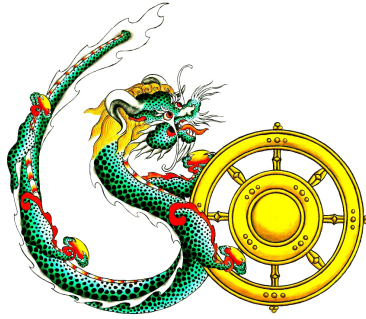




**INTELLIGENT TRANSPORT SYSTEMS (ITS)
FEASIBILITY STUDY AND PREPARATION OF A
COMPREHENSIVE ITS ACTION PLAN FOR THIMPHU CITY**

2015



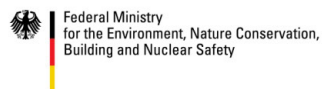
Intelligent Transport Systems (ITS) Feasibility Study and Preparation of a Comprehensive ITS action plan for Thimphu City

Ministry of Information and Communications
Royal Government of Bhutan

Published with technical and financial support of UNDP 'Low Emission Capacity Building Programme funded through EU, Australia Government and Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)



Supported by:



based on a decision of the German Bundestag



*Empowered lives.
Resilient nations.*

TABLE OF CONTENTS

EXECUTIVE SUMMARY	iv-vii
1. INTRODUCTION	
1.1 Preamble	1
1.2 Structure of this draft report	1
1.3 Issues identified	2
1.4 Presentation of the final report	3
2. TRAFFIC CONGESTION IN THIMPHU	
2.1 Introduction	3
2.2 Several key factors affecting mobility in Thimphu	3
2.3 Smart congestion reduction strategies for Thimphu	4
3. DEVELOPMENT OF AN ITS PLAN FOR THIMPHU	
3.1 Introduction	10
3.2 What is ITS	10
3.3 The role of ITS	12
3.4 Barriers to ITS implementation	12
3.5 Prioritisation of ITS Investments	13
3.6 ITS measures identified in the TOR	13
3.7 Current ITS related developments	15
3.7.1 Safe City Initiative	15
3.7.2 Real-Time Bus Information System (BIS)	16
3.7.3 Car park Management in Thimphu City	17
3.8 Essential supporting non-ITS traffic measures	18
3.9 Existing legal documents related to transport	19
4. SHORT MEDIUM AND LONG TERM ACTION PLAN	
4.1 Introduction	20
4.2 Short Term Action Plan	21
4.3 Medium Term Action plan	44
4.4 Long Term Action Plan	51
5. SYSTEM REQUIREMENTS AND NATIONAL ITS ARCHITECTURE	
5.1 System Requirements	52
5.1.1 Bus Information System	52
5.1.2 Car parking automation	54
5.1.3 eTicketing	55
5.2 National Architecture	56

APPENDICES

Appendix A	Case Study – Public Private Partnership for Urban Bus Transport Services in Thimphu
Appendix B	Technical Information Paper - Design Elements for Bus Stops and Bus Shelters

ABBREVIATIONS

APC	Automatic Passenger counters
AVL	Automatic Vehicle Location
BOD	Bhutan Oil Distributors
BIS	Bus Information System
BPC	Bhutan Power Corporation
BRT	Bus Rapid Transit
BTL	Bhutan Telecom Limited
BUTS	Bhutan Urban Transport Systems
CBS	City Bus Service
CCC	Command Control Centre
CCTV	Closed Circuit Television
GPS	Global Positioning System
ICT	Information and Communications Technology
IFC	International Financing Corporation
ITS	Intelligent Transport Systems
JDWNRH	Jigme Dorji Wangchuck National Referral Hospital
LATMP	Local Area Traffic Management Plan
LCC	Life Cycle Costing
MOIC	Ministry of Information and Communications
PPP	Public Private Partnership
PTZ	Pan Tilt Zoom
RBP	Royal Bhutan Police
RFID	Radio Frequency Identification
RSTA	Road Safety & Transport Authority
RWIS	Road Weather Information System
TCC	Traffic Control Centre
ToT	Training of Trainers
TSP	Transit Signal Priority
TT	Thimphu Thromde
TWG	Transport Working Group
UNDP	United Nations Development Programme
VMS	Variable Message Signs
VOC	Vehicle Operating Cost
VWS	Virtual Weigh Stations

EXECUTIVE SUMMARY

Introduction

The Intelligent transport systems (ITS) feasibility study aims to develop a desirable intelligent transport system for Thimphu city which is practical and cost-effective for an efficient and effective transport management system in Thimphu city. An ITS action plan has also been developed for Thimphu city as part of the study.

Issues Identified – Section 2

Nine key issues/preconditions have been identified that would need to be addressed for the successful implementation of ITS:

- Current urban public transport services, operations and facilities need to be improved before public transport related ITS measures can be successfully introduced and rolled-out
- Identification and implementation of congestion management strategies to ensure ITS measures are effective in Thimphu City
- A plan to achieve a Modal Shift from car to public transport and walking to enable the introduction of more effective ITS measures
- Changes to the hierarchy of travel - where the car no longer dominates
- Traffic engineering improvements to complement and enhance the introduction of ITS applications
- The possible introduction of “BRT features” in urban public transport
- Integration of the current fragmented transport system with the support of ITS
- Land use planning and compliance to complement the transport system
- Essential institutional changes and developments.

The introduction of ITS measures should not be implemented in isolation to other essential prerequisite and/or supporting measures

Traffic Congestion in Thimphu – Section 3

There are 5 key issues affecting mobility in Thimphu, they are:

Population Growth

- Thimphu has about 120,000 inhabitants
- Population growing at 13% per annum

High Automobile Ownership

- Around 30% of Thimphu population owns personal vehicles
- Average household vehicle ownership is 1.4 per household
- Vehicle import and registration costs relatively inexpensive
- Insurance and licensing costs relatively inexpensive

High Automobile Usage

- High levels of private automobile usage with current land use practices

Uncontrolled Downtown Parking

- Relatively inexpensive parking in downtown
- Lack of time restrictions

Underperforming Public Transport System

- Poor services
- Lack of unified transportation system
- Individual operators with little coordination
- Underutilised system

The solution is to implement a “Smart” congestion reduction strategy for Thimphu, comprising:

- Changing the road user hierarchy
- Modal Shift to optimise use of Road Space by reducing private vehicle trips
- Traffic Management Improvements
- Enforce land use planning
- Consider introduction of Parallel Parking in Norzin Lam

Development of an ITS Plan for Thimphu – Section 4

The ITS measures recommended have been specifically developed for Thimphu but most can be replicated for other urban centres in Bhutan. The Bus Information System designed for Thimphu should be extended to include bus services in Phuentsholing including the provision of CCTV monitoring and surveillance of the bus terminal area.

Role of ITS

- Reduce congestion and journey time
- Enhance mobility of people and goods
- Improve accessibility
- Reduce environmental impact - energy consumption and traffic emissions
- Improve quality of life in city centres to promote smart living and sustainability
- Increase market share of clean vehicles in private and public fleets
- Increase efficiency of the transport system
- Make public transport attractive/encourage modal shift
- Facilitate freight delivery and servicing
- Enhance road safety.

Currently three encouraging, and directly relevant, developments will facilitate the introduction of ITS in Thimphu they are:

- Safe City Initiative
- Real-time Bus Information System (BIS)
- Car-park management in Thimphu City.

Essential supporting non-ITS traffic measures

There are a range of other traffic measures that are of a non-ITS nature but form part of the solution while also being an integral part of the transport system as a whole, this includes, inter alia:

- Road signs
- Road markings
- Traffic Engineering
- Warning lights
- Pedestrian crossings
- Dedicated bus and taxi bays
- Bus stop and shelters
- Bus terminal

Short, Medium and Long Term Action Plan - Section 4

The Action Plan developed identifies a number of key actions or activities that are recommended for implementation over a short, medium and long term. The short-term plan starts with the remaining 3 years, 2015-2018 of the Governments 11th Five Year Plan, the medium term corresponding with the 12th Five Year Plan for the period 2018-2023 and the long-term extends beyond 2023.

To make the Plan more manageable each proposed activity has been categorised into the following 7 different integrated actions – each supporting the other to achieve an optimum integrated urban transport system.

- Institutional Initiatives - some are really prerequisites
- Policy Initiatives
- Local Procurement and Government Procurement Policies and Regulations
- Public-Private Partnership for Urban Bus Transport in Thimphu
- Congestion Management
- Public Transport Fare Collection
- Traffic Engineering
- ITS Measures (and provision of electronic traffic devices).

Section 4 includes an extensive list of activities including explanatory notes, wherever appropriate.

System and National Architecture requirements for an ITS Plan – Section 5

The system requirements, including itemised costs, for ITS measures proposed in Short Term Action Plan are outlined for:

- Bus information system
- Requirements for real time bus information for City Bus Services
- Possible car parking automation
- E-Ticketing

Conclusion

The Action Plan developed herein provides a structured approach for Government to phase-in ITS measures including concurrent pre-requisite requirements. In addition to the preparation of a short, medium and long term Action Plan, a list of start-up projects/initiatives was also drawn with recommendations for immediate implementation. The idea is to “kick start” the ITS implementation process. The list was prepared in conjunction with UNDP and MOIC. It was presented to the high level Stakeholders’ presentation on the 2nd of July 2015 in Thimphu where it received broad endorsement.

List of start-up projects/initiatives

1. Urban Transport Policy Plan for Thimphu
2. CCTV at bus terminals at Thimphu and Phuentsholing and on all CBS’s Green Buses
3. Provision of -1-2 Integrated/functional Bus Stops
4. Pilot eTicketing one of CBS’s bus routes
5. Bus Stop Signs with Bus Timetable housed in small metal enclosures
6. Re-organisation of traffic in Norzin Lam including bus bays for northern routes, taxi rank, line marking and pedestrian crossing with flashing warning lights centrally located to improve traffic flow, road safety and to facilitate a change in pedestrian and motorist behaviour
7. Development of a Bus Timetable App for CBS
8. Compulsory GPS on all Regional Bus Services with phased implementation
9. Development of an App for live bus location information system starting with the Thimphu–Paro and Thimphu–Phuentsholing region bus routes
10. Government to make formal application to AusAid for recruitment of a transport specialist as a volunteer to be attached to CBS
11. Short term consultancy assistance to develop a Transformation Plan for CBS
12. Increase parking fees in Norzin Lam and Chang Lam

1. INTRODUCTION

1.1 Preamble

The Bhutan Transport 2040: Integrated Strategic Vision for Bhutan is to provide the entire population with a safe, reliable, affordable, convenient, cost-effective, and environment-friendly transport system in support of strategies for socioeconomic development.

With the urban population increasing at an alarming rate of 13%, this has resulted in several environmental issues, and has had a direct impact on human health, economic hindrances, traffic congestion, and pollution. Road transport is the only mode of transport in the country besides air travel. The National Green House Gas (GHG) inventory of 2000 identifies the energy sector as the second highest contributor of GHG emissions after agriculture. The transport sub-sector accounts for about 44% of all energy-related GHG emissions.

The growth of vehicles in Bhutan in general and Thimphu in particular has been quite alarming especially during the last decade, with numbers hugely concentrated in the west. The vehicle population has grown from a mere 5,000 in the 1990s to over 76,118 as of 30th September 2015. On the other hand, road space, parking space or alternate transportation options have not kept pace with the growth of vehicles to reduce traffic congestion and vehicle emission.

At the current rate of increase in vehicle numbers, Bhutan's commitment to remain carbon neutral will be significantly challenged with increased import of fossil fuels. In an effort to address the issue, the Ministry of Information and Communication (MOIC) along with key stakeholders felt the need for a more intelligent transport system (ITS) for Thimphu city to reform the transport sector into a more environment friendly system as demonstrated in many cities around the world. The ITS study will help to assess design options, system requirements, and identify solutions to address the city's growing traffic problems and improve the quality of transport services.

1.2 Structure of this report

Section 1 aims to set out the parameters or pre-conditions for the successful introduction of ITS measures appropriate for Thimphu. This takes the form of identifying key issues holding back the overall development of the current transport system.

Section 2 outlines the basic reasons for Traffic Congestion in Thimphu and offers a congestion reduction strategy which would address the current problems based on worldwide best practices.

Section 3 introduces ITS and outlines those ITS developments that are currently under consideration in Bhutan - some of which are in planning phase and others progressing as pilot projects.

Section 4 outlines the ITS and supporting measures that are recommended under a short, medium and long term timeframe in the form of an Action Plan. It includes various explanatory notes and information as a guide to facilitate implementation and a list of start-up projects.

Section 5 outlines the System requirements for early start-up ITS projects and a National Architecture of the proposed ITS framework.

The Appendices provides technical information on design elements for bus stops and bus shelters and a case study for possible PPP for Urban Bus Transport Services

1.3 Issues identified

The following nine key issues that have been identified need to be addressed for the successful implementation of ITS in Thimphu (and other urban centres):

- Current urban public transport services, operations and facilities need to be improved before public transport related ITS measures can be successfully introduced and rolled-out
- Identification and implementation of congestion management strategies to ensure ITS measures are effective
- A plan to achieve a Modal Shift from car to public transport and walking to enable the introduction of effective ITS measures
- Changes to the hierarchy of travel - where the car no longer dominates
- Traffic engineering improvements to complement and enhance the introduction of ITS applications
- The possible introduction of “BRT features” in urban public transport
- Integration of the current fragmented transport system with the support of ITS
- Land use planning and compliance to complement the transport system
- Essential institutional changes.

Any recommendation for the introduction of ITS measures should not be developed without consideration of the above issues. This could result in the deployment of ineffective, inappropriate and premature ITS measures. In fact, the success of ITS solutions for Thimphu is dependent on certain non-ITS initiatives.

The short, medium and long-term Action Plan (Roadmap) will reflect such considerations. Many of these non-ITS supporting activities will not require capital resources but a strong determination from both Local and National Governments to improve the urban transport situation in Thimphu (and elsewhere in Bhutan). These issues support the successful implementation of many ITS measures.

1.4 Presentation of the Report

The report was developed through several rounds of consultations with key Government and IT industry stakeholders and presented to senior officials on 2 July. The forum resulted in a valuable exchange of comments and ideas which have been incorporated in the report, wherever relevant.

2. TRAFFIC CONGESTION IN THIMPHU

2.1 Introduction

The TOR requires the identification of Thimphu city's growing traffic problems. It would be misleading to declare that Thimphu has a serious level of traffic congestion. In fact, the traffic movements are relatively low and peak periods are short. This means that by addressing the underlying reasons the current situation is readily curable. The recent World Bank IFC parking study team summarised the problem in Thimphu as follows.

SNAPSHOT OF THE CURRENT TRAFFIC SITUATION IN DOWNTOWN THIMPHU

From a recent traffic volume and speed survey for Norzin Lam and Chang Lam (carried out recently through the International Finance Corporation) it is noted that Taxi movements in Norzin Lam are about 50% of the traffic movement and about 45% in Chang Lam. This is an extraordinarily high proportion and largely a reflection of the poor quality of public bus services. At present there is no incentive to change modes. The existing public bus service needs radical transformations as without an improved bus service a modal shift from car travel to public transport will not occur and traffic congestion will increase unabated

As a way forward, therefore, we must first understand what is causing current traffic congestion in order to consider ways and means of easing the congestion. There are many factors that contribute to the situation which, as stressed above, cannot be solved by ITS measures alone. The following chart identifies the underlying reasons prevailing.

2.2 Several key factors affect mobility in Thimphu

There are 4 key issues affecting mobility in Thimphu, they are:

Population Growth¹

- Thimphu has about 120,000 inhabitants
- Population growing at 13% per annum

¹ Figures quoted in the Project's TOR

High Automobile Ownership²

- Around 30% of Thimphu population owns personal vehicles
- Average household vehicle ownership is 1.40
- Vehicle import and registration costs relatively inexpensive
- Insurance and licensing costs relatively inexpensive

High Automobile Usage

- High levels of private automobile usage with current land use practices

Uncontrolled Downtown Parking

- Relatively inexpensive parking in downtown
- Lack of time restrictions

Underperforming Public Transport System

- Poor level of service
- Lack of unified transportation system
- Individual operators with little coordination
- Underutilised system

2.3 Smart congestion reduction strategies for Thimphu

This section describes various win-win congestion reduction strategies which need to be adopted for Thimphu. The key is to achieve greater use of alternative modes of travel.

HOW DO WE WANT TO SEE THE URBAN TRANSPORT SYSTEM OF THIMPHU IN THE FUTURE?

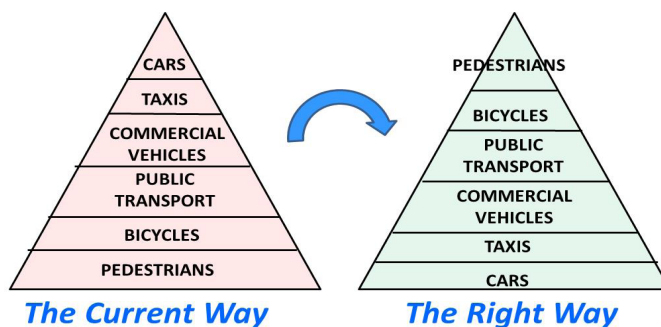
An automobile prioritized and dominated system with hundreds of cars stuck in traffic?

