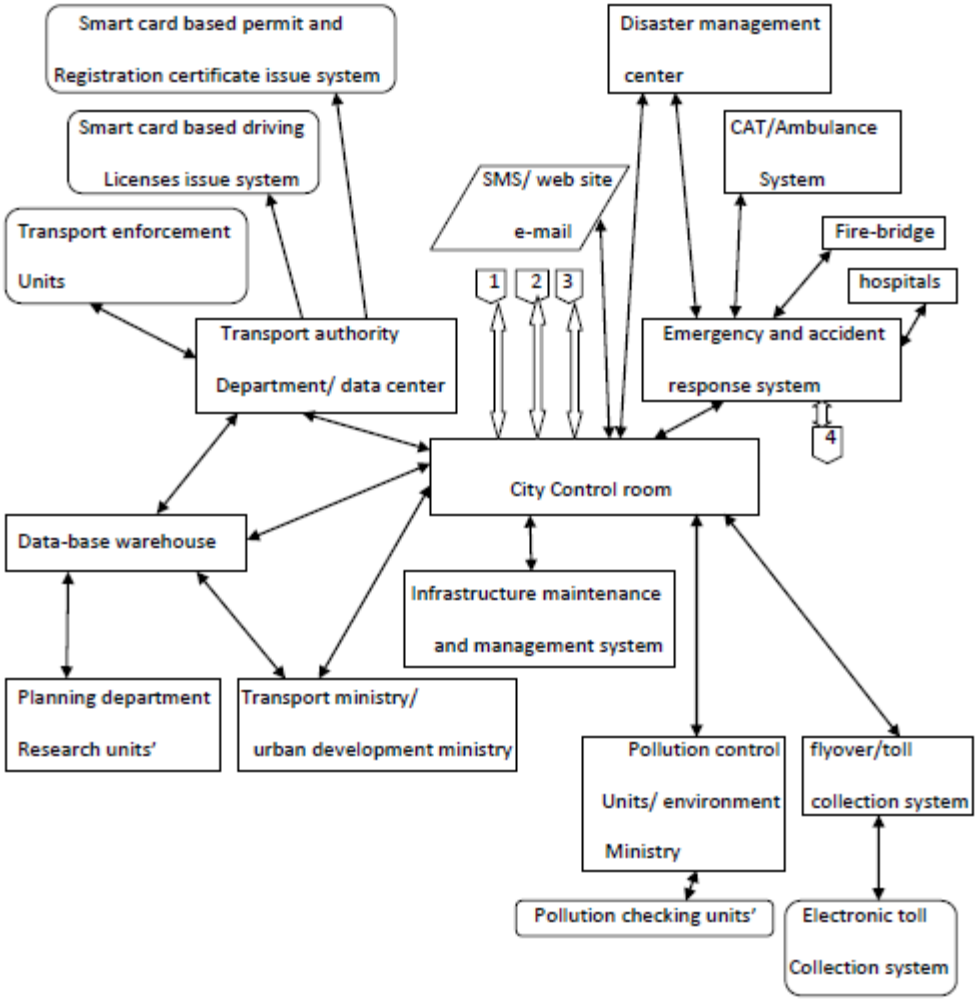
ADDITIONAL SYSTEMS PROPOSED FOR PHASE III

SYSTEM PROPOSED	SUB-SYSTEM	AIM
Automatic incident detection system	Automatic vehicle detection system (Image processing) Towing system Journey time monitoring system	To clear the network in time of breakdown of vehicles for un-interrupted traffic flow To take action after detecting any incidents and reduce casualties

Emergency and accident response system	Transportation monitoring system (fleet monitoring system- public transport, ambulances) Distress call response management system- emergency road side telephone system	To provide immediate relief to road users To save life of road-side accident victims To help road users in case of emergency
Automatic air pollution capturing system – meteorological sensors		To save the city and habitats from pollution To book the vehicles for violation of pollution norm and collect fine and book them in law of court