OR

A sustainable transport system with a strong network supplemented by other modes - pedestrian, cycling, buses, taxis

Changing the road user hierarchy

In order to achieve a safe and well connected transport network, it is imperative that authorities give priority to transport modes in the following hierarchical order.



² Bhutan Transport 2040 Integrated Strategic Vision
Bhutan Urban Transport Systems System

The challenge of a sustainable transport system is that it must meet the mobility and accessibility needs of people by providing safe and environmentally friendly modes of transportation. This is a complex and difficult task in the cities of developing countries such as Thimphu because the needs of people belonging to various income groups are not only different, but also often conflicting in nature. For example, if a large section of the population cannot afford to use motorized transport – private vehicles or public buses – they have to either walk to their place of work or use bicycles. Providing a safe infrastructure for cyclists and pedestrians means either physically segregating road space for cyclists and pedestrians from motorized traffic, or, if that is not possible, reducing the speed of motorized traffic.

A pedestrian-oriented hierarchy of transportation promotes density, safety, economic viability, and sustainability.

Examples of how the road user hierarchy can be applied in Thimphu include:

- Ensuring that both levels of government development budgets focuses on projects that support pedestrians as the most important road user
- New traffic engineering projects are planned and implemented following consideration of how to provide for the accessibility and safety of pedestrians and bike riders
- Reallocate road space used for parking where pedestrians, cyclists and public transport users will benefit
- Use the planning and management of urban development to minimise the need for people to use private cars.

Modal Shift to optimise use of Road Space by reducing private vehicle trips

The current situation in downtown Thimphu can be best demonstrated by the observations made in the recent IFC Parking Study supported by 2 photos illustrating current on-street parking and congestion on two main roads in Thimphu.

PARKING CONGESTION IN THIMPHU CITY

The following photos illustrate current on-street parking and congestion on two important arterials in Thimphu CBD. As shown in these photos, 1/3 to 1/2 the road space in city centre is allocated for on-street parking. The vehicles parking and coming out of parking bays further shrink the road space that is available for general traffic movement. This results in further reduction in road capacity and severe congestion



Alternative modes include walking and cycling, public transport (buses), and sometimes, high-occupancy vehicles, car sharing, telecommuting, taxi services, and delivery services. If alternative modes are inferior (inconvenient, uncomfortable, dangerous, etc.), people who own a motor vehicle will drive even if congestion is severe, but if alternatives are improved some travellers will shift from driving, reducing congestion. Even small shifts can provide significant benefits. For example, a 5% reduction from 2,000 to 1,900 vehicles per lane-hour typically increases roadway traffic speeds by 10 to 20 kilometres per hour.

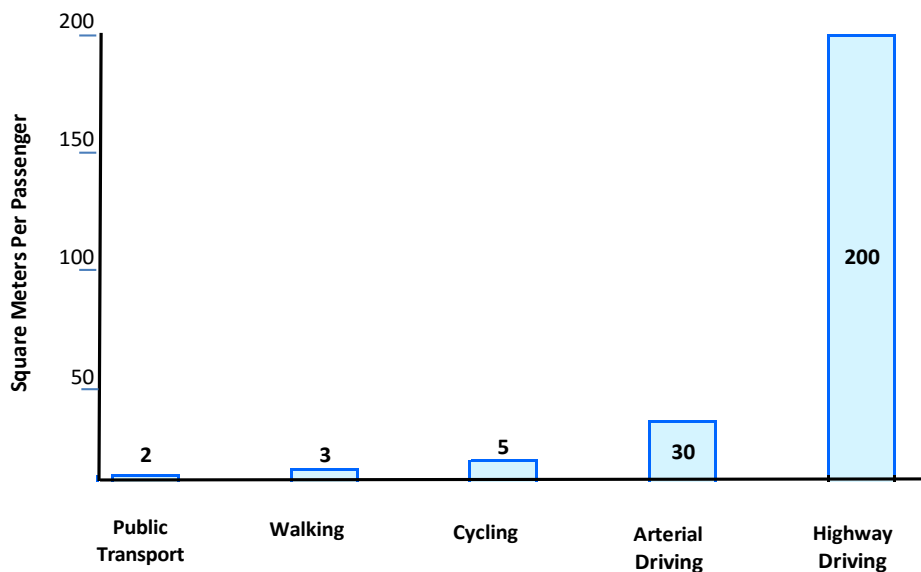
Walking	Bicycling	Public Transport
<ul style="list-style-type: none"> ▪ More sidewalks and paths ▪ More crosswalks ▪ Traffic speed reductions ▪ Improved way finding ▪ More compact and mixed development so more services are within walking distance ▪ Improved safety and security ▪ <i>Universal design</i>, so pedestrian facilities accommodate pedestrians with disabilities ▪ Improved connectivity 	<ul style="list-style-type: none"> ▪ More paths ▪ More bike lanes ▪ Traffic speed reductions ▪ Improved way finding ▪ Bike parking ▪ More compact and mixed development so more services are within cycling distance ▪ Improved safety and security ▪ Loans and subsidies to purchase bicycles and safety equipment (lights and helmets) ▪ Bicycle training and encouragement programs ▪ Bicycle racks for buses 	<ul style="list-style-type: none"> ▪ More routes ▪ Increased frequency of service ▪ Faster service ▪ Grade separation (bus lanes) ▪ Nicer vehicles ▪ Nicer stations ▪ Improved user information ▪ Improved safety and security ▪ Reduced fares and more convenient payment systems ▪ Improved stop/station access ▪ Better marketing ▪ World best practice design, so transit services accommodate pedestrians with disabilities

Typical Alternative Mode Improvements

Improved conditions for walking and cycling can reduce traffic congestion in several ways. Poor conditions for walking and cycling force people to drive for even short trips. In urban areas a significant portion of motor vehicle travel (typically 10-30%) consists of short trips that could shift to a non-motorized mode.

Poor walking and cycling conditions also force motorists to chauffeur non-drivers for local trips, for example, driving children to school. Such trips often include empty backhauls, so a kilometre of passenger travel generates two kilometres of vehicle travel. Since most public transport trips include walking and cycling links, improving these modes tend to increase public transit travel.

The space required to transport a person increases with vehicle size and speed (faster vehicles require more “shy distance” between them and other objects), and declines as passengers per vehicle increase. As a result, vehicular travel requires 10 to 100 times (can be even more on highways) as much road space as walking, cycling and public transport.



Road Space needed for the different Modes of Travel

As a result, transport system efficiency, economic productivity, and community liveability tend to increase if automobile travel is minimized, particularly under urban-peak conditions. This does not require eliminating automobile travel entirely; even in large cities a portion of trips are efficiently made by car. However, as cities become larger and denser, automobile mode share should decline.

Traffic Management Improvements

The current level of traffic congestion in Thimphu is largely a result of a lack of effective traffic management. The first step has been taken to improve the management of traffic in Thimphu City by concessions out of the parking management to IFC under a PPP arrangement. It is understood this will shortly be supported by a Parking Management Plan. But this work needs to be broadened in the form of a Local Area Traffic Management Plan (LATMP) for the central area of the city.

The current level of traffic congestion in Thimphu is largely a result of a lack of effective traffic management and the absence of a congestion reduction strategy

LATMP is concerned with the planning and management of the usage of road space within a local traffic area, often to modify streets and street networks which were originally designed in ways that are now no longer considered appropriate to the needs of residents and users of the local area. It involves the use of physical devices, street scaping treatments and other measures (including regulations and other non-physical measures) to influence vehicle operation, in order to create safer and more pleasant streets in local areas. The primary aim of LATMP is to change driver behaviour, both directly by physical influence on vehicle operation, and indirectly by influencing the driver's perceptions of what is appropriate behaviour in that street. The result is intended to be an improvement in traffic-related safety for all road users of the local street. The LATMP will need to incorporate Bus Network and Circulation Plan for the whole City.

Consideration of the introduction of Parallel Parking in Norzin Lam

Angle on-street parking has been considered problematic by traffic engineers for many years. In fact, numerous studies have concluded that diagonal or angle parking in particular is potentially more of a safety concern than parallel or no parking at all. It is a common practice in many cities to discourage or completely prohibit angle parking on primary roads in urban areas.

While those seeking to fit more vehicles in a limited space prefer the angular style, traffic management experts favour parallel parking saying it is cleaner and requires lesser space for entry and exit. (Parking in shopping malls and multi-storied parking structures in a city, however, is dominated by the perpendicular style).

One major drawback of angle parking is that it is a lot more hazardous to get out of a perpendicular spot compared to a parallel spot. Traffic vision is generally much more constrained (by adjacent vehicles, mostly) and you tend to have to stick yourself right into the flow. This is the situation in Norzin Lam and other areas of the city. Although, perpendicular parking will allow you to park more vehicles in the same length of road, it reduces the available road width. Parallel parking is highly desirable in Norzin Lam provided the width of parking bays are wide enough for passengers to get out of their vehicles on the passenger-side to safely accommodate the raised foot path.

Land use planning and compliance

Land use determines transport needs and in turn available transport options determine how land will be used. However, land use planning and transport planning in Thimphu are largely undertaken in isolation with each other. Although the strategies outlined in Thimphu Structure Plan 2002–2007, August 2004 are sound, it would be fair to conclude that most of these have not been followed.

One key concern is the lack of compliance for the provision of parking space associated with new building developments, which seem to be “springing up” all over the place in Thimphu, although there are clear standards designated in the “Planning Standards for Urban Centres in Bhutan” and the “Guidelines for Urban Roads in Bhutan”. These stipulate the minimum mandatory parking space requirements, as per the table below.

Description	Minimum requirement
Residential building with more than 2 bedrooms	1 light vehicle parking per dwelling unit
Residential buildings with 2 bedrooms	1 light vehicle parking per dwelling unit if it is a single occupant unit. In case of two or more number of dwelling units,
Residential buildings with less than 2 bedrooms	1 two-wheeler parking per dwelling unit
Hotels	1 parking space for every 30 sq. metre
Cinema halls	1 parking space for every 10 fixed seats

3. DEVELOPMENT OF AN ITS PLAN FOR THIMPHU

3.1 Introduction

Thimphu is fast transiting from a “large country town” to a bustling city with a rapidly growing urban population and private car ownership. Poor driving and inconsiderate behaviour with lack of traffic regulations are some of the challenges that continue to be faced in the transport sector.

Land use has given priority to urban dwelling – which is understandable as suitable land for housing is limited largely because of the topography. State of major roads are inadequate to accommodate future mass transit corridors. Provision for pedestrian foot paths and crossings in Thimphu are inadequate and of a low standard; often in poor condition.

Such issues need to be addressed in conjunction with ITS developments.

The ITS measures recommended herein have been specifically developed for the Thimphu area but can be replicated for other urban centres in Bhutan. The Bus Information System however, could be extended to include the bus services in Phuentsholing and the CCTV monitoring and surveillance of the bus terminal.

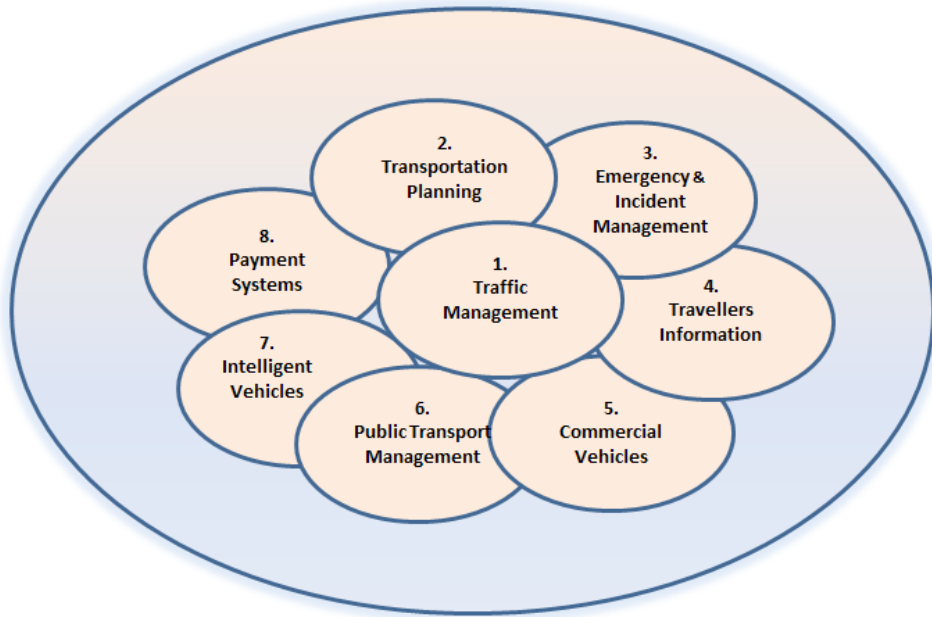
3.2 What is ITS

Intelligent Transport System (ITS) refers to the application of computer and communication technologies to manage transport problems.

Intelligent Transport Systems (ITS) use new and emerging technology (i.e. computers, sensors, communications technology, electronic devices, etc.) to improve the safety, efficiency, effectiveness, accessibility and sustainability of the transportation network without having to increase the capacity of the network itself. ITS applications can also help to reduce environmental impacts in all areas of transportation.

The rapid advances in ITS technologies have enabled the collection of data or intelligence which provides relevant and timely information to road managers and users. The aim is to utilise the various information gathering technologies to solve the many transport challenges that Thimphu and other areas in Bhutan face and to make roads in the respective places smarter.

A way of looking at ITS is to take a market view that identifies buyers and users of the ITS and trying to group them into those having similar needs or objectives. ITS market areas can be defined as that which represents groups of ITS users, operators and procurers with similar needs and buying characteristics. These market areas are illustrated in the concept diagram below.



Area 1: Traffic Management: In this market area, the customers are primarily local and central government agencies. These are the people responsible to improve the transportation process, making it safer and more efficient.

Area 2: Transportation Planning: Customers in this market area try to match transportation supply with demand both now and in the future. These are the people who try to determine current transportation use patterns and make predictions about future use patterns. They include local, state, and federal transportation planners, traffic planners, and transit planners.

Area 3: Emergency and Incident Management: The people responsible for getting people out of trouble are in this market area. This group responds to incidents and emergencies and has primary responsibility for identifying problems, deciding on appropriate responses and resources, and then managing the situation. This encompasses the Fire, Police and Ambulance.

Area 4: Traveller Information: In this market area, the customers for ITS are the providers and users of travel information.

Area 5: Commercial Vehicles: There are two primary groups of customers in this area—the trucking industry and the local agencies that regulate them.

Area 6: Public Transport Management: These are represented by those who plan and operate the transit systems in both urban and rural areas. They are concerned with increasing the operational efficiency of all transit modes as well as achieving a tangible improvement in the attractiveness of these service offerings.

Area 7: Intelligent Vehicles: The automobile manufacturers, automotive electronics manufacturers, and truck and transit vehicle manufacturers all belong in this

category. They are all concerned with enhancing the capability of road vehicles through the use of electronics, sensors, communications, and control actuator technologies. Vehicle drivers also belong in this group, as it is they who will be the eventual consumer or end user of the various ITS applications.

Area 8: Payment Systems: This area includes all the people that try to take money in return for providing a service. It includes toll road operators, public transport operators, car parking operators, and all the customers and users of ITS involved in the process of fee payment for transportation services.

3.3 The role of ITS

ITS has a clear role to play in helping to deliver sustainable transport policy goals at an urban level. Whilst each urban area will have its own transport policies, there is now a considerable degree of uniformity of policy goals to be found in many towns and cities throughout the world. The policy goals outlined below are representative of those adopted by many urban areas and help transport authorities to:

- Reduce congestion and journey time
- Enhance mobility of people and goods
- Improve accessibility
- Reduce environmental impact - energy consumption and traffic emissions
- Improve quality of life in city centres/promote smart living and sustainability
- Increase market share of clean vehicles in private and public fleets
- Increase efficiency of the transport system
- Increase attractiveness of public transport / encourage modal shift
- Facilitate freight delivery and servicing
- Enhance road safety.

ITS will provide timely and accurate information making it possible to choose alternative modes, times and routes of travel. Electronic payment capability will improve the convenience of transit and parking (and toll) facilities. Communication and coordination among state and local traffic, police, emergency services, and private towing companies will greatly reduce accidents and incident response and clearance time thus reducing delay, secondary accidents and emissions caused by stop and go traffic.

3.4 Barriers to ITS implementation

ITS is often technologically complex which requires careful planning and public consultation and monitoring. Barriers to implementation include:

- High initial investments and chicken-and-egg problem, decision makers only recognize the need for investments once they experience the benefits of a fully functional ITS system
- Complex implementation process due to roll-out to large numbers of end-users
- Technological complexity
- Uncertainty regarding costs, benefits and public acceptance
- Protection of privacy, security and legal issues
- High data requirement for ITS operations.

3.5 Prioritisation of ITS Investments

It is difficult to prioritise major ITS investments without a meaningful cost-benefit analysis and/or business case. Any measures funded by public sector will need to demonstrate financial benefit.

The nature and extent of impacts of ITS projects is fundamentally different from those of conventional road projects. Evaluation of ITS projects is complicated by the presence of the unique variables affecting the outcomes, which include driver behavioural response and market penetration issues. ITS project evaluation methods must be developed to the same standard as evaluation procedures for conventional transport investment. It is important that the costs and benefits of both ITS and conventional projects are evaluated comprehensively in order to ensure efficient and cost-effective project selection and prioritisation.