System Architecture for phases III




Smart card based permit and
Registration certificate issue system
Disaster management
center
Smart card based driving
Licenses issue system
CAT/Ambulance
System
SMS/ web site
e-mail
Transport enforcement
Units
Fire-bridge
hospitals
1
2
3
Transport authority
Department/ data center
Emergency and accident
response system
4
City Control room
Data-base warehouse
Infrastructure maintenance
and management system
Planning department
Research units'
Transport ministry/
urban development ministry
Pollution control
Units/ environment
Ministry
flyover/toll
collection system
Pollution checking units'
Electronic toll
Collection system

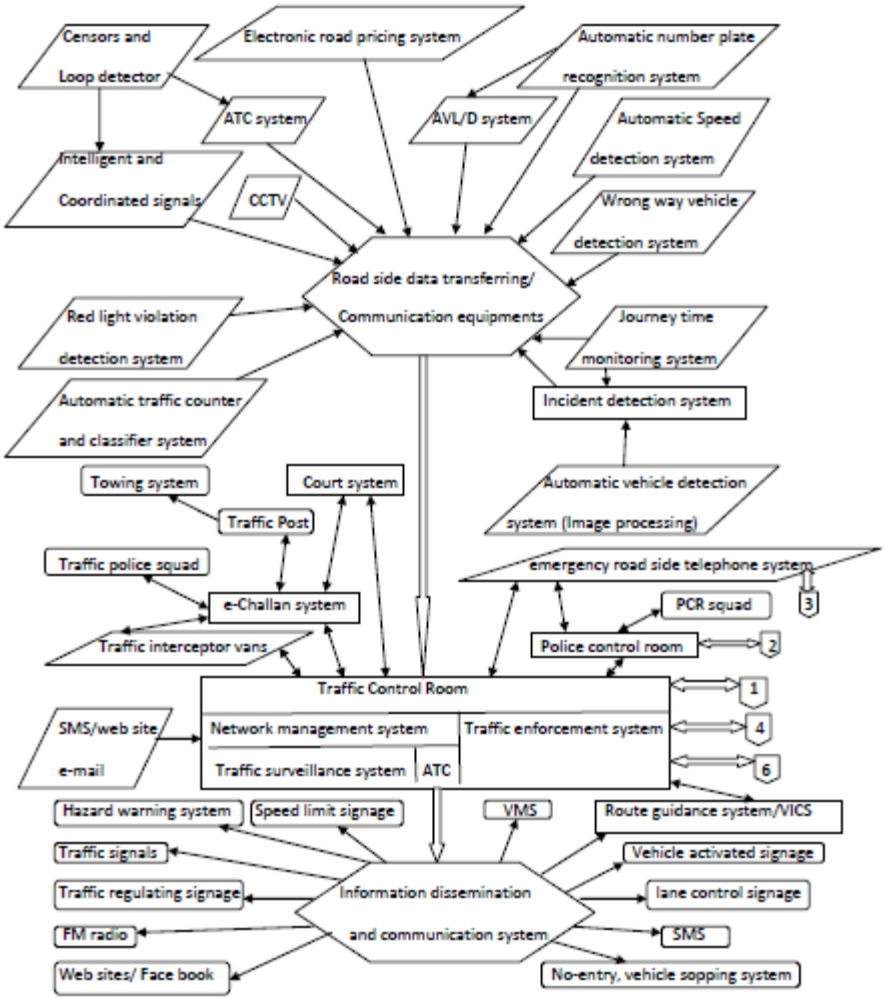
Phase IV

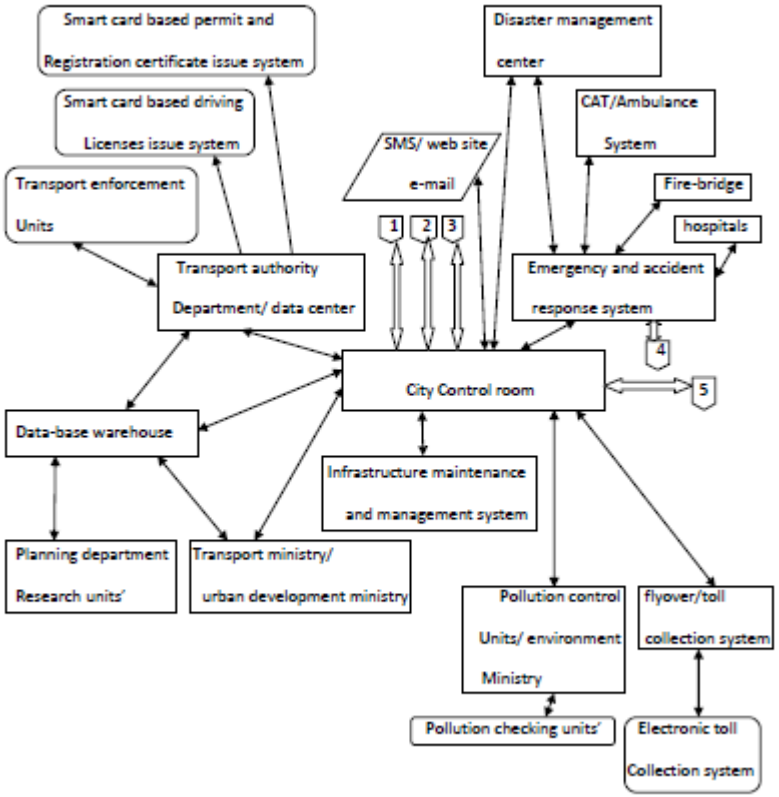
Phase IV is for those cities/ areas where pedestrian or bicycle traffic fatality is high and also an major component of the transportation system