Despite the widely promoted anecdotal evidence of the benefits of ITS, the projects with ITS must compete with conventional road projects for funding at the local and national levels of government. It is therefore important that the costs and benefits of both ITS and conventional projects are evaluated comprehensively in order to have efficient and cost-effective project selection and prioritisation

To add further complexity, the same impacts generated by ITS and conventional road projects may be generated by different mechanisms. Vehicle operating costs (VOC), for example, are calculated in existing evaluation methodologies as a function of the average traffic speed, road roughness, terrain and vehicle type whereas an ITS project may reduce VOC by easing traffic flow and reducing the number of vehicle stops. To evaluate ITS with existing road project evaluation processes that exclude or undervalue these impacts would severely understate total project benefits.

3.6 ITS measures identified in the TOR

The TOR identifies a wide range of ITS as deliverables. The table below lists these and includes an overview of their applicability for Bhutan. It is noted that one essential ITS measure not included is Electronic ticketing (eTicketing) - hence this important measure has been included in the scope of the Project.

The short, medium and long term plans will reflect when it will be possible and advisable to introduce a particular ITS measure. Some will first require certain developments, for example, until all urban bus services operate to a schedule there is no point in providing real time information. Also, it will be more practical to stage the implementation of most ITS measures that are justified; possibly starting with a pilot scheme.

Deliverables as per TOR	Application/Purpose
<p><i>24/7 operation control centre</i></p> <p>Such centres can either be a Police Operations Control Centre (CCC) as proposed by the Royal Bhutan Police (RBP) or a Traffic Control Centre (TCC) but preferably operating as a combination of both to ensure a coordinated approach to traffic management and security surveillance.</p>	<p>The purpose of a Traffic Control Centre is to offer a level of monitoring, surveillance and adaptive management meeting requirements of small, medium and large urban agglomerations.</p>
<p><i>CCTV cameras</i></p> <p>As described in Section 3.7.1 below, the RBP is currently in the process of finalising their brief and TOR for the introduction of a Safe City Solution Project which involves a system of CCTV surveillance.</p>	<p>Video monitoring (CCTV) cameras serve as a valuable criminal deterrent and provide video evidence of monitored areas.</p>
<p><i>Speed monitoring cameras</i></p> <p>It is presumed these are to be used to enforce speed limits – the RBP has indicated they would like to employ automatic photo system to reduce contact with drivers as with a small community many drivers and police are related or familiar with each other - this seems to favour the introduction of the point-to-point speed camera system to supplement mobile radars which are in use at present.</p>	<p>There are different types of speed and red light cameras commonly used to deter drivers from driving over the speed limit and disobeying traffic signals. These include:</p> <ul style="list-style-type: none"> - mobile speed cameras - fixed speed cameras - red light cameras - combined red light and speed cameras - point-to-point speed camera systems.
<p><i>Traffic lights at identified junctions</i></p> <p>No road junction has yet to be identified as a candidate for traffic lights. This is primarily because there is no traffic data available to determine whether any can be justified for signalisation.</p>	<p>The Consultant has carried out a joint field survey with RSTA and RBP of the busiest intersections in Thimphu to determine whether there are any likely candidate projects that exist at present. The Norzin Roundabout may be a candidate but it is understood there may be cultural implications.</p>
<p><i>Parking guidance systems and other ITS equipment along the city roads</i></p> <p>It is considered such ITS measures should only be considered in future for the multi-level parking facilities being constructed in Thimphu. Although there will be a need for off-street and on-street information on parking space availability when the multi-level car parks are in operation.</p>	<p>Such a system is primarily used in car parks to improve deterring customers from return visits within a car park. Usually a common problem for complex car parks and sites with high turnover. The solution is to install a series of sensors with integrated signal lights that communicate to drivers where open spaces are located.</p>

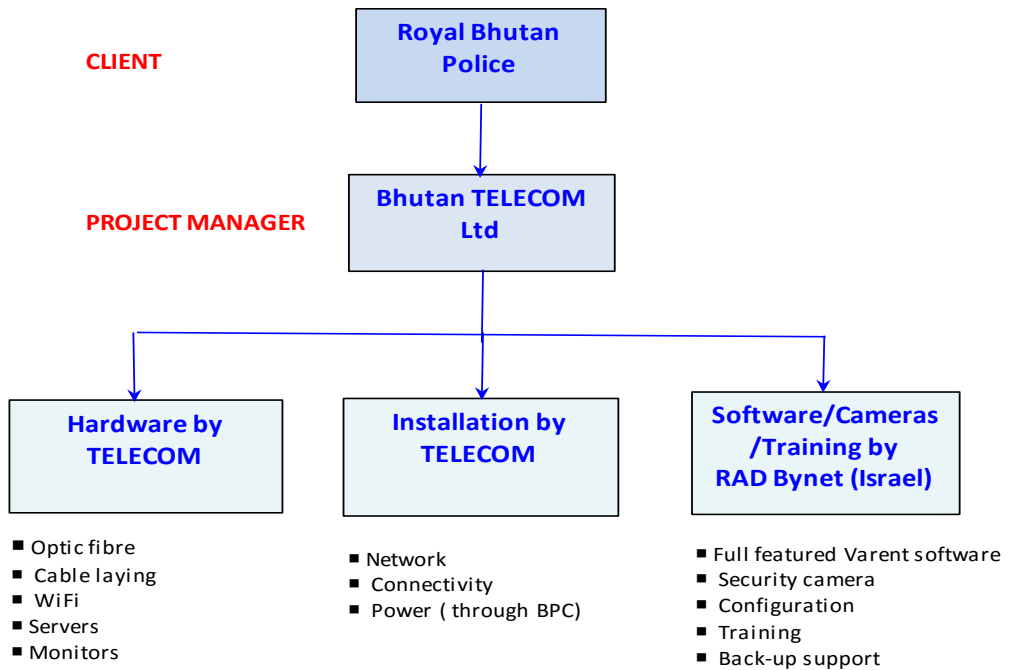
<p><i>Traveller Information Systems (TIS)</i></p> <p>For the purposes of this Project, TIS and BIS (Bus Information System) are synonymous. A trial of BIS for one regional bus operator has already been started by the installation of a GPS tracking device with SIM to relay real time information.</p>	<p>Effective TIS are multimodal and support many categories of drivers and travellers. They apply many technologies to allow customers to receive roadway, transit network, and other information important to their trip.</p>
<p><i>Video incident detection systems</i></p> <p>See CCTV above.</p>	<p>The Safer City Solution Project will have the capability to record video footage of incidents.</p>
<p><i>Weigh-in-motion, virtual weigh stations</i></p> <p>Currently there are 6 weight bridge stations to regulate vehicle overloading but none of these are located north or south of Thimphu.</p>	<p>Virtual Weigh Stations (VWS) are Weigh-In-Motion systems that provide vehicle records for enforcement, traffic surveillance and/or data collection in real-time over a computer network connection to a laptop, tablet, mobile device or workstation computer.</p>
<p><i>Automated vehicle identification systems (AVI)</i></p> <p>The application for AVI as a tool for ITS will be considered for the medium term. Although, Safe City Solution Project will include an AVI capability.</p>	<p>Automatic Vehicle identification (AVI) systems identify, monitor, track and collect data on vehicle movements, enabling better management of a variety of vehicle activities.</p>
<p><i>Road and weather information systems (RWIS) including real time emission recorder/data collectors.</i></p> <p>Such ITS features can only realistically be considered in the long term.</p>	<p>This technology is expensive and has not been adopted worldwide except in a very few places.</p>

3.7 Current ITS-related developments

Currently there are three encouraging, and directly relevant, developments that will facilitate the introduction of ITS in Thimphu, these are described below..

3.7.1 Safe City Initiative

Under this initiative the Government is currently finalising the Terms of Reference for a Safe City Solution Project through the RBP. The scope of this Project involves the installation of CCTV cameras in Thimphu and Vehicle Licence Plate recognition. The RBP will then establish a Security Contact Centre - Command and Control Centre (CCC) in Thimphu City to control and monitor the Thimphu City area. For its implementation of the system, the RBP will work in collaboration with Bhutan Telecom Limited (BTL) as the Project Manager and RAD Bynet from Israel as the software provider and back-up support. The organisation for the implementation of the Project is outlined in the diagram below.



Organisation for the Safe City Project

This is an extremely important development with respect to the launching of ITS as it could provide the platform for “bolt-on” ITS features. Especially, as the software proposed is comprehensive with the capability of including a number of ITS features. This project also incorporates a 24 hour manned Command Control Centre (CCC) which would be capable of including the monitoring of ITS operations. The joint operation of this Centre will need to be explored by RBP and RSTA following identification of possible bolt-on ITS measures.

The Bynet technical team visited Thimphu to conduct a final detailed survey in late April.

3.7.2 Real-Time Bus Information System (BIS)

This initiative is being undertaken by eDruk ICT Consultancy which is a prominent software company based in Thimphu with an office also set up in Phuentsholing. It offers a wide range of ICT solutions directly applicable to ITS. It is fully staffed by well-trained and experienced Bhutanese IT personnel.

Greater Government Support Needed

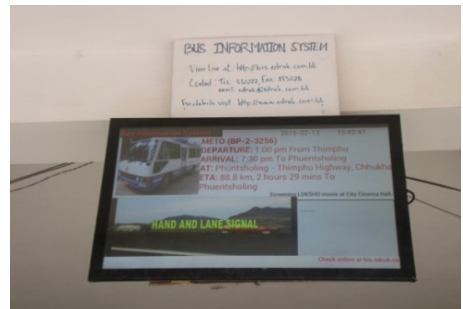
Such private initiatives need to be actively support by Government especially at this crucial trial phase

The company has already set up a Bus Information System (BIS) for one regional bus operator on a trial basis. This provides real-time bus information which is displayed on a monitor located at RSTA’s bus terminal in Thimphu, as shown in the pictures below.

BUS Information System: For 16-10-2014



METO (BP-2-3256)
DEPARTURE: 07:00 From Phuentsholing
ARRIVAL: 13:30 To Thimphu
AT: Lobnekha, Chhukha
ETA: 50.7 km, 1 hour 17 mins To Thimphu



Bus Information display monitor at the RSTA Bus Terminal

The functionality of the system enables it to track the bus in real-time, monitor speed of the bus, location; arrival and departure time. Also, it is capable of alerting, in real-time, the concerned agency if there is a bus accident via Email, SMS, or System alerts and able to record live CCTV camera footage from the bus and monitor from the central control room.

This is a ground-breaking development for Bhutan and a good starting point for the introduction of ITS solutions for public transport. Unfortunately, the system is currently not in operation as the operator seems to believe, quite fairly, that the information may be used negatively by Government and other operators. This is one crucial reason why the Government must make it GPS-fitting compulsory for all Regional Bus Services with a phased implementation. Plans were also underway to add online booking and buying functionality to the system. This cannot proceed without a GPS capability.

3.7.3 Carpark Management in Thimphu City

The Thimphu Thromde initiative to outsource car parking management and parking fee collection provides an excellent opening for the introduction of ITS for car parking. Under PPP, a concession agreement made between the World Bank International Finance Corporation (IFC) and the Thimphu Thromde has been established. This includes the development of multi-level car parks to the north and south of the City. The multi-level car parking for the south is now under construction (shown in the photo below).

Construction underway for multi-level car park to north of Thimphu



3.8 Essential support for non-ITS traffic measures

There are a range of other traffic measures that are of a non-ITS nature but are still part of the solution. These measures which form an integral part of the transport system as a whole includes (naming a few):

- Road signs
- Road markings
- Traffic Engineering
- Warning lights
- Pedestrian crossings
- Dedicated bus and taxi bays
- Bus stop and shelters
- Bus terminals.

Thimphu's congestion issues can be considerably eased by improving traffic management paired with some traffic engineering measures. It is noted that at certain times of the day Norzin Lam becomes a car park, as evident by the photo below. Taxi and private vehicles stop and pick up wherever they want. There are straightforward solutions to this which will significantly improve traffic flow and ease congestion. A number of such significant projects are described in the Short Term Action Plan.

Traffic Management along Norzin Lam



3.9 Existing legal documents related to transport

After consultation with key stakeholders no legal documents presently exist that would be a barrier to ITS implementation. The process was undertaken as part of the TOR. Nevertheless, a necessary legal and regulatory framework needs to be developed in conjunction with the roll-out of ITS. Briefly, the issues that need to be addressed are centred on the following.

- Legal and liability issues associated with ITS equipment and applications (indicating the responsibility of drivers, government regulators, road managers, transport system users and manufacturers of ITS applications) will need to be a key element of the establishment of regulatory and legal frameworks. This includes compliance and enforcement issues as ITS systems create the potential for continuous monitoring of characteristics such as speed, location and distance driven. These issues also need to be taken into account in the development of regulatory frameworks for ITS.
- There are also privacy issues to be considered. Privacy has long been a central issue in the deployment of ITS. This is particularly the case where government agencies seek to use data collected for one purpose in another purpose (in particular, enforcement activities).

4. SHORT, MEDIUM AND LONG TERM ACTION PLAN

4.1 Introduction

The Action Plan identifies a number of key actions or activities that are recommended for implementation over a short, medium and long term. The short-term plan starts with the remaining 3 years i.e 2015-2018 of the Governments 11th Five Year Plan, the medium term corresponding with the 12th Five Year Plan for the period 2018-2023, and the long-term extends beyond 2023.

This Plan can serve as a roadmap for the staged and systematic implementation of actions needed to improve the traffic and transport situation in Thimphu and eventually other urban areas. Obviously, this list of actions proposed is not limited. It should be a dynamic plan to be reviewed and updated on a regular basis to ensure it continues to reflect key changes in technology, policy directions and stakeholder input. Furthermore, the timing of each action is indicative as it is dependent on many factors, especially the availability of funds.

Hopefully, the Action Plan developed in this study will be approved by Government and used as a mandate for implementation.

Some of the specific actions will not require funding such as those that are of a policy and institutional nature, however, any investment in traffic engineering and ITS will require considerable investment in addition to those barriers mentioned in Section 3.4 above. This means that the recommended Action Plan is largely dependent on the level of funds forthcoming.

Rather than waiting until sufficient funds are available for the roll out of a complete system or infrastructure requirements over the entire road network, the Project has adopted a strategy of incremental development, and where appropriate, using pilot projects to “showcase” each initiatives, for instance - the phased roll-out of fully integrated bus stops as per the guidelines outlined in Appendix A. Once the public and advocacy groups³ see and experience the benefits of such enhancement to their transport system, there will be a greater impetus to accelerate the roll-out.

LACK OF FUNDS A MAJOR BARRIER

Any investment in traffic engineering and ITS will require considerable investment. This means that the recommended Action Plan is largely dependent on what level of funds is forthcoming

³ Also referred to as pressure groups, lobby groups, campaign groups, interest groups, or special interest groups.

Start-up projects/initiatives

In addition to the preparation of a short, medium and long term Action Plan, a list of start-up projects/initiatives for which funding is available or do not involve funding was also developed. The list was prepared in discussions with UNDP and MOIC and was presented to the high level Stakeholders Presentation on 2 July 2015 in Thimphu where it received support and endorsement.