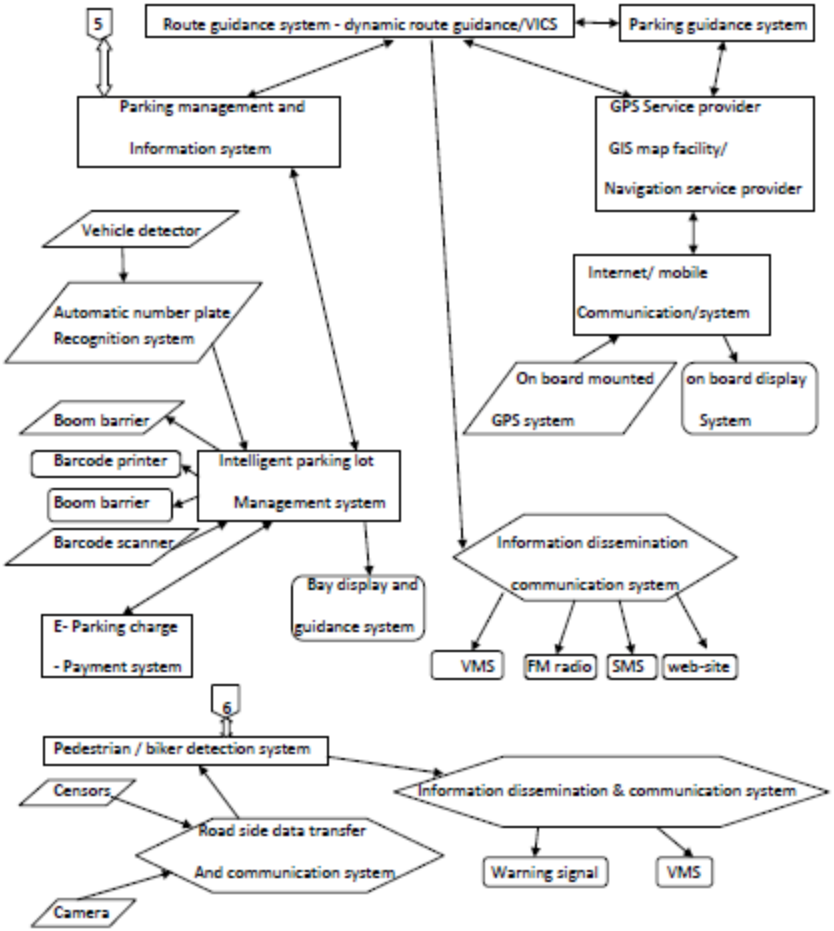
ADDITIONAL SYSTEMS PROPOSED FOR PHASE IV

SYSTEM PROPOSED	SUB-SYSTEM	AIM
Parking management and information system	Parking guidance system Intelligent parking lot management system Car navigation system – vehicle information and communication system (VICS) Route guidance system - dynamic route guidance electronic parking charge payment system	Guide the driver to particular parking sites among number of sites within a area Guiding the drivers to park at particular parking bay Help the drivers to locate particular location in city through unit fitted in car Help the drivers or road users to locate particular location in city through system available on road side
Pedestrian / biker detection system		To reduce and avoid pedestrian/biker causality in road accidents