List of start-up projects/initiatives

1. Urban Transport Policy Plan for Thimphu
2. CCTV at bus terminals at Thimphu and Phuentsholing and on all CBS's Green Buses
3. Provision of 1 or 2 Integrated/functional Bus Stops
4. Pilot eTicketing one of CBS's bus routes
5. Bus Stop Signs with Bus Timetable housed in small metal enclosures
6. Re-organisation of traffic in Norzin Lam including bus bays for northern routes, taxi rank, line marking and pedestrian crossing with flashing warning lights centrally located to improve traffic flow, road safety and to facilitate a change in pedestrian and motorist behaviour
7. Development of a Bus Timetable APP for CBS
8. Compulsory GPS on all Regional Bus Services with phased implementation
9. Development of an APP for live bus location information system starting with the Thimphu–Paro and Thimphu–Phuentsholing region bus routes
10. Government to make formal application to AusAid for recruitment of Transport specialist as a volunteer to be attached to CBS
11. Short term consultancy assistance to develop a Transformation Plan for CBS
12. Increase parking fees in Norzin Lam and Chang Lam

4.2 Short Term Action Plan – 2015 to 2018

Indicative Timing	General Activity	Specific Projects/Actions	Lead Agency
<i>Institutional and Policy Initiatives</i>			
For Immediate Action 2015 See Note 1	<ul style="list-style-type: none"> Establish an appropriate Institutional Framework to guide and oversee the implementation of the Action Plan 	<ul style="list-style-type: none"> Establishment of a high-level Government Transport Working Group (TWG) to oversee the implementation of this Action Plan The TWG should first concentrate on tackling traffic engineering improvements, public transport initiatives and congestion management 	MOIC
Starting ASAP 2015	<ul style="list-style-type: none"> RBP, BTL, Thimphu Thromde (TT) and RSTA to identify appropriate bolt-on ITS measures to the Safe City Project RSTA needs to upscale its knowledge of ITS appropriate for Bhutan (inhibited by a lack of resources and expertise in traffic and transport engineering and planning) 	<ul style="list-style-type: none"> RSTA to nominate a person as the focal person for ITS issues RSTA and RBP to formulate a joint operational plan for the proposed CCC (Central Control Centre) 	RSTA RSTA, RBP

Start-up project 2015 See Note 2	<ul style="list-style-type: none"> Urban Transport Policy Plan for Thimphu 	<ul style="list-style-type: none"> This is one of the start-up projects/initiatives which could be undertaken as short term consultancy, which could be achieved with a 30/45 day input 	MOIC
On-going 2016-2018 See Note 3	<ul style="list-style-type: none"> Raise Community Awareness and Government Support 	<ul style="list-style-type: none"> Starting in 2016, develop a Communication Plan and mechanism of information dissemination so that users will embrace ITS developments 	MOIC, RBP
2016 Ongoing	<ul style="list-style-type: none"> Training in Traffic Engineering and Management, Public Transport and ITS development and operation 	<ul style="list-style-type: none"> On-the job training Formal overseas studies to “kick-in” during medium term plan 	MOIC, RCSC
2015 See Note 4	<ul style="list-style-type: none"> Seek a Government mandate to implement, all or parts, this Action Plan 		MOIC, TWG
2015 – 2018	<ul style="list-style-type: none"> Implement smart congestion reduction strategies for Thimphu along the lines proposed in Section 2.3 above 	<ul style="list-style-type: none"> Promote modal shift to public transport Promote walking and cycling Establish road user hierarchy Improve traffic management – including enforcement Update traffic regulations Improve land use planning implementation 	TT, MOIC TT, RBP RSTA DoHS
2015 – 2018 See Note 5	<ul style="list-style-type: none"> Source funding to implement signature and pilot projects 	<ul style="list-style-type: none"> Government to assess scope for increasing user pay opportunities Alternatively, TWG to recommend the introduction of user charges to fund public transport and pedestrian facilities or to levy an increase in existing transport-related charges TWG to prioritise projects and facilitate the sourcing of funds 	TWG, MOIC, MoF, TT
2015	<ul style="list-style-type: none"> Roads Department and local authorities incorporate bus bays in any new road works (including upgrading and rehabilitation works) 	<ul style="list-style-type: none"> MOIC may be best to initiate the adoption of this policy proposal 	MOIC, TT
2016-2018 Ongoing See Note 6	<ul style="list-style-type: none"> Improve driver training and behaviour 	<ul style="list-style-type: none"> RSTA to prepare a submission to Government for funding for essential needs 	RSTA
Starting ASAP See Note 7	<ul style="list-style-type: none"> Support to City Bus Services 	<ul style="list-style-type: none"> Short term consultancy assistance to develop Transformation Plan for CBS Government to make formal application to AusAid for recruitment of Transport Specialist as a volunteer These are two of the start-up projects/initiatives 	BP, MOIC
<i>Local Procurement and Government Procurement Policies and Regulations</i>			
2015-2018 Ongoing See Note 8	<ul style="list-style-type: none"> Promote procurement from local suppliers for goods and services as there is considerable, and increasing, in-country ITS capability 	<ul style="list-style-type: none"> Tenders broken down to smaller and manageable components so that local vendors and developers are engaged 	MoF
2016 See Note 9	<ul style="list-style-type: none"> Existing Government procurement policies and regulations are not necessarily suited to ITS procurement and certain transport equipment (especially those with insufficient in-country expertise to draft a performance oriented technical specification) 	<ul style="list-style-type: none"> TWG hold discussions with the Ministry of Finance on how the Procurement Rules and Regulations dated 2009 can be applied to better reflect life-cycle costing 	MoF

Public-Private Partnership for Urban Bus Transport in Thimphu			
Ongoing See Note 10	<ul style="list-style-type: none"> ▪ Explore possible PPP arrangements to establish certain ITS initiatives ▪ Explore alternative models of asset ownership, such as private finance initiatives and such other public-private partnership 	<ul style="list-style-type: none"> ▪ Possible privatisation of urban transport services in Thimphu under a PPP arrangement. This can be achieved on an incremental basis under a performance based contract ▪ Commission a Consultant to prepare a performance based contract for operation of urban bus routes 	BP, MOIC, MoF BP/ CBS, RSTA
Congestion Management			
2015 – 2020 See Note 11	<ul style="list-style-type: none"> ▪ TWG to oversee the implementation of a Congestion Reduction Strategy for Thimphu City 	<ul style="list-style-type: none"> ▪ This should be a joint effort with RSTA and Thimphu Thromde 	TT, RSTA
2015 See Note 12	<ul style="list-style-type: none"> ▪ Increase parking fees along Norzin Lam and Chang Lam 	<ul style="list-style-type: none"> ▪ This is one of the start-up projects/initiatives 	TT
Public Transport Fare Collection			
2016	<ul style="list-style-type: none"> ▪ Undertake a business case study for a mixed eTicketing System for Regional Buses Services 	<ul style="list-style-type: none"> ▪ This could be a joint effort with a Bhutanese IT Company and the Government – the cost of implementing eTicketing system would be borne by individual bus operators 	BP, RSTA
Traffic Engineering			
2016-2017 See Section 2.3 Re: Traffic Management	<ul style="list-style-type: none"> ▪ Prepare a Local Area Traffic Management Plan which needs to include the Bus Network and Circulation Plan for the whole City and dedicated Taxi parking space for taxis among other things 	<ul style="list-style-type: none"> ▪ This should be a joint effort with RSTA and Thimphu Thromde 	TT, RSTA
2016 See Note 13	<ul style="list-style-type: none"> ▪ Establish designated bus stops after placing new bus stop signs ▪ Put up bus bays and bus shelters at selected locations 	<ul style="list-style-type: none"> ▪ In conjunction with the three urban bus operators in Thimphu, RSTA and Thimphu Thromde to review current bus stop locations and determine the number and location for each bus route in Thimphu 	TT, BP RSTA
2016 See Note 14	<ul style="list-style-type: none"> ▪ Establish a Bus Stand in Norzin Lam 		TT, BP/ CBS
2016 See Note 14	<ul style="list-style-type: none"> ▪ Upgrade the Thimphu City Bus Stand located off Chang Lam 		TT
ITS Measures (and provision of electronic traffic devices)			
2016	<ul style="list-style-type: none"> ▪ Compulsory GPS on all Regional Bus Services with phased implementation 	<ul style="list-style-type: none"> ▪ This is to create a level playing field 	RSTA
2016	<ul style="list-style-type: none"> ▪ Development of an APP for live bus location information system starting with the Thimphu–Paro and Thimphu–Phuentsholing region bus routes 	<ul style="list-style-type: none"> ▪ Use local IT company such as Scan Bhutan 	RSTA
2015-2016 See Note 15	<ul style="list-style-type: none"> ▪ Install CCTV cameras in the City Centre, RSTA bus terminal and major road junctions 	<ul style="list-style-type: none"> ▪ This project is being implemented by the Royal Bhutan Police 	RBP
2015-2016 See Note 16	<ul style="list-style-type: none"> ▪ Establish a 24/7 operation control centre 		RBP
2016 See Note 17	<ul style="list-style-type: none"> ▪ Install CCTV cameras to monitor driver testing and security surveillance at the Phuentsholing Bus Terminal 		RSTA
2016-2020 See Note 18	<ul style="list-style-type: none"> ▪ Extend current BIS on Regional bus services 	<ul style="list-style-type: none"> ▪ Use local IT company such as eDruk 	RSTA
2016 See Note 18	<ul style="list-style-type: none"> ▪ Pilot Bus Information System (BIS) on City Bus Services 	<ul style="list-style-type: none"> ▪ Use local IT company such as eDruk 	BP/ CBS
2016-2017 See Note 19	<ul style="list-style-type: none"> ▪ Establish first stage of eTicketing System for Regional Bus Services 	<ul style="list-style-type: none"> ▪ Use local IT company such as eDruk 	RSTA

Late 2018	<ul style="list-style-type: none"> ▪ Automation of multi-level car parks 	<ul style="list-style-type: none"> ▪ The timing is dependent on the completion of the multi-level car parks 	TT
2016 See Note 20	<ul style="list-style-type: none"> ▪ Install Pedestrian flashing warning lights on Norzin Lam 	<ul style="list-style-type: none"> ▪ This is to include a speed hump and sensors 	TT
2016 See Note 21	<ul style="list-style-type: none"> ▪ Evaluate justification for Traffic Signals at busy intersections 	<ul style="list-style-type: none"> ▪ RSTA and Thimphu Thromde to prioritise intersections and organise intersection traffic counts at top 5 rated intersections 	RSTA/ TT
2016 See Note 22	<ul style="list-style-type: none"> ▪ Evaluate the justification for Traffic Signals on Norzin Lam 		RSTA, TT
2016-2017 See Note 23	<ul style="list-style-type: none"> ▪ Carry out a pre-feasibility Study for the introduction of Weigh-in-Motion Stations 		RSTA

Note 1 – Institutional Framework

As current arrangements and information flow between stakeholders on transport issues seems irregular, an appropriate institutional framework needs to be established to steer and drive the implementation of this Action Plan.

Drastic measures are required to reform and strengthen the existing institutions responsible for transport. Most would call for the establishment of new institutions, such as an Urban Transport Authority. By doing this there is a real danger of conflict with, and/or duplication of established arrangements. Sometimes it may be necessary to let new institutions evolve within a framework of a complete package of reform. Transition needs to be carefully sequenced. New authorities can be top heavy, political and have a Board of Directors who fail to “add value”.

As a general rule, it is more effective and sustainable to build capacity within an existing institution rather than establishing a new organisation. However, there are clear exceptions especially where there is commercial motivation, and consequently, good economic reason for franchising, corporatisation or privatisation of activities; such as, the establishment of a BRT.

For Bhutan, it is recommended that a high level Transport Working Group (TWG) be established among other things :

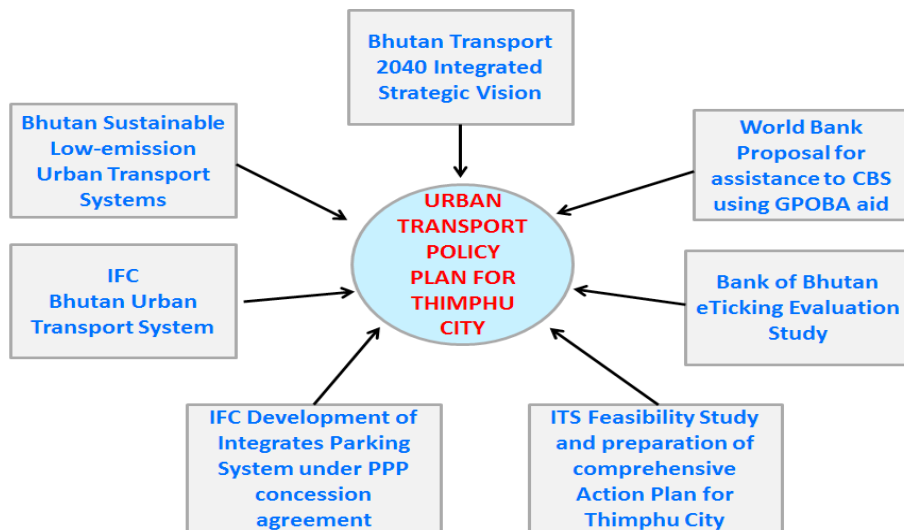
- Prioritise actions
- Coordinate activities
- Develop and implement transport policies
- Obtain Government endorsements
- Facilitate funding for transport projects.

Note 2 – Urban Transport Policy Plan for Thimphu

This ITS Project is happening within a policy vacuum as no Urban Transport Policy Plan exists at present. As shown in the diagram below, there are a number of studies that are relevant to Urban Transport in Thimphu. It is recommended that these, and other Government policies and initiatives, be distilled to form an Urban Transport Policy Plan for Thimphu.

Such a Policy Plan will set the direction for the re-organisation and improvement of transport in the capital. Also, importantly a clear and comprehensive policy will assist the political leadership to see all transport initiatives within the context of a rational set of objectives.

This is one of the start-up projects/initiatives which could be undertaken as short term consultancy, and which, could be achieved within few months of consultancy input.



Note 3 – Public awareness

The community’s present level of awareness and decision-making of the current and potential benefits of ITS investments has not yet evolved. Concerns over issues such as protection of privacy will emerge once awareness of the potential use of ITS technologies spread. Support with Government commitment is key to facilitating new ITS initiatives.

Note 4 – Government mandate of the Action Plan

A lot of good ideas and proposals on addressing traffic congestion, urban transport and ITS measures are floating around. A government position needs to be established to move these forward in a structured and realistic manner. This will enable implementation with a clear definition on an agreed approach s in “who is responsible for what”. The first step in this process is to seek a mandate from Government to implement, all or parts, of this Action Plan.

Note 5 – Securing funding for public transport, pedestrian facilities and traffic Engineering measures

Funding provided for public transport, pedestrian facilities and traffic engineering is bare minimum compared to funding provided for roads. This needs to be addressed as it adversely affects traffic performance, road safety, the environment and liveability of larger urban areas of Bhutan.

It is recommended that some form of creative funding scheme be established by the Government to fund the areas with compelling needs rather than relying on Local Governments in the urban centres. After all, the larger urban centres are the major generators of economic activities in Bhutan.

The introduction of new road user charges except for parking may be limited especially as the current road network is not configured to accommodate toll roads. This leaves few alternatives other than some form of cross-subsidy such as; a surcharge on fuel or a levy on vehicle registration.

Note 6 – Driver training

The general lack of knowledge on road rules, and poor driving practices among drivers reduces the effectiveness of any ITS measure employed to improve traffic flow and congestion.

Efforts are on from respective authorities and relevant quarters but multiple issues stand as hurdles. Some of them are:

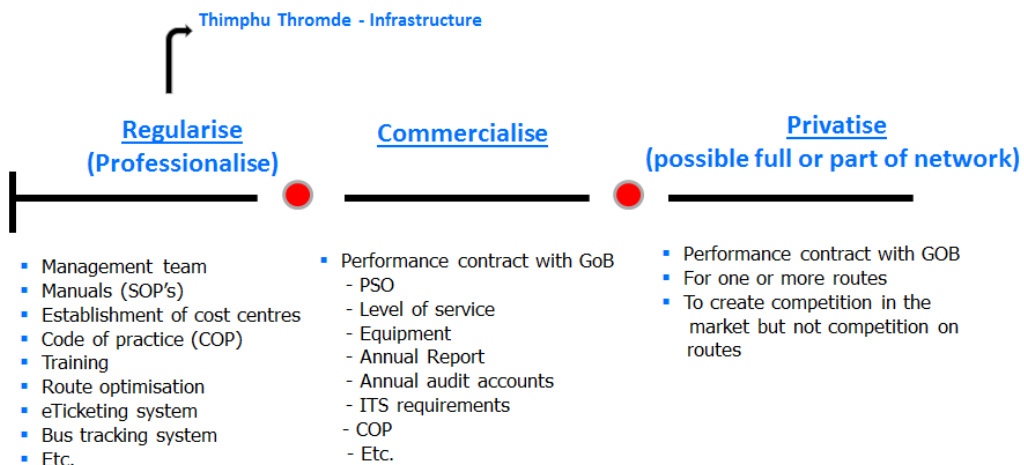
- (a) Highway Code
- (b) RSTA does not have sufficient capacity and funds to improve driver training
- (c) Inadequate driving instructors in driving institutes
- (d) Lack of proper facilities⁴ in driving institutes such as dedicated space for driving practice
- (e) Lack of funds for Training of Trainers (ToT)

This ITS Project should support the development of a manual for traffic signs, signals and road marking standards. It should encourage production of training materials such as videos, updated manuals or new manuals for driving standards for learners, drivers, instructors, RSTA officials and Traffic Officers.

Note 7 – Support to City Bus Services (the Company)

The need to regularise or professionalise the company is foremost with all the prevailing developments involving possible support and changing the ownership of the company. The process of changing ownership/control will take considerable time especially, without support from development partners and funding from International assistance. All the same, regularisation and professionalization of the CBS is urgently required and should not be deferred under any circumstances. This will enable the phased transformation of the Company. What is required is depicted in the following Transformation diagram. The first stage will take a number of years with the support of an international transport expert.

⁴ Currently people learn driving along the highways and other open spaces. There is a need to come out with at least 1-2 proper driving grounds in all the 20 districts with all required facilities such as sealed pavements, pavement line markings, signs and signals, etc. and of course qualified trainers. There are around 14 private driving training institutes and 1 Government Vocational Training Institute in the country. There is huge room for improvement and to professionalise the management and operation of the institutes.



Transformation Plan for City Bus Service

Note 8 - Local procurement

The cost of software and systems support from overseas is costly and cannot always provide adequate response time. Therefore, local software companies should be used as much as possible. It will also build their skills for future ITS projects and updates to systems.

Unless local expertise is not available employing costly vendors from outside should be avoided. There are well trained and experienced Bhutanese IT personnel in the private sector to participate in ITS development. Primarily, this requires tenders to be broken down to small and manageable components. .

Note 9 – Government procurement policies and regulations

Very often, a public procurement model does not deliver the best value for tax payers' money. Same could be said about the existing Government procurement regulations where the lowest price bid predominates. This would be case especially with speciality goods and services of a technical nature. A procurement process must emphasize quality and establish performance as well as price. Awarding a contract primarily on the basis of lowest price creates a false economy, if there is subsequent default or unsatisfactory performance. This can be avoided by adopting life-cycle costing (LCC). Making a decision on the basis of LCC however may mean paying more upfront.

A general appreciation for LCC is critical to change the procurement and public sector budgeting mindset from “the best value for money” to the “best value across the asset life-cycle.”

LCC can be feasibly applied to most categories of products and services except software. LCC should be part of public expenditure policy - including procurement policy - and thereby should be integrated into sustainable public procurement policies. LCC, or whole life value thinking, will then be an integral part of the resource allocation process. Since resource allocation and budget setting is undertaken at a much higher level in the

organization than routine procurement decision-making, “whole life value thinking” will begin to permeate all public spending decisions.

In addition, alternative models of asset ownership such as, private finance initiatives and other forms of public-private partnerships need to be explored to provide more efficient models for delivering LCC efficient public procurement.

Note 10 – Public-Private Partnership for urban bus services in Thimphu

Deployment of ITS is limited by budget in most areas of government worldwide. Nevertheless, private sector involvement in many aspects of transport is increasing, such as new toll roads and operation of public transport. Public-private partnerships provide an opportunity to pool resources to introduce ITS quicker than it would otherwise come about. These partnerships need to address wider strategies to ITS systems developed for particular components of the transport system, are able to exchange and make use of information, and readily capable of being inter-connected.

The way forward in Thimphu is to establish an appropriate PPP arrangement to bring about fundamental changes to the organization of the public transport system. This can be readily achieved by Government entering into a Performance Contract with private bus companies for specific routes, even if it is one route at a time.

A performance contract will provide a mechanism for transport operators/companies to start putting more emphasis on improving passenger service as satisfaction of the customer is the key to their existence. As in many countries, the public transport market has been opened up to competition and the awarding of public transport contracts now takes place through tenders instead of the previous monopoly situations.

The solution to managing public transport relies on properly defining the roles and responsibilities of government and bus operators. As demonstrated in the table below, most of the risk being carried by bus operators is out of their control, causing a severe negative impact on service levels as they struggle to survive. It shows that operators in fact, carry all the risk but can manage only a small part. In any business, success depends on the ability to manage or deal with risks. In the case of a bus operator, the reasons for failure are obvious. Any proposed business model for bus operators must address the risk issue.

Risk profile between players in urban bus operations

Controlled by Operators	Controlled by Government
<ul style="list-style-type: none"> • Customer service 	<ul style="list-style-type: none"> • Rules of engagement
<ul style="list-style-type: none"> • Bus operation 	<ul style="list-style-type: none"> • Fare levels
<ul style="list-style-type: none"> • Spending decisions 	<ul style="list-style-type: none"> • Competition levels
<ul style="list-style-type: none"> • Revenue collection 	<ul style="list-style-type: none"> • Route planning
Controlled by Market forces	<ul style="list-style-type: none"> • Roads and infrastructure
<ul style="list-style-type: none"> • Fuel cost 	<ul style="list-style-type: none"> • Traffic management
<ul style="list-style-type: none"> • Cost of finance 	<ul style="list-style-type: none"> • Road works
<ul style="list-style-type: none"> • Cost of buses 	<ul style="list-style-type: none"> • Land use planning
<ul style="list-style-type: none"> • Cost of spare parts and repairs 	<ul style="list-style-type: none"> • System promotion and marketing
<ul style="list-style-type: none"> • Wage levels 	Dictated by external factors
	<ul style="list-style-type: none"> ▪ Traffic congestion

When operators are faced with financial deficits or marginal profits, their natural survival response is to cut costs. The result is a decline in service delivery to the citizens of Thimphu. The impact of the operator's unsustainable business model feeds directly into a severe Negative Quality Cycle as shown in the figure. Declining quality of bus services assists to stimulate greater dependence on private car use and thus creates more traffic congestion. This then impacts further on the bus operator's financial viability as buses stuck in traffic do not generate income. This increases business risk and reduces the ability to invest in new bus fleets, further affecting service quality.

The result of this negative spiral is increasing pressure for government support and thus ultimately the cost will be borne by government; not only to financially support the ailing bus industry but also to invest scarce resources into the increasing demand for traffic infrastructure. When government is forced into a spending program for roads and traffic infrastructure it will divert funds from other priority areas and deprive essential social programs of funding. However road infrastructure will not solve the traffic crisis as more road space generates more car use. Ultimately the quality of city life will be degraded through poor air quality, noise, low mobility and urban degradation.



Source: 'Bus Rapid Transit Planning Guide' (Institute for Transportation & Development Policy, 2007)

Note 11 - Congestion reduction strategy

As outlined in Section 2.3 above, a congestion reduction strategy is needed for Thimphu to:

- Achieve a modal shift to public transport
- Promote walking and cycling supported by better facilities
- Implement a range of traffic engineering improvements and traffic management initiatives
- Improve land use planning and enforcement of existing regulations
- Update traffic regulations.

Note 12 - Increase parking fees along Norzin Lam and Chang Lam

Parking fees along Norzin Lam and Chang Lam should be increased to reduce demand for long term stays and reflect its prime location. This requires the designation of parking zones which need to be mapped and supported by an awareness campaign to inform motorists. Furthermore, an App can readily be developed to show the different zones via mobile phone.

Note 13 – Provision of bus stops and supporting facilities

The current situation is quite dire, as:

- Buses are operating like taxis by picking and dropping off passengers wherever the passenger desire; in particular:
 - there are too many stops at undesignated bus stops
 - the distance between stops is very short
 - passengers are not willing to walk to the nearest bus stop
 - buses stop on demand often at unsafe locations such as bends, intersections
 - buses stop within the road carriageway often blocking traffic
- Designated bus stops are either unsigned or poorly marked
- There are few bus bays or bus shelters and no basic shelter furniture.

The first task is to establish designated bus stops by putting in place new bus stop signs, bus bays and shelters at selective locations. It will then be necessary too for bus operators to adhere to designated stops to enable the establishment of real-time Bus Information System (BIS). This will also improve the overall efficiency of operations and instil a level of discipline in passenger behaviour.

A bus bay must be functional, comfortable, safe and aesthetic. The bus shelter should not be designed in isolation to the entire facility. A fully functional facility would usually incorporate:

- A paved and curbed indented bus bay with bus door stopping position
- Bus shelter should be integrated facilities, preferably comprising
 - prefabricated (sourced overseas)
 - aluminium or stainless steel structure
 - aesthetic design with local Bhutanese badging bolted-on
 - adequate seating
 - provide some shelter from the weather
- Lighting
- Notice board or real-time information display unit
- Rubbish receptacle
- Signing
- Landscaping.

There is no valid reason why bus bays at key points should not be provided. In economy terms, the full potential of the investment on roads will not be realized if buses stop and block one or more traffic lanes.

A Technical Information Paper on Design Elements for Bus Stops and Shelters is provided as Appendix A. This provides more information for bus stop requirements, as a complete package, including provision to accommodate ITS.

Note 14 – Establishment of a Bus Stand in Norzin Lam and upgrading the current Thimphu City Bus Stand

Authorities need to give greater priority to pedestrians and public transport in central Thimphu as a national policy. This will put pressure on private vehicles and taxis when parking and dropping-off in Norzin Lam, although once the multi-level car parks are in operation there should be a reduction in parking demand in Norzin Lam.

It is recommended that bus operations in the City are reorganised including the provision of additional dedicated taxi drop-off and pick-up lanes. In the most crucial areas in the City this can be achieved by upgrading the current Thimphu City Bus Stand located off Chang Lam and establishing a new and additional Bus Stand in Norzin Lam.

City Bus Stand located off Chang Lam



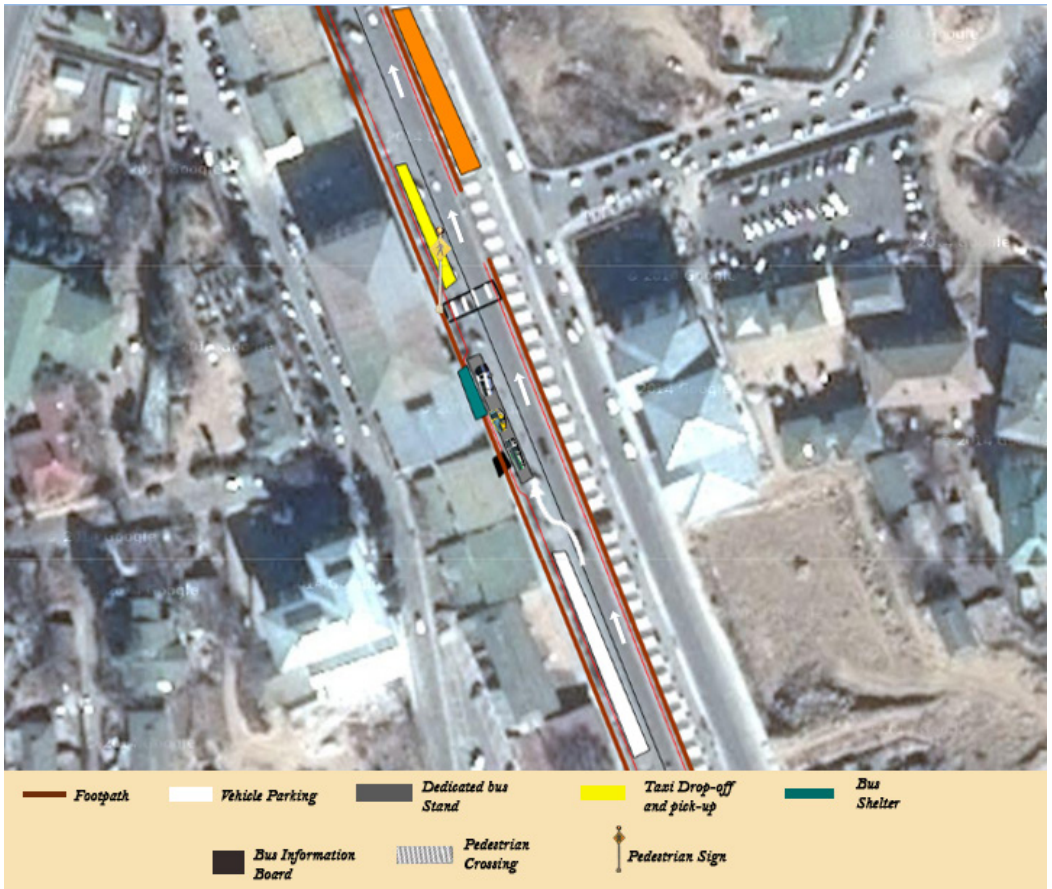
Pedestrian Traffic to and from Norzin Lam

Passenger waiting area at bus terminal



This would free up space and allow a split of the Northern and Western bus routes currently operating out of the current City Bus Stand by relocating the Northern routes to Norzin Lam as shown on the layout diagram below, including the integration of Lama Transport Services.

This will also reduce the pedestrian traffic presently crossing Norzin Lam to catch a bus, improve convenience for bus passengers, and relieve congestion at the current City Bus Stand. It will also indicate that authorities are serious about improving public bus services. Such an initiative will start putting some system in downtown traffic and improve the integration of transport modes.



The relocation of bus terminal for Northern routes to Norzin Lam supported with a designated taxi drop-off and pick-up zone and pedestrian crossing with flash amber warning lights

The proposal includes a pedestrian crossing installed with flashing amber warning lights – see Note 20 below(pg 41).

Note 15 - Installation of CCTV cameras in the City Centre

As described in Section 3.7.1, the Royal Bhutan Police are currently in the process of finalising their brief and TOR for the introduction of a Safe City Solution Project.

There are calls for the system to be extended to cover major road junctions, bus terminals and a number of key commercial buildings within the City to provide an integrated surveillance system.

CCTV systems are capable of recording events as they happen (DVR) providing indisputable evidence should an intrusion, vandalism or a theft occur.

PTZ (Pan Tilt Zoom) cameras gives remote surveillance capabilities, being able to move the camera up, down, left and right as well as zooming functions to pinpoint areas of interest.

Cameras allow functioning and recording in complete darkness, while you are able to view and record as if it were daylight.

The system can be configured for activation when motion is detected, to capture any motion and create an event as it happens. It can also include vehicle plate recognition which can display a car's number plate even when vehicles are moving over 100Km/h – day or night.

Note 16 - Establishment of a 24/7 Operation Control Centre

As part of Safe City Project the RBP proposes to establish a Police CCTV Operations Control Centre. This means there is no justification in establishing a separate Traffic Control Centre (TCC). What should happen is to establish a joint control centre to ensure a coordinated approach between traffic management and security surveillance.

The basic principle of TCC centres is the comprehensive monitoring and control of light signalling system of all intersections (when such are installed) to ensure relevant traffic flow. An integral part of the system is a preference of Public Transport vehicles and Integrated Rescue System vehicles.

A CCC/TCC should have the facility for road users to report traffic incidents or road hazards 24 hours a day by calling the Incident Reporting Line.

Note 17 – Provision of Monitoring and Security Camera at the Phuentsholing Bus Terminal

During the consultation meeting in Phuentsholing on 17 and 18 April, discussions with RSTA Base In-Charge Officer and other RSTA officials, identified the need for cameras to monitor driver training operations. The cameras could also be used for overall security surveillance, monitoring bus operations (using an additional roof-top camera) and monitoring ticketing counter operations (using a smaller camera inside the ticketing area). An image of such external cameras and proposed location for the cameras is shown below.

These cameras, as shown in the image below, are readily available in Bhutan as they are being installed on other sites. The cameras have the capability to tilt, pan, zoom, relay and record, including night vision.



**Proposed roof top
camera locations at
Phuentsholing Bus Terminal**

The cost and system requirement for such provisions is provided in Section 5 below.

Note 18 - Introduction of a Bus Information System (BIS) and Variable Message Signs

For the purpose of this Project, Traveller Information System (TIS) and Bus Information System (BIS) are synonymous.

Effective traveller information systems are multimodal and support many categories of drivers and travellers. They apply many technologies to allow customers to receive roadway, transit network, and other information important to their trip. This information assists the customers in selecting their mode of travel (car, train, bus, etc.), route and departure time. Bus schedule and status information may be obtained from Bus Management Systems. Most of the roadway-based information is collected by surveillance equipment (vehicle detectors, cameras, automated vehicle location systems) and is processed by computers

in transportation management centres for further distribution to traveller information systems. Other information used in a traveller information system may be static in nature, such as; map databases, emergency services information, and information on motorist services and tourist attractions and services. The technologies for requesting, receiving, and interacting with all of this information can be based in the home, office, passenger vehicle, commercial vehicle, transit vehicle, public transit station, or in the case of personal communication devices, can travel with a person.

Recent advances in AVL systems based on the global positioning system (GPS) have provided public transport operators with tools to monitor and control the operation of their vehicles and manage their fleets in an efficient and cost effective way. It can also assist to improve service by increasing schedule adherence and enabling agencies to easily monitor bus driver performance. AVL also helps to reduce response time to operational problems by improving communication between bus drivers and dispatchers. Dispatchers can handle communication with and monitoring of a greater volume of vehicles. AVL also aids in planning by collecting better historical data.

There are a number of fundamental elements that go into building an AVL. The required technology components are depicted in the following diagram.



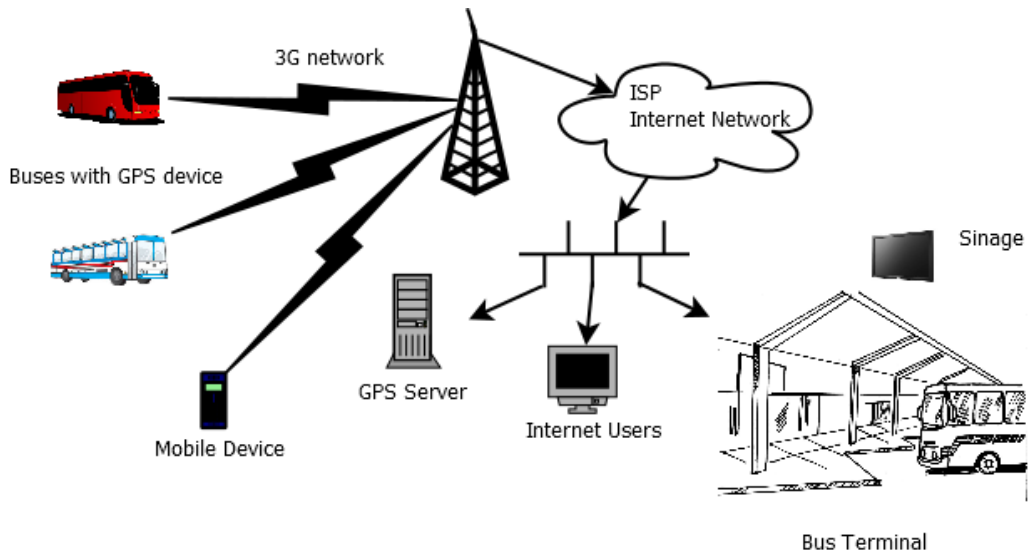
1. An integrated GPS device on each bus to collect real-time bus location data as it relates to the schedule, and send it to the office.
2. A wireless network to send the data from the buses over to the office.
3. Automatic Vehicle Location (AVL) software in the office to make sense of all the data and output it in a user/ developer-friendly format.

The goal of any transit agency is to provide efficient, reliable service to their riders. For this to occur, information about an agency's service must be effectively distributed to the public.

Lack of appropriate information system for transportation, particularly for passengers who use public transport, specifically buses for commuting, causes considerable anxiety among the commuter. Passengers wait for long time at the bus terminus expecting the bus to arrive as per schedule. At present there is no such Bus Information System (BIS) in place in Thimphu for the benefit of passengers. Although, a trial of BIS for one regional bus operator has already been installed using a GPS tracking device with SIM to relay real-time information.