System Architecture for IV phases




Smart card based permit and
Registration certificate issue system
Disaster management
center
Smart card based driving
Licenses issue system
CAT/Ambulance
System
SMS/ web site
e-mail
Transport enforcement
Units
Fire-bridge
hospitals
1
2
3
Transport authority
Department/ data center
Emergency and accident
response system
4
City Control room
5
Data-base warehouse
Infrastructure maintenance
and management system
Planning department
Research units'
Transport ministry/
urban development ministry
Pollution control
Units/ environment
Ministry
flyover/toll
collection system
Pollution checking units'
Electronic toll
Collection system


5
Route guidance system - dynamic route guidance/VICS
Parking guidance system
Parking management and
Information system
GPS Service provider
GIS map facility/
Navigation service provider
Vehicle detector
Automatic number plate
Recognition system
Internet/ mobile
Communication/system
On board mounted
GPS system
on board display
System
Boom barrier
Barcode printer
Boom barrier
Barcode scanner
Intelligent parking lot
Management system
Information dissemination
communication system
Bay display and
guidance system
E- Parking charge
- Payment system
VMS
FM radio
SMS
web-site
6
Pedestrian / biker detection system
Information dissemination & communication system
Censors
Road side data transfer
And communication system
Warning signal
VMS
Camera