The functionality of a BIS enables it to track the bus on real-time, monitor the speed of the bus, its location, the arrival and departure time and helps passengers with effective transit decision. Also, it is capable of alerting, in real time, the concerned bus agency if there is a bus accident via Email, SMS, or System alerts and able to record live CCTV camera footage from the bus and monitor from the central control room.

There are a number of fundamental elements that go into building a passenger information system. The required technology components are shown in the following diagram.



With these elements in place, passenger information system technologies work to distribute bus status and location information to riders. Bus operators can decide which combination of methods would best serve their riders and fits within their budget

A common way of getting information to passengers is through the use of LED wayside signs. Such signs stand at a bus stop or terminals and inform passengers of the Estimated Time of Departure of upcoming vehicles. They are a useful way for bus operators to dynamically manage and distribute their information. In addition to providing passengers upcoming bus departure times, they can also provide information such as time, temperature and news updates.

LED signs use the real-time data generated by the AVL software to tell riders when buses are expected. It is important for bus operators to look at the pros and cons of installing wayside signs to get a better idea if it is a right fit for their operation.

LED wayside signs are expensive, and may not fit within every agency's budget. It's not just the signs themselves that are expensive; the up-front costs of installing wayside signs, like construction and power, are high as well.

Due to the cost, LED wayside signs are not usually put up at all bus stops. They are usually installed at main terminals or bus centres instead.

Whereas the cost with setting each bus with AVL system is low as all that is needed is a GPS at US\$ 150 and WIFI connection device at about US\$ 100.

Variable message signs (VMS) are now common place across larger towns and cities. While these may be considered to be a tool for delivering travel information to the roadside they are also a valuable traffic management tool. VMS can be used to inform and direct drivers of problems and incidents as they occur, reducing their impact on the highway network. VMS can also be used to inform about specific reduction in capacity in the network; e.g. when an incident makes it necessary to give priority to public transport or a major event (sports, exhibition or others).

Note 19 - Electronic Ticketing System

Fare leakage is a common problem throughout the world wherever cash collection system prevails. Among other things, this calls for introduction of an appropriate form like electronic ticketing as an ITS measure.

In Bhutan fare leakage in urban public transport is widespread and deeply rooted - and largely uncontrolled. This calls for bus operators to make urgent changes to the current collection system. A study supported by the World Bank to the City Bus service estimated that fare leakage is in the order of 30%. Experience in other countries would suggest this may well be a conservative figure. Hopefully, the Government leads the way in facilitating change by strongly supporting the introduction of eticketing, as proposed herein.

This solution is to change the fare media from the present cash collection to electronic ticketing. This will make bus operators more viable and give them greater financial ability to improve services and invest in modern buses and systems. The fare media path is shown below.



Progression of Fare Media

Ideally, the ultimate fare media is the use of Smart Cards, as it offers:

- Secure data transfer
- No physical connection required for contactless applications
- Larger memory capacity
- Can perform complex security validation calculations (microprocessor card)
- Highly reliable
- High resistance to fraud.

EVOLUTION OF E-PAYMENTS IN PUBLIC TRANSPORT SINGAPORE'S EXPERIENCE

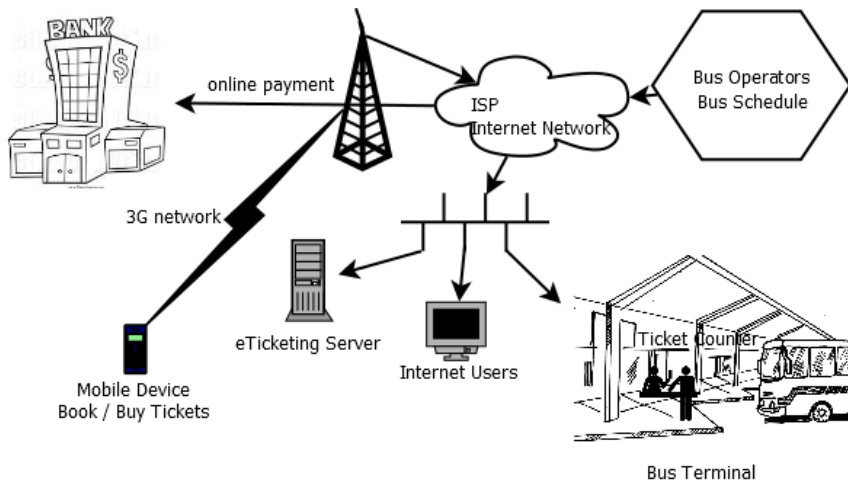
Public transport ticketing in Singapore has evolved over the past 20 years from manual cash collection to an advanced e-payment system using smart cards - developing from the automatic fare collection system introduced in 1987 for the first metro system in Singapore, to the current contactless smart card system used for travel across the entire public transport network

However, the technology associated with this fare media is costly and sophisticated, and therefore, not considered suitable for Bhutan until sometime in the future.

Instead, the Short Term Action Plan herein recommends the introduction of a mixed-mode ticketing system for the City Bus Service. This should be implemented as soon as possible – possibly by early 2016. Some developments for one Regional bus operator by a local IT company has started and this can act as a catalyst for wider action.

Regional bus operators will update their Bus schedule, and other ticketing details, which will be processed by the ticketing server, and users can book or buy tickets online using their mobile device or internet users, and online payment can be done using their debit or credit cards, and purchase tickets. Ticket counters at Bus terminals will also be connected to the system, so the ticketing can be made online.

There are a number of fundamental elements that go into building an Electronic Ticketing System. The required technology components are shown in the following diagram.



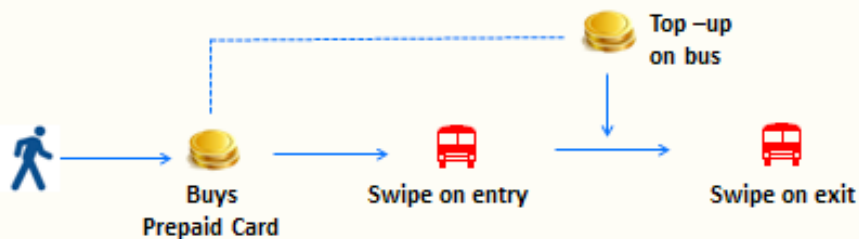
The ticketing system has to be a mixed mode in Bhutan so that it remains user-friendly, especially for those passengers from rural places who will find the new system too demanding to cope with. The system would use both Cash Mode (where a passenger pays in cash as in place in the present system) and Cards and Paper Pass (where cards will be used for long term users and paper passes for short journey).

RFID⁵ cards would be used which can be topped up and used for frequent commuters (students, office-goers, and others), where pre-paid RFID cards can be issued from counters around the city. This should be made possible to be recharged or Top Up from the bus too. Each Bus will have a RFID card reader, for entry and exit, or a hand held reader by the collector to read it

Paper pass will have QR⁶ codes, which can be read by a QR code reader, and can be purchased on the Bus having a small thermal printer for printing paper pass. Each Bus will have WiFi, 3G connection to connect to the centralized eTicketing system.

Mixed Fare Collection System - eTicketing

1. PREPAID USING RFID CARD



2. QR Code System



26.

To start-off , the QR Code system can be used for the urban bus services, . This system allows the purchase of tickets in cash from an RFID reader which is directly linked via the 3G network to record all purchases, time, sectors and so forth. It can be considered a closed system if tickets are not recycled. However, passengers can readily check whether this is being done or not.

⁵ Radio-frequency identification (RFID) is the wireless use of electromagnetic fields to transfer data, for the purposes of automatically identifying and tracking tags attached to objects. The tags contain electronically stored information

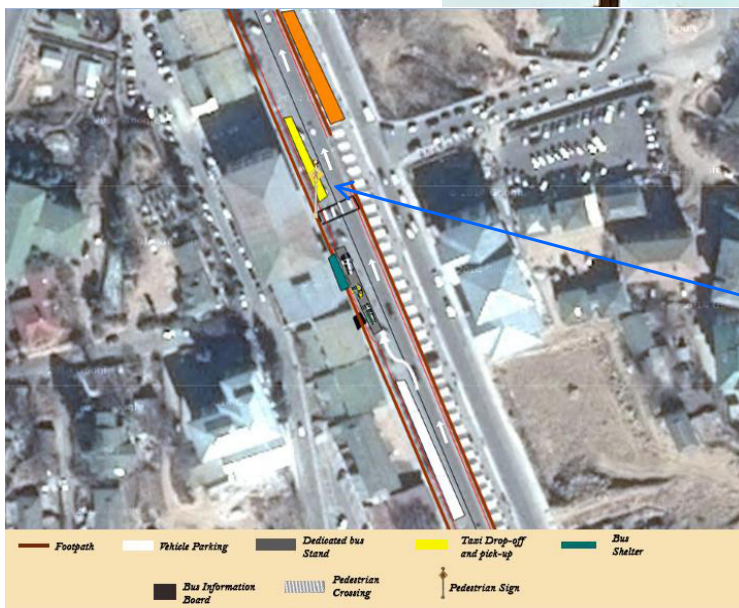
⁶ QR is a barcode which is a machine-readable optical label that contains information about the item to which it is attached.

This is a feasible approach as the technology is available in Bhutan to support it. At a later date the ticketing system can be refined and developed further.

Mobile ticketing system is now becoming more widespread in many countries and will, no doubt, eventually gain familiarity in Bhutan once the necessary ITS is in place. Mobile ticketing systems based on the use of the passenger's mobile phone for the payment of travel cost. Mobile tickets are being issued using short message services (SMS) or mobile barcodes. The ticket selection is performed by sending an SMS to the background system, either accompanied by a specifying text or by sending it to a specific phone number for each possible ticket. An electronic ticket is then returned via SMS to the user. Mobile phones can also be used to purchase tickets in the same way as they do with contactless smartcards by placing the RFID technology into the battery casing of the device.

Note 20 – Provision of Pedestrian flashing warning lights on Norzin Lam

The proposal includes a pedestrian crossing installed with flashing amber warning lights, speed hump and sensors. Something similar to the image shown here on the right.



Location of proposed Pedestrian lights

These could also be installed at other pedestrian crossings when funds permit.

Note 21 - Criteria for the selection of Traffic Signal sites

Possibly the longest established ITS application used within the urban environment is traffic signal control. Although initially traffic signals did not really include any intelligence, with the advancement in computer technologies junction control has become more sophisticated since the 1980s. Rather than just being a tool that typically separates conflicting movements at an individual junction, microprocessor modules enable modal-based, artificially intelligent, ever-present control using data from inductive loops and other detector systems.

This has enabled the development of features such as prioritisation of public transport (e.g. through systems that recognise buses, trams, etc.) and optimisation of traffic throughout at individual arms of junctions. Within the urban road network it is often the case that there is a concentration of traffic signal controlled junctions. Central computerised control and management systems enable wider area based network management.

Traffic signals are usually installed at an intersection:

- to provide traffic control at a site with a traffic capacity or road safety problem
- to control conflicting movements with high traffic flows
- to facilitate access to and from local areas in a major/minor road system.

Factors influencing the provision of traffic signals include:

- traffic flows
- traffic conflicts
- traffic accidents
- pedestrian requirements
- access to major roads
- cost of installation

Where the volume of traffic is the principal reason for providing a control device, signals may be considered when traffic volumes of 600 vehicles per hour exist on the major road concurrently with 200 vehicles per hour on the higher-volume approach of the minor road for each of any 4 hours of an average day.

The Consultant has undertaken a joint field survey with RSTA and RBP to determine whether likely candidates exist for the present or future. However, based on current traffic volume none of those inspected qualify for signalisation.

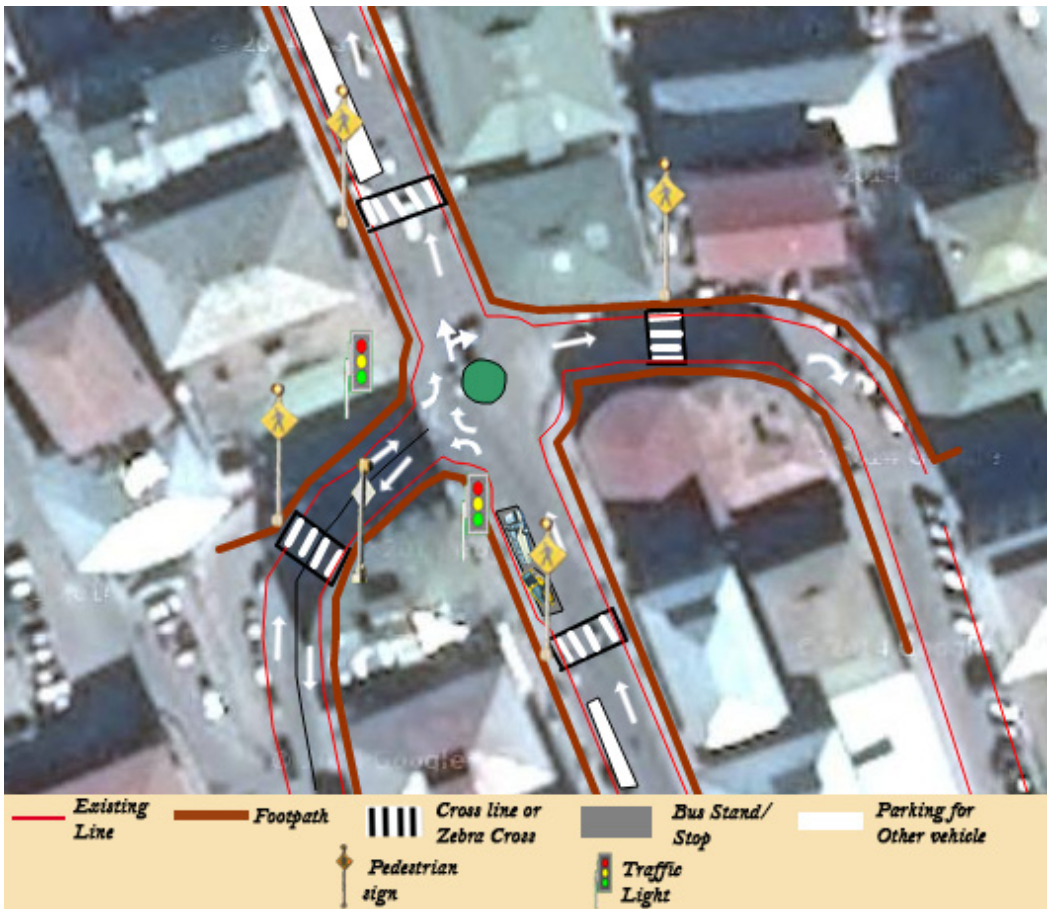
Nevertheless, further investigation is needed based on traffic count data. RSTA has identified a number of junctions/intersections that need to be evaluated as to whether traffic signalisation is justified (sometime in the future), these are:

- Chubachu Roundabout junction
- Junction below Bhutan Telecom
- Lungtenzampa Junction and Bus Terminal
- Babesa Roundabout Junction

- Main Traffic Junction
- Junction near the BOD and RBP Gate
- Swimming Pool Junction
- Memorial Chorten and JDWNRH Junction
- Fly-over Bridge Junction
- Junction Near Water Tanks in Motithang
- Pangrizampa and Dechencholing Junction
- Chuzom - Paro Check Post Junction.

Note 22 - Evaluate the justification for Traffic Signals on Norzin Lam

A possible candidate for traffic lights in the future is the roundabout on Norzin Lam, although there may be some cultural implications. Typical layout is shown as follows.



Note 23 - Carry out a pre-feasibility Study for the introduction of Weigh-in-Motion stations

Currently there are six weigh bridge stations to regulate vehicle overloading but none of these are located north or south of Thimphu. The existing ones are located in Phuentsholing (one Government and two private), Gelephu (one Government) and Samdrup Jongkhar (one Government and one private). There are no weigh bridges on Thimphu’s northern and southern boundaries.

Virtual Weigh Stations (VWS) are Weigh-In-Motion systems that provide vehicle records for enforcement, traffic surveillance and/or data collection in real-time over a computer network connection to a laptop, tablet, mobile device or workstation computer.

The use of a VWS system benefits the transportation agency, the trucking industry, and the general public in many ways, including:

- Protection of pavement and bridge structures against premature damage due to overweight vehicles
- Policing of trucks on secondary roads attempting to bypass main inspection stations
- Better identification of potential violators, leading to more efficient enforcement
- Increased resources to focus on safety issues
- Better data collection to improve road design.

VWS uses a series of high-speed in-motion vehicle scale, a high resolution camera, over height detector and cellular interface are added to form a complete virtual weigh station. As the vehicle passes over the quartz sensor array, its image is captured along with its axle weights and speed. A vehicle record containing this information plus vehicle classification, time and date, location, and identification number is transmitted wirelessly to the Internet allowing the enforcement officer to monitor commercial traffic in real time from a lap top in the officer’s vehicle.

4.3 Medium Term Action Plan (2018-2023)

The Medium Term Action Plan concentrates on ITS measures, the roll-out of bus bays and shelters, signalisation and public transport reform. Most of these can be implemented if funds are forthcoming whereas the “soft” issues are more dependent on Government endorsement of policy issues recommended in the Short Term Action Plan. Also, there will be many activities in the Short Term Action Plan that will be ongoing, refined and subjected to further development.

Indicative Timing	General/Specific Activity
<i>Institutional Initiatives</i>	
2018 -2023	▪ Source funding to implement signature projects
2018 -2023	▪ Training in ITS Management and Transportation
2018 -2023 See Note 1	▪ Recruitment of Traffic Engineer/Urban Transport Planner

<i>Public Transport</i>	
2018 -2023	<ul style="list-style-type: none"> ▪ Using performance-based contract, privatise selective City Bus Service routes
2018 -2023	<ul style="list-style-type: none"> ▪ Roll out BIS on City Bus Services
<i>Traffic Engineering</i>	
2018 -2023	<ul style="list-style-type: none"> ▪ Roll out bus bays and bus shelters
2018 -2023	<ul style="list-style-type: none"> ▪ Invest in Traffic Engineering improvements – pedestrian facilities, intersection improvements, etc.
<i>ITS Measures (and electronic traffic devices)</i>	
2018 -2023	<ul style="list-style-type: none"> ▪ Roll out Bus Information System (BIS) on City Bus Services
2018 -2023	<ul style="list-style-type: none"> ▪ Provide signalised pedestrian crossing at selective locations
2018 -2023	<ul style="list-style-type: none"> ▪ Provision of traffic signalisation of intersections at selective locations
2018 -2023 See Note 2	<ul style="list-style-type: none"> ▪ Introduction of Automatic Vehicle Location (AVL) to manage bus operations
2018 -2023 See Note 3	<ul style="list-style-type: none"> ▪ Introduce Electronic Ticketing process for City Bus Services
2018 -2023 See Note 4	<ul style="list-style-type: none"> ▪ Establish Automatic Passenger Counting capability for City Bus Services
2018 -2023 See Note 5	<ul style="list-style-type: none"> ▪ Introduce point-to-point Speed Cameras at selective areas where road safety is a problem
2018 -2023 See Note 6	<ul style="list-style-type: none"> ▪ Possible introduction of Transit Signal Priority (TSP) if traffic signals are installed
2020 -2023 See Note 7	<ul style="list-style-type: none"> ▪ Automation of multi-level car parks ▪ Automation of City Parking Collection Charges
2018 -2023 See Note 8	<ul style="list-style-type: none"> ▪ Parking guidance systems
2018 -2023	<ul style="list-style-type: none"> ▪ Provision of 2 Weight-in-Motion stations

Note 1 - Recruitment of Traffic/Urban Transportation Engineer

It is understood there are no Traffic Engineers or Urban Transport Planners working in the public sector in Bhutan. With increasing traffic, and resultant traffic congestion in urban areas, it is imperative that Government recruits and/or trains nationals in such disciplines. This should be given priority in the Government’s human resources policy.

Furthermore, to enhance any formal under-graduate and post-graduate qualifications, it is recommended that a national counterpart, suitably qualified in appropriate discipline, be attached to any transport related study undertaken by international specialist(s) in Thimphu. Recently studies/projects have provided a number of excellent opportunities for such attachments, namely: The Bhutan Urban Transport System (BUTS), 2012; Bus Service, January 2015; Development and Management of Integrated Parking System, 2013 and now the ITS Feasibility Study. Such opportunities will no doubt arise again in the future but this recent plethora of opportunities is probably exceptional.

Note 2 – Automatic Vehicle Location (AVL) to manage bus operations

Despite all the benefits of AVL, it is considered that it will take considerable time for bus operators in Thimphu to have the capability and/or will to use AVL as an ITS tool to assist them in improving the management of their operations. The Short Term Action therefore recommends that AVL be installed for the purposes of Bus Information System (BIS) as soon as possible and at a later date expand its use to assist the management of bus operations.

Automatic Vehicle Location (AVL) technology is applied to monitor the location of transit vehicles in real-time through the use of GPS devices or other location-monitoring methods. Information about the vehicle location is transmitted to a centralised control centre (and to bus operations office) in either raw data format or as processed data.

There are several benefits associated with application of an AVL system, including the following:

Improved bus safety	In an emergency, the transit control centre can relay vehicle location immediately to emergency response agencies
Improved quality of service	Passengers can be notified in real time of the location of the next bus and its expected arrival time
Improved system integration	Bus transfers can be better scheduled and controlled by knowing the location of each vehicle
Reduced need for voice communication	This can simplify vehicle operation for the bus operator
Follow-up analysis	Storing the AVL data collected over time can provide the opportunity to complete off-line analysis of service performance and comparison of schedules with actual running times

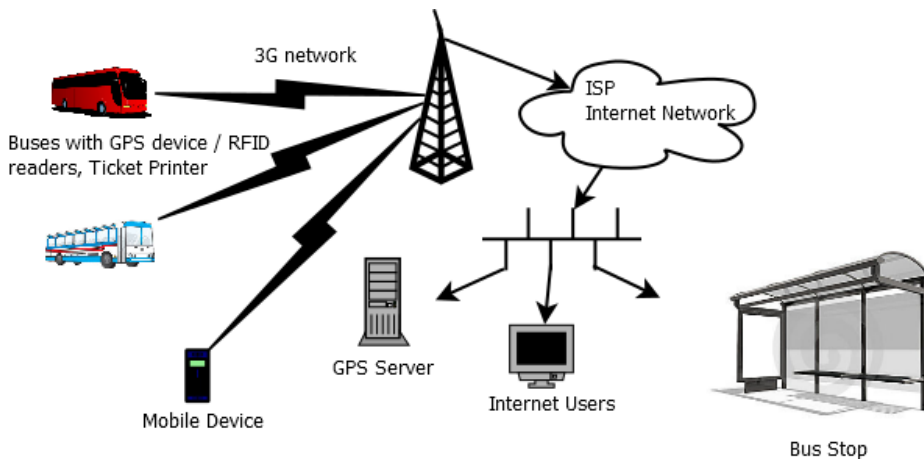
Benefits of an AVL System for the management of bus operations

Note 3 - Introduce Electronic ticketing process for City Buses

RFID travel card can be issued from shops around and can be topped-up online. The RFID travel card is read when entering the Bus either by the RFID reader on the DOOR or by the portable Reader. Cash payers will be issued QR coded paper ticket printed from the Portable Reader and Printer (one device), and the RFID card is read while boarding and exiting. The data will be sent to the server, where accounting will be done, as per the GPS location of the Bus to identify the Bus stops automatically.

City buses will be fitted with GPS device, as well as a portable handheld RFID/QR Code reader which also has inbuilt thermal printer to print out on cash payment ticket. RFID reader will be fitted on doors to check in and check out during exit and entry depending on the number of doors in the bus, or the handheld device could be used for check in and check out by the helper in the bus. Bus stops will have signage to display the bus routes, timing and when it will reach the Bus stop.

The required technology components are depicted in the following layout diagram.



Note 4 - Establish Automatic Passenger Counting capability in City Bus Services

Automatic passenger counters (APCs) are devices on-board buses used to record boarding's and lightings at each stop and keeping a running total of passengers on-board the vehicle. The APC units include sensors (typically infrared) at doorways to monitor passenger movements on and off a vehicle. An APC system creates an electronic record at each bus stop, typically including stop location, stop date and time, time of door opening and closing, and number of passengers boarding and getting down. APC data downloading options include manual downloading via a laptop computer, wireless data via a local area network, and real time reporting.

Note 5 - Introduce point-to-point Speed Cameras

There are different types of speed and red light cameras commonly used to deter drivers from driving over the speed limit and disobeying traffic signals. These include the following types of cameras:

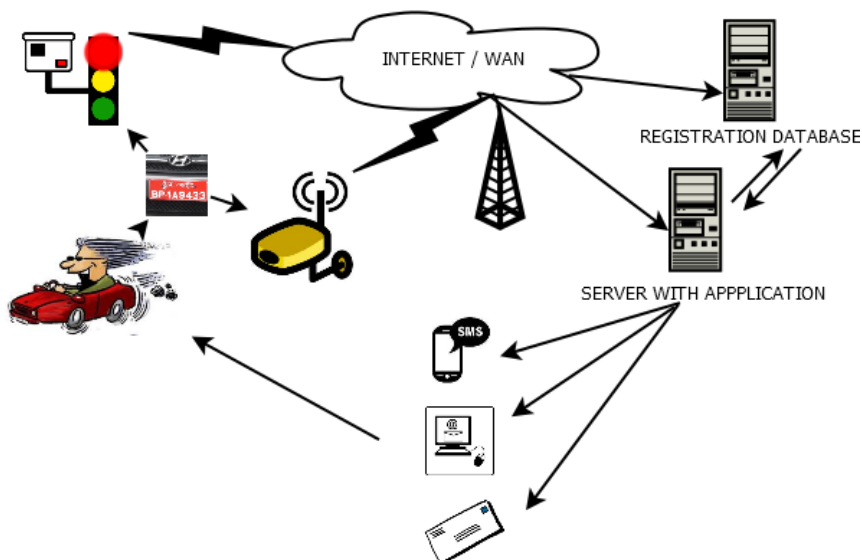
- mobile speed cameras
- fixed speed cameras
- red light cameras
- combined red light and speed cameras
- point-to-point speed camera systems.

Point-to-point speed cameras are systems made up of two cameras along a length of road. The cameras work out how long it takes to get between the two points and calculate average speed—to work out if you have been speeding along the length of the road using the following formula: $\text{Speed} = \text{distance} \div \text{time}$. The vehicle has been speeding if its average speed is more than the speed limit. Point-to-point camera systems, like other fixed speed cameras monitor traffic 24 hours a day, seven days a week.

Camera should be capable of taking pictures and also should have registration plate recognition function, so it will pick up the registration plate number, send it to the Application Server, which will get the data from the Registration Database, and send the

owner the violation alert as SMS, EMAIL, NOTICE, and can also be used for notifying the Traffic police/RSTA.

The following diagram shows the components that would be required for the system.



To address speeding violations the RBP has indicated they would like to employ automatic photo system to reduce contact with drivers as with a small community many drivers and police are related or familiar with each other - this seems to favour the introduction of the point-to-point speed camera system to supplement mobile radars which are in presently in use.

Note 6 - Transit signal priority if traffic signals are installed

Transit (bus) signal priority (TSP) is the process of altering traffic signal timing at intersections to give priority to transit operations. TSP can be triggered by BRT or Commuter Buses vehicles operating in their own right-of-way or in mixed traffic along a street (known as “mainline” priority), or operating in an auxiliary lane at an intersection (known as a “queue jump”). With mainline TSP, the typical treatment is to extend the green signal or truncate the red signal to allow priority for BRT/Commuter Buses vehicles, thus reducing intersection delay. With a queue jump, the transit vehicle receives a separate green phase to go through the intersection before the adjacent through traffic. In either case, the signal timing is adjusted to preserve the signal cycle length and thus keep the signal system in coordination. TSP is different from signal pre-emption, which interrupts normal signal operation and changes the signal cycle length to accommodate special events, such as a train approaching a railroad grade crossing adjacent to a signal or an emergency vehicle responding to an emergency call.

Note 7 - Automation of City parking collection charges

Automation of multi-level car parks will enable the dispensing of parking tickets from vending machine and later make cash payments at parking fee collection machine. The operation is simple – on entry to the car park drivers will be able to get a parking ticket from dispensing machine which will activate opening the boomer gate and number plate recognition; then upon exit, the driver or passenger is able to pay the parking fee and insert the paid-up card to activate the raising of the boomer gate to allow exit.

Most places in the world have taken out their parking meters and replaced them with park-and-pay machines. The technology is so good now that the latest Pay and Display parking machines have the facility for Mobile Phone Payment (MPP) solutions to pre-registered motorists to conveniently pay for car parking by using a standard mobile phone.

The Pay and Display Machine (PND) solution

For Thimphu, the Pay and Display parking machines offer an alternative payment method to both current cash system or the use of parking metres. The Pay-and-Display works as follows:

1. Consumer goes to pay station
2. Consumer purchases time
3. Consumer returns to vehicle
4. Consumer displays ticket on dashboard of his/her vehicle.

The advantage of this type of parking model is that enforcement is easy and inexpensive to implement: officers simply check vehicle dashboards to verify the consumer has purchased a permit and that it has not expired. It is superior to single-head meter parking because of the numerous benefits offered by multi-space pay stations. PND also allows on average 10% more vehicles to be parked in the same curb space and eliminates costs associated with painting and maintaining space markings.

The Mobile Phone Payment (MPP) solution

The aim is to introduce a virtual cashless parking solution to councils, delivering numerous benefits including the ability to:

- Rationalise technology
- Drive costs out of business
- Provide motorists with a superior parking experience with a virtual on-street parking solution that allows motorists to conveniently pay for car parking by using a mobile telephone.

The systems available offer councils/concessionaires a cost effective and reliable solution to meet the needs of its public by managing parking facilities using modern hand-held computers hosting an extensive infringement and parking permit application. The system is very easy to use from the motorist's viewpoint, whilst having no impact on infrastructure upgrades, delivering excellent management and control features to the parking operator.

A pre-registered motorist simply drives into a nominated parking bay and calls into the system, whereby the system prompts the motorist to enter a car park "Zone" number followed by the nominated fee. The system then simply confirms the parking payment and what time it expires. Ten minutes prior to meter expiry, the system automatically sends an SMS "expiry reminder" message to the motorist, requesting if they wish to reply with a fee value to "top up" the virtual parking meter, up to the maximum permissible time. The parking inspector simply uses a hand-held computer or mobile phone to verify payment of parking by scanning the windscreen barcode sticker. Immediately the screen displays vehicle and paid parking details, including expiry time. If the parking has expired, the application will prompt the inspector to issue an infringement. The benefits of this solution are:

Council/Concessionaire Benefits

- No cash collection, reconciliation or banking
- No revenue leakages
- No infrastructure or equipment
- No vandalism
- No machine maintenance
- Detailed parking statistics
- Real-time management
- Distinguish motorist profiles.

Motorist Benefits

- No need to carry loose change
- Ability to remotely top-up paid parking without having to leave a meeting or appointment
- No need to open wallets or purses at ticket machines
- Itemised billing history
- Receive SMS parking expiry and Clearway reminders
- No need to locate ticket machines.

Note 8 - Parking guidance systems

There are a wide range of vehicle detection devices in use than ever before on highways, starting from the popular inductive loops and magneto meters to video and radar-based detectors. Advances in electronics have had a tremendous impact on enhancing and improving detection systems, new non-intrusive traffic detection devices are in use more these days because of their easiness of installation and maintenance in addition to their accuracy and affordable cost.

It is considered this ITS measure should only be considered in the future for use in the multi-level parking facilities being constructed in Thimphu. Such a system is primarily

used in car parks to improve deterring customers from return visits within a car park - usually a common problem for complex car parks and sites with high turnover. The solution is to install a series of sensors with integrated signal lights that communicate to drivers where open spaces are located.

For reversing, most vehicles manufactured these days now incorporated a rear vision camera which is the primarily used as a parking guidance system.

4.4 Long Term Action Plan (beyond 2023)

The contents of a Long term action plan will depend on the future growth and largely be based on projection and estimations. It will be completely dependent on whether Activities/Projects recommended in the earlier years of the Action Plan have progressed. On the other hand the further rollout of bus stops, BIS and eTicketing will no doubt proceed. Also, the scarcity of funding will probably result in a backlog of projects arising.

Nevertheless, once ITS measures have successfully been introduced the pace of implementation is expected to “snowball” as experienced in other countries throughout the world.

Two new measures that are expected to ripe for implementation will be the introduction of Weight-in-Motion (WIM) capability and full electronic ticketing using smart cards. The former could be established much earlier, but will be held back as a full WIM capability is costly.

Road and weather information systems (RWIS) including real-time emission recorder/data collectors can only be realistically considered in the long term although, growing attention is currently being placed on weather and road conditions, especially in high altitude or mountainous regions where these parameters represent a fundamental source of information for maintenance action. RWIS systems help with highway operations and maintenance through the supply of accurate information including forecasts about the atmospheric parameters and the conditions of road surfaces.

The basic components of these systems are: weather instrumentation, data acquisition systems, communications systems and control centres with forecasting capacity. The solution not only improves safety on roads and traffic fluidity, but also permits fast and accurate decision-making when dealing with the appearance of ice on roads or congestion and lack of fluidity on highways. On the other hand the solution also favours protection of the environment since, through accurate data in real-time, unnecessary application of chemical and antifreeze on roads can be reduced.

Real time emission recorder/data collectors are an on-board diagnostic device that is designed to monitor vehicle emissions and diagnose various types of vehicle data. By integrating a GSM module and G-mouse, data can be transmitted to remote servers for storage and analysis. Additionally, real-time tracking and positioning function are supported as well.

5. SYSTEM REQUIREMENTS AND NATIONAL ITS ARCHITECTURE

5.1 System Requirements

The system requirements for ITS measures proposed in Short Term Action Plan are outlined in this Section.

It is noted that all ITS servers and equipment must comply with the Department of Information Technology and Telecom, MoIC standards prior to its implementation.

In addition to the legal requirement outlined in Section 3.9, those ITS measures which are online-based systems need to address cyber security.

5.1.1 Bus information system

Interface

The CCTV in the Bus will be linked through IP⁷ based streaming service, and through an open protocol⁸. So the audio video stream (live stream) from the CCTV in the Bus can be sent over the IP network to the control centre, where it can be recorded, and also displayed live on their display screen. This should not be a problem. It will also support metadata⁹, such as the Bus route number, and timestamp, and others for the purpose of achieving, and later generating reports from it.