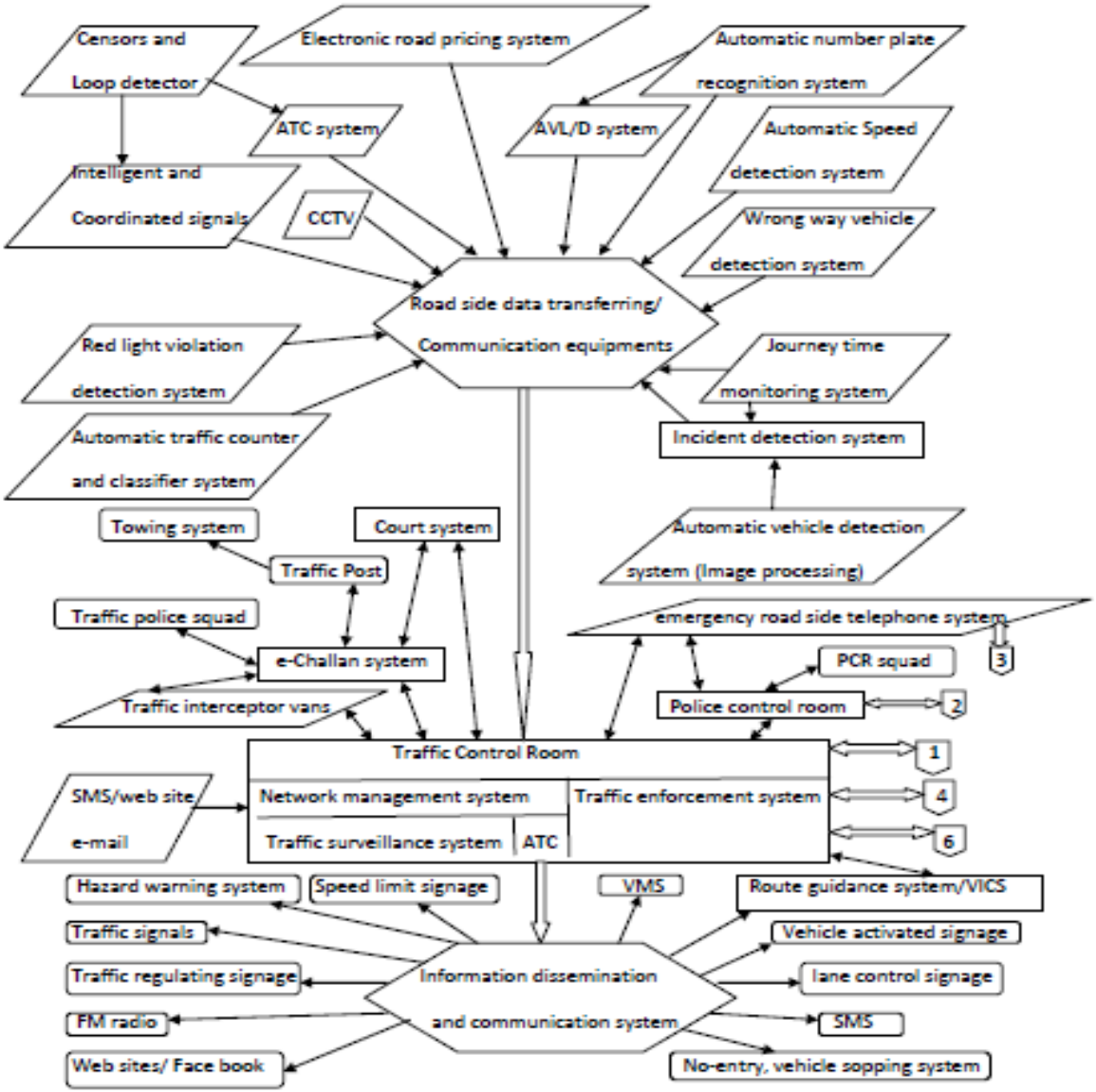
Phase V

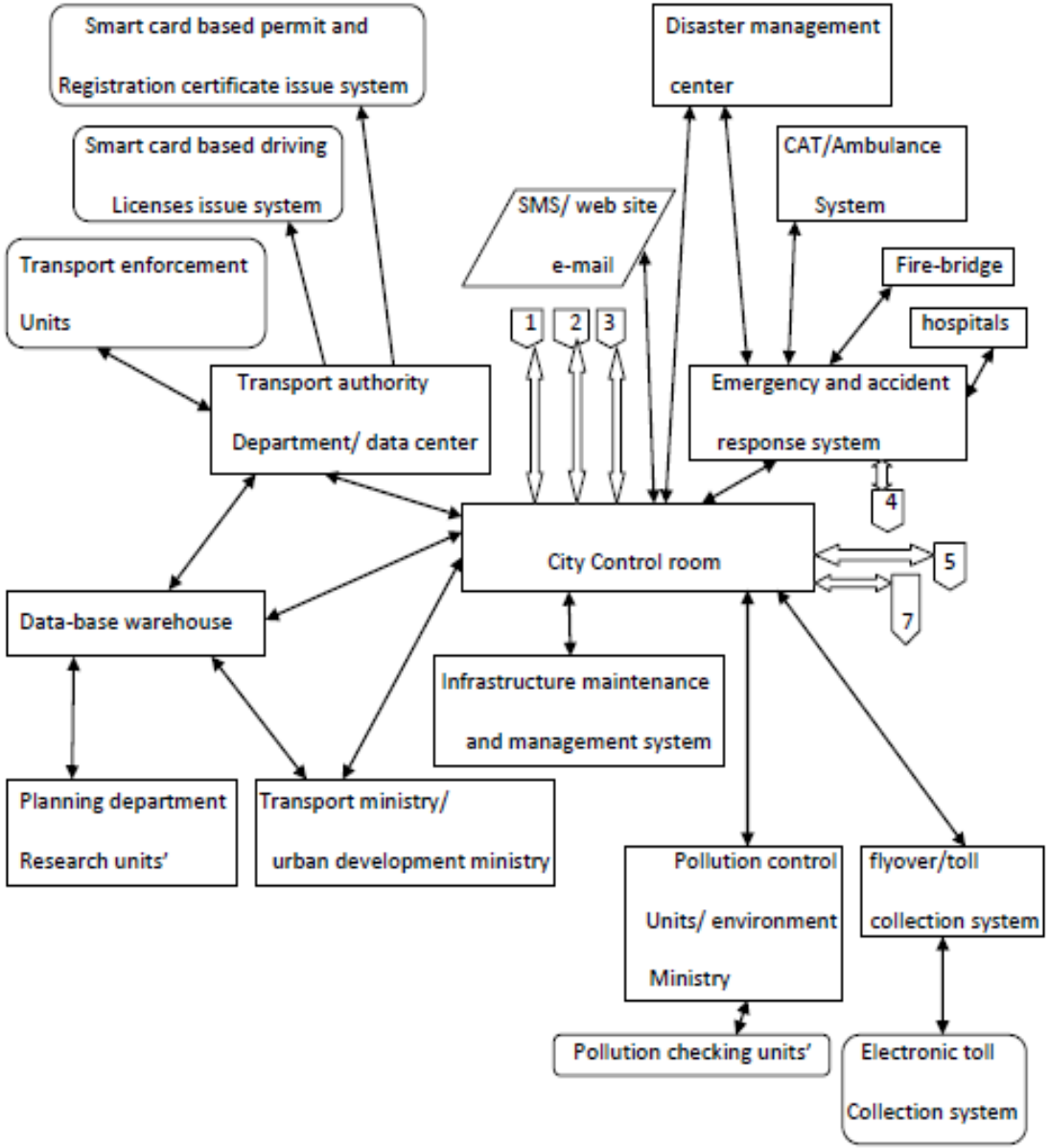
Phase V is the fully built-out phase and incorporates all functionality required to manage traffic in any Indian city

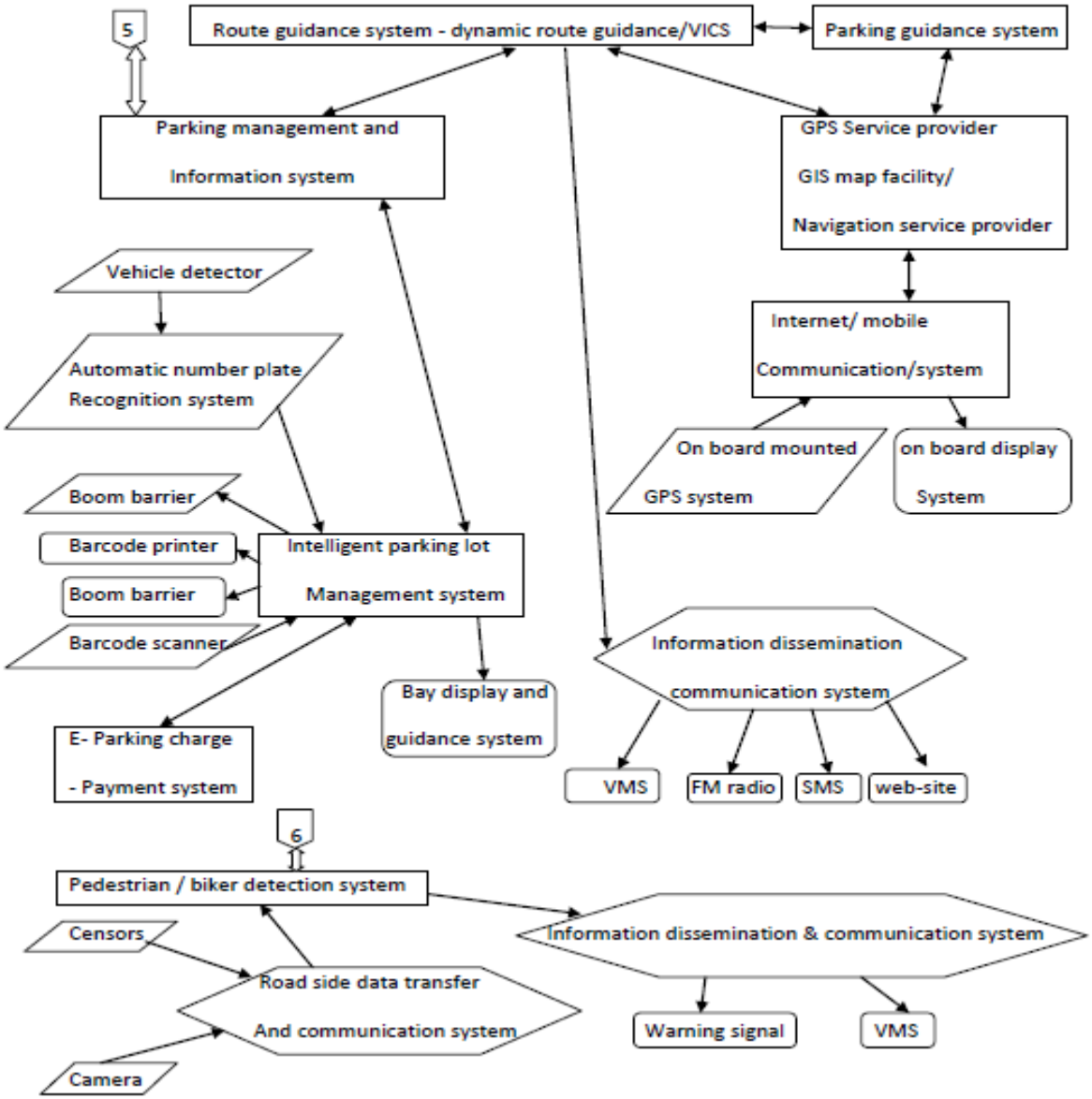
ADDITIONAL SYSTEMS PROPOSED FOR PHASE V

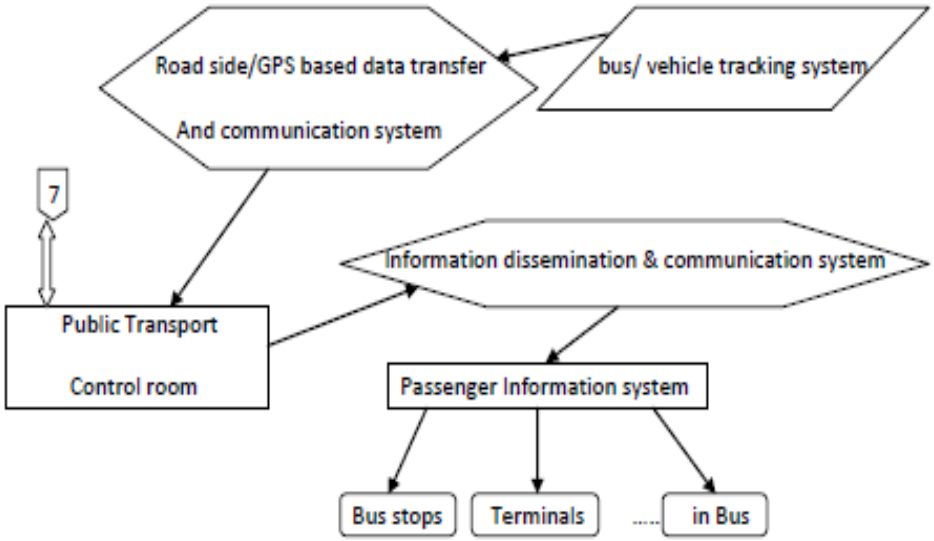
SYSTEM PROPOSED	SUB-SYSTEM	AIM
Advanced Traveler Information System (ATIS)	Passenger information system	To help the road user for information related to public transport /IPT at road side

System Architecture of all phases




Smart card based permit and
Registration certificate issue system
Disaster management
center
Smart card based driving
Licenses issue system
CAT/Ambulance
System
SMS/ web site
e-mail
Transport enforcement
Units
Fire-bridge
hospitals
1
2
3
Transport authority
Department/ data center
Emergency and accident
response system
4
City Control room
5
7
Data-base warehouse
Infrastructure maintenance
and management system
Planning department
Research units'
Transport ministry/
urban development ministry
Pollution control
Units/ environment
Ministry
flyover/toll
collection system
Pollution checking units'
Electronic toll
Collection system


5
Route guidance system - dynamic route guidance/VICS
Parking guidance system
Parking management and
Information system
GPS Service provider
GIS map facility/
Navigation service provider
Vehicle detector
Automatic number plate
Recognition system
Internet/ mobile
Communication/system
On board mounted
GPS system
on board display
System
Boom barrier
Barcode printer
Boom barrier
Barcode scanner
Intelligent parking lot
Management system
Information dissemination
communication system
Bay display and
guidance system
E- Parking charge
- Payment system
VMS
FM radio
SMS
web-site
6
Pedestrian / biker detection system
Information dissemination & communication system
Censors
Road side data transfer
And communication system
Warning signal
VMS
Camera


Road side/GPS based data transfer
And communication system
bus/ vehicle tracking system
7
Information dissemination & communication system
Public Transport
Control room
Passenger Information system
Bus stops
Terminals
.....
in Bus

Thanks