The GPS device on the Bus also sends data over the IP network using standard TK102 / TK103 protocols, which is a common and standard GPS data transfer protocol, and it can be stored in any SQL¹⁰ compliant database. It can then be sent to the control centre which will be capable of processing the live data, its location, speed, date, time, and other details and stored for report generations in future.

The interface is straight forward as the proposed solutions are open-and-use standard protocols.

Requirements for real time bus information for Regional Bus Services

- Signage / Display screen at the RSTA Bus terminals of Bhutan - 60 inch monitor
- Signage / Display screen for the bus drivers -10 inch monitor or more, for the driver and the Central control room to exchange data, and information if required

⁷ Internet Protocol

⁸ An open protocol allows vendors' equipment to interoperate without the need for a proprietary interface or gateway. They talk the same language and no translation is needed. A closed protocol is one that is proprietary and not open to communication other products without an interface or gateway

⁹ Metadata is a set of data that describes and gives information about other data

¹⁰ SQL is Structured Query Language which is a special-purpose programming language designed for managing data

- GPS device to track the Bus
- Data Connectivity – preference is for Dual SIM, to use for data connection even while travelling through India, with SIM of Bhutan and India
- Accident Sensor¹¹, to detect accident of the BUS, and alert the concerned agency
- CCTV inside Bus for safety
- Online eTicketing system.

Functionality for Regional Bus Services

Capability to book and buy tickets for bus online, track the bus on real-time, monitor the speed of the bus, location, and the arrival and departure times. Also, alert on real time the concerned agency if there is bus accident via Email, SMS, or System alerts. Be able to record live CCTV camera footage from the Bus which can be monitored from the central control room.

Network Requirements for Regional Bus Services

The system will work on the existing 3G connectivity provided by the telecom companies.

Estimated Financial Implication

Item/Component	Cost - BTN
60 inch Signage / Display screen at the RSTA Bus terminals	60,000
Signage/Display screen for the bus drivers (10 inch or more), for the driver	15,000
GPS device to track the Bus	7,500
Data Connectivity for Dual SIM	200 per month
Accident Sensor	2,500
CCTV inside Bus for safety	9,000
Relay real time video information to a Central Server	2000 per month
Development of System Software for online ticketing	1,000,000

Requirements for real time bus information for City Bus Services

- Signage / Display screen at the Bus stops
- Signage / Display screen for the bus drivers (10 inch or more), for the driver and the Central control room to exchange data, and information if required.
- GPS device to track the Bus
- Data Connectivity by 3G or over City Wi-Fi
- Accident Sensor, to detect accident of the BUS, and alert the concerned agency
- CCTV inside BUS for safety
- CCTV Camera on the Bus Stop

¹¹ In case of an accident or collision, the crash sensor would detect the vibration of the bus and if it exceeded a certain level, the emergency exit windows would break open and if there is a fire, the smoke sensor will detect the change in the ambiance and trigger the alarm, which will open the emergency exits.

- Ticket Dispensing Machine
- Ticket or Frequent Travel Card Check In
- Ticket or Frequent Travel Card Check Out
- Real-time Bus Map, with live data to see where the Bus is located.

Functionality for City Bus Services

Capability to have card to travel in the bus, have arrival time displayed on the signage display of bus stop, monitor the speed of the bus, location, and the arrival and departure times. Also, alert on real time the concerned agency if there is bus accident via Email, SMS, or System alerts. Be able to record live CCTV camera footage from the BUS, and monitor from the central control room.

Network Requirements for City Bus Services

The system will work on the existing 3G connectivity provided by the telecom companies or build City Bus Services WIFI connection network.

Estimated Financial Implication for CITI bus services

Item/Component	Cost - BTN
40 inch Signage / Display screen at the RSTA Bus stops	40,000
GPS device to track the Bus	7,500
Data Connectivity for Dual SIM	200 per month
Accident Sensor	2,500
CCTV inside Bus for safety	9,000
Relay real time video information to a Central Server	2000 per month
Development of System Software for online ticketing	1,000,000
Development of System Software for online ticketing	15,000
Check in and Check out Ticket machines	30,000 pair
Real-time City Bus Services information and schedule web page, with live Bus location	150,000

5.1.2 Car parking automation

Requirements

- Parking Ticket Dispenser
- Parking ticket cash collection machine
- Number plate recognition camera
- Automatic boomer gates.

Functionality

As explained in Section 4 above, automation of multi-level car parks will enable the dispensing of parking tickets from vending machine and later make cash payments at parking fee collection machine. The operation is simple – on entry to the car park drivers

will be able to get a parking ticket from dispensing machine which will activate the opening of the boomer gate and number plate recognition; then when exiting, the driver or passenger is able to pay the parking fee and insert the paid-up card to activate the raising of the boomer gate to allow exit.

Network Requirements.

Will work on the existing 3G / broadband connectivity provided by the telecom companies

Estimated Financial Implications

Item/Component	Cost - BTN
Parking Ticket Dispenser	30,000
Parking ticket cash collection machine	450,000
Number plate recognition camera	40,000
Automatic boomer gates	75,000

5.1.3 eTicketing

Requirements

- Hosting Server
- Internet Lease Line
- System Development
- Working with Bus Operators

Functionality

Be able to securely host eTicketing system on a server, with good internet lease line, people can buy tickets online, and pay through BOBL e-payment gateway, or can book tickets, and pay later while boarding the BUS.

Network Requirements

Public can use their mobile and internet connectivity to book tickets online, and also purchase the ticket if they have VISA/Credit Card account, and soon use DEBIT cards too.

Estimated Financial Implication

Item/Component	Cost - BTN
Hosting Server	200,000
Internet Lease line	.30,000 per month
System Development	1,000,000
Bus operators to work out a model of per ticket commission to the eTicketing agent	Minimal

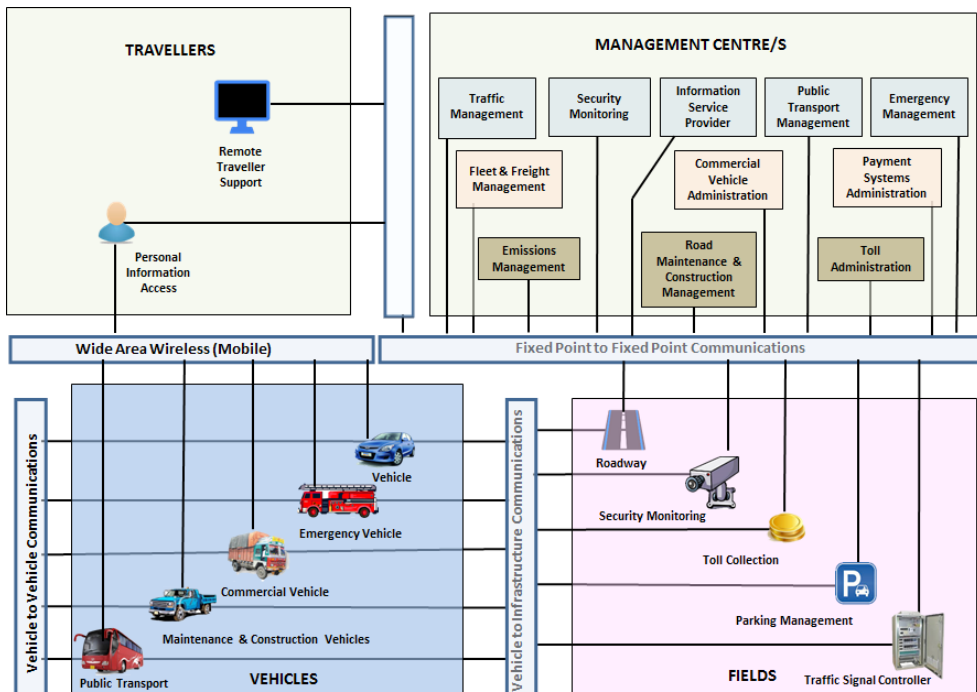
Financials

Item/Component	Cost - BTN
Fixed RFID reader	45,000
RFID card	200
Portable reader and printer	20,000
Thermal paper for printer (58mm)	130
Ticketing application	TBD ¹²

5.2 National Architecture

With many different technologies involved with ITS applications guidance is necessary to develop compatible systems and system connections. A National ITS Architecture should be established, which defines the functions that must be performed, the subsystems that provide these functions, and the information that must be exchanged to support the user services. The benefits of having a common architecture are that ITS products can be applied to markets throughout Bhutan and thus reduced costs will accompany more efficient operations through economies of scale and competition. The architecture should have communications, transportation and institutional elements attached to it - all of which must work together for ITS to be successful.

Intelligent Transport Systems use a range of communication, detection and processing components to support solution delivery. A conceptual view of the relationships amongst vehicles, systems, services and users in the ITS domain is shown in the figure below.



A high-level Intelligent Transport Systems National Architecture

¹² TBD - To be determined

As can be seen in the diagram above there are 3 levels of Management Centres or ITS systems that can manage:

Components

Level 1 includes Traffic Management, Security Monitoring, Information Service Provider, Public Transport Management and Emergency Management.

Level 2 includes Fleet and Freight Management, Commercial Vehicle and Payment Administration.

Level 3 includes Emissions Management, Road Maintenance and Construction Management and Toll Administration are unlikely to be seriously considered within the life time of this Project.

Timing

Level 1 measures can and should start being rolled out in Short Term Action Plan and progress into Medium Term Action Plan.

Level 2 measures could be rolled out in the Medium Term Action Plan.

Level 3 measures could be considered in the Long Term Action Plan.

APPENDIX A

CASE STUDY

PUBLIC-PRIVATE PARTNERSHIP FOR URBAN BUS TRANSPORT SERVICES FOR THIMPHU

Public-Private Partnership for Urban Bus Transport Services for Thimphu

Background

It is understood that the Government has previously tried to privatise the City Bus Services but apparently this was not successful. It unknown on what basis this was attempted. Nevertheless, the current arrangement is not satisfactory, and without change the desired outcomes are unlikely to be achieved.

What is suggested in this Case Study is staged approach - starting off with a pilot project and at the same time proceeding with the proposed transformation of CBS.

Proposition

The Government to enter in a formal contract with a private bus operator to give them sole right to operate on one of Thimphu urban bus routes through the form of PPP arrangement by way of a performance contract.

There are a number of contract forms that could be considered but the one most appropriate for Thimphu would be a Net-Cost Contract (NCC). The characteristic of an NCC is that it only has moderate number of bidders and requires a low level of monitoring. It usual operates on the basis of fare levels enough to cover operating and capital costs and low public funding.

Net-Cost Contract

A net-cost contract is typically a lease contract. The private operator procures, owns, and runs the buses for a specified period, and also collects and retains all the revenues. The authority may consider paying a subsidy to the operator if the bus services in the area are unprofitable. If the services are profitable then the private operator can consider paying a fixed amount to the relevant government authority.

Net-cost contracts are preferred when revenues from the project are enough to cover both operating and capital costs. A net-cost contract is a type of PPP arrangement that has been successfully and widely applied throughout the world.

An NCC Contract usually specifies certain performance requirements, such as:

- Equipment
- Schedule
- Public Service Obligations
- Stand-by bus
- Comfort
- Code of practice for drivers and conductors.

It could also stipulate any ITS requirements such as BIS and eTicketing as recommended in this report.

Possible Savings to Government

Privatising City Bus Services has many benefits if regulated by means of an NCC contract. Apart from improving service levels, the savings to Government would be substantial as the level of subsidy provided to the City Bus Services is high and increasing in absolute terms.

Current subsidy comprises 3 components, namely:

- i. Short-fall in operating costs i.e. cost minus revenue
- ii. Depreciation on capital investment for new buses (and equipment)
- iii. Tax exemptions –private bus operators are required to pay Nu 8,000 per bus per year

Table used to calculate depreciation of current CITY bus fleet

Buses	Number	Cost per Bus US\$	Cost per Bus Nu	Total cost for each bus type
Toyota Coaster	12	27,619	1,519,045	18,228,540
GAC	4	42,800	2,354,000	9,416,000
TATA	5	32,400	1,782,000	8,910,000
Golden Dragon	11	54,000	2,970,000	32,670,000
Total Bus Investment				69,224,540

Table used to calculate CITI total deficit in 2013/2014

Item	Basis of calculations		Total
Short-fall in operating costs	Total Operating Cost less total revenue from CITI Accounts	=35,338,000 – 17,190,000	18,148,000
Depreciation	Straight line depreciation over 8 year bus life	= 69,224,540/8	8,653,068
Tax exemption	Total number of buses by Nu 8,000	= 32*8,000	625,000
Total Deficit in 2013/2014			27,426,068

Current Financial Position of CBS

1. In 2013/2014 the City Bus Services short fall in operating costs was BTN 18,148,000
2. Over the 9 years from 2005/2006 to 2013/2014 the short fall in operating costs has increased from BTN 5,135,00 to BTN 18,148,000, which is a 353% increase, or, on average 39% per year
3. The full deficit for City Bus Services in 2013/2014 was BTN 27,426,068 when incorporating depreciation on the bus fleet and tax exemptions
4. Based on the 2013/2014 deficit, historical trends and with the status quo remaining, the annual deficit in 5 years time would be BTN 17,931,492 and in 10 years time BTN 93,790,584.
5. The proposition is to test the market to introduce competition in the market place but not on routes.

APPENDIX B

TECHNICAL INFORMATION PAPER ON DESIGN ELEMENTS FOR BUS STOPS AND BUS SHELTERS

Bus Stop and Bus Shelter Facilities

Current Situation

The Consultant took the opportunity to ride on the public transport in Thimphu to gauge the level of service provided and facilities in place. It was found that:

- Buses are operating like taxis picking and dropping off passengers wherever the passengers desire; in particular:
 - There are too many stops at undesignated bus stops
 - The distance between stops is very short
 - Passengers are not willing to walk to the nearest bus stop
 - Buses stop on demand often at unsafe locations such as bends, intersections, etc.
 - Buses stop within the road carriageway blocking through traffic
- Designated bus stop are either unsigned or poorly marked
- During peak hours buses are crowded and uncomfortable especially for women, elderly and small children
- Fare collection arrangement is basic and inefficient
- There were no bus bays or shelters or basic furniture
- Overall drivers and conductors are well-presented but do not have uniforms.

Bus Stop Location

It is important to ensure that all stops along a bus route are accessible to an acceptable standard to maintain equitable access for all passengers. Failure to implement accessible bus stops will reduce the quality of the public transport experience for passengers and may consequently hinder the development of a high-quality public transport system that is easy to use. A bus stop is not interpreted as simply a location for boarding and de-boarding a bus, but instead as the key connection between the surrounding land use and a public transport service (i.e. as a point of interchange between a pedestrian trip and a public transport trip)

It is intended that stop spacing on a bus route is ideally between 400 metres and 800 metres for most services. In the case of inner city or densely built-up areas, a spacing of less than 400 metres may be warranted along a route while express services may range greater than 800 metres between stops.

RSTA in consultation with relevant stakeholders should determine the most appropriate location for bus stops taking into account the present and future network requirements.

It is the intent for bus stops to be located in areas:

- with high visibility and lighting (or access to power for future lighting) which are clearly visible from surrounding locations (i.e. away from dense foliage and other objects hindering direct sightlines)—the use of street lamps can assist in maintaining visibility at night
- where the bus driver and waiting passengers are clearly visible to each other close to other stops (and in some cases, stations) to minimise walking if transferring between services centres) to minimise walking distances and assist with passenger safety (and shelter if required)
- safely away from tight bends, hill crests or gullies as these can create blind spots for vehicles
- close to other stops (and in some cases, stations) to minimise walking if transferring between services
- preferably on the far side of an intersecting street to assist with sightlines of intersecting vehicles not adjacent to an intersecting street (i.e. at a T-intersection)
- a minimum of 10 metres far side of non-signalised intersections or non-signalised pedestrian crossings (refer to statutory regulations)
- a minimum of 10 metres approaching non-signalised intersections and a minimum of 20 metres approaching non-signalised pedestrian crossings (refer to statutory regulations)
- a minimum of 20 metres far side of signalised intersections or pedestrian crossings
- a minimum of 20 metres approaching signalised intersections or pedestrian crossings

However each bus stop needs to consider local road operations and should be assessed on a case-by-case basis.

Bus Stop and Supporting Facilities

A bus bay must be functional, comfortable, safe and aesthetic. The bus shelter should not be designed in isolation to the entire facility. A fully functional facility would usually incorporate:

- A paved and curbed indented bus bay with bus door stopping position
- Bus shelter should be an integrated facility, preferably comprising
 - Prefabricated off-the-shelf structure that is modern and functional (sourced overseas)
 - Aluminium or stainless steel structure
 - Aesthetic design with local Bhutanese badging bolted-on
 - Adequate seating

- Provide some shelter from the weather
- Lighting
- Notice board or real time information display unit
- Rubbish receptacle
- Signage
- Landscaping.

The following two sketches show a low volume bus stop without a shelter and a high volume bus stop with a shelter which would be suitable for Thimphu.



Furthermore, it is understood that a locally designed bus shelter has been prepared, as per the architectural sketch below – it seems this has been carried out in isolation to other important considerations and is not fully functional.

Building locally will probably be more costly compared to a prefabricated bus shelter sourced from overseas which has now become a shelf item. The fabricated units can readily be made to look Bhutanese by attaching an appropriate anodised template along the roof-line.

