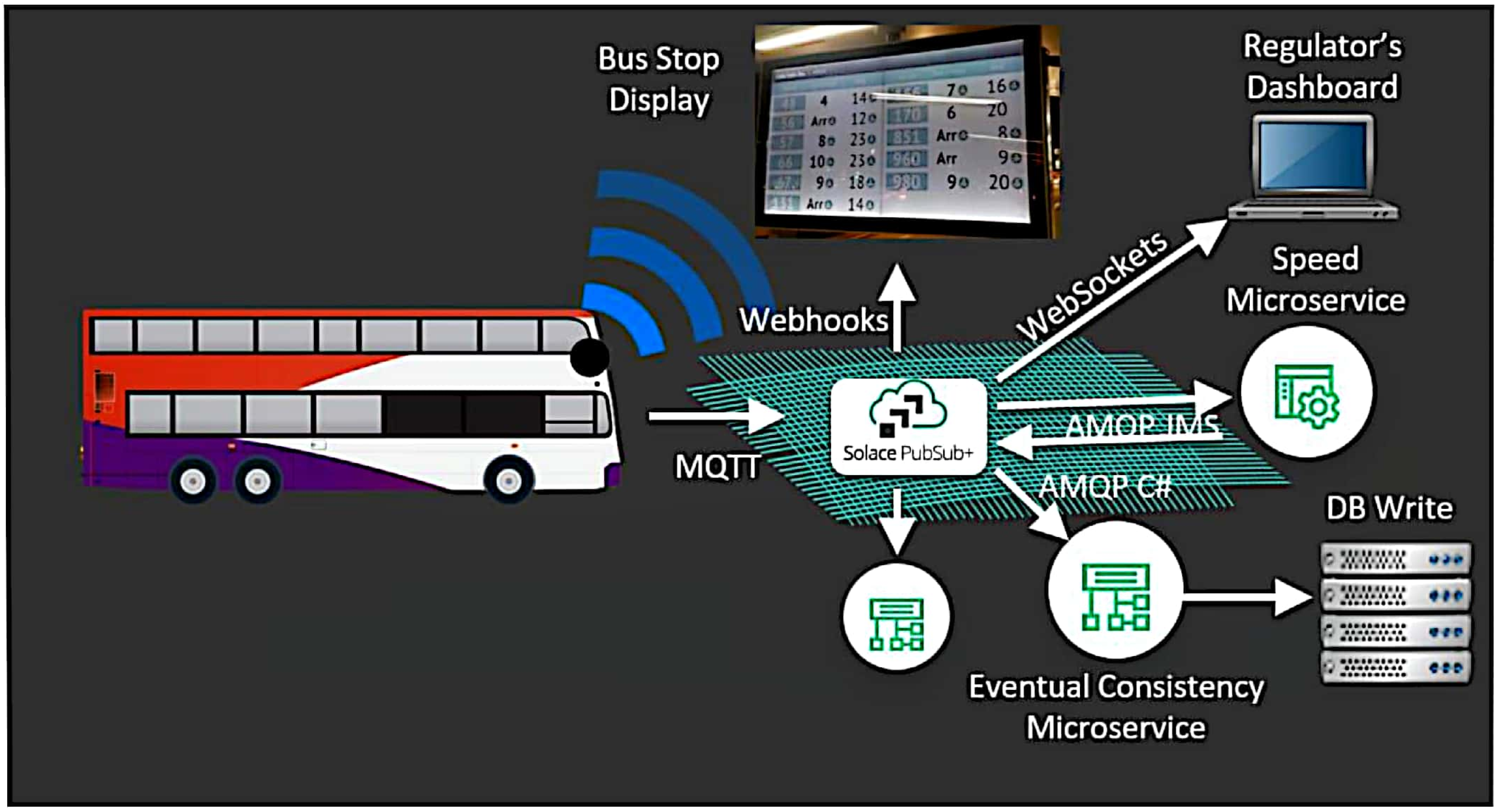
Public Transportation Optimization

Project Objectives :

Public transportation optimization refers to the process of improving the efficiency, accessibility, and sustainability of public transit systems. This involves various abstract concepts and methodologies, including:

Route Planning: **Abstract mathematical algorithms are used to determine optimal ro:utes and schedules, considering factors like demand, traffic patterns, and resource constraints.**

Scheduling: **Optimization techniques are applied to create efficient timetables that minimize waiting times and maximize service coverage.**



Fleet Management: Abstract models help allocate vehicles effectively, ensuring they are deployed where and when they are needed most.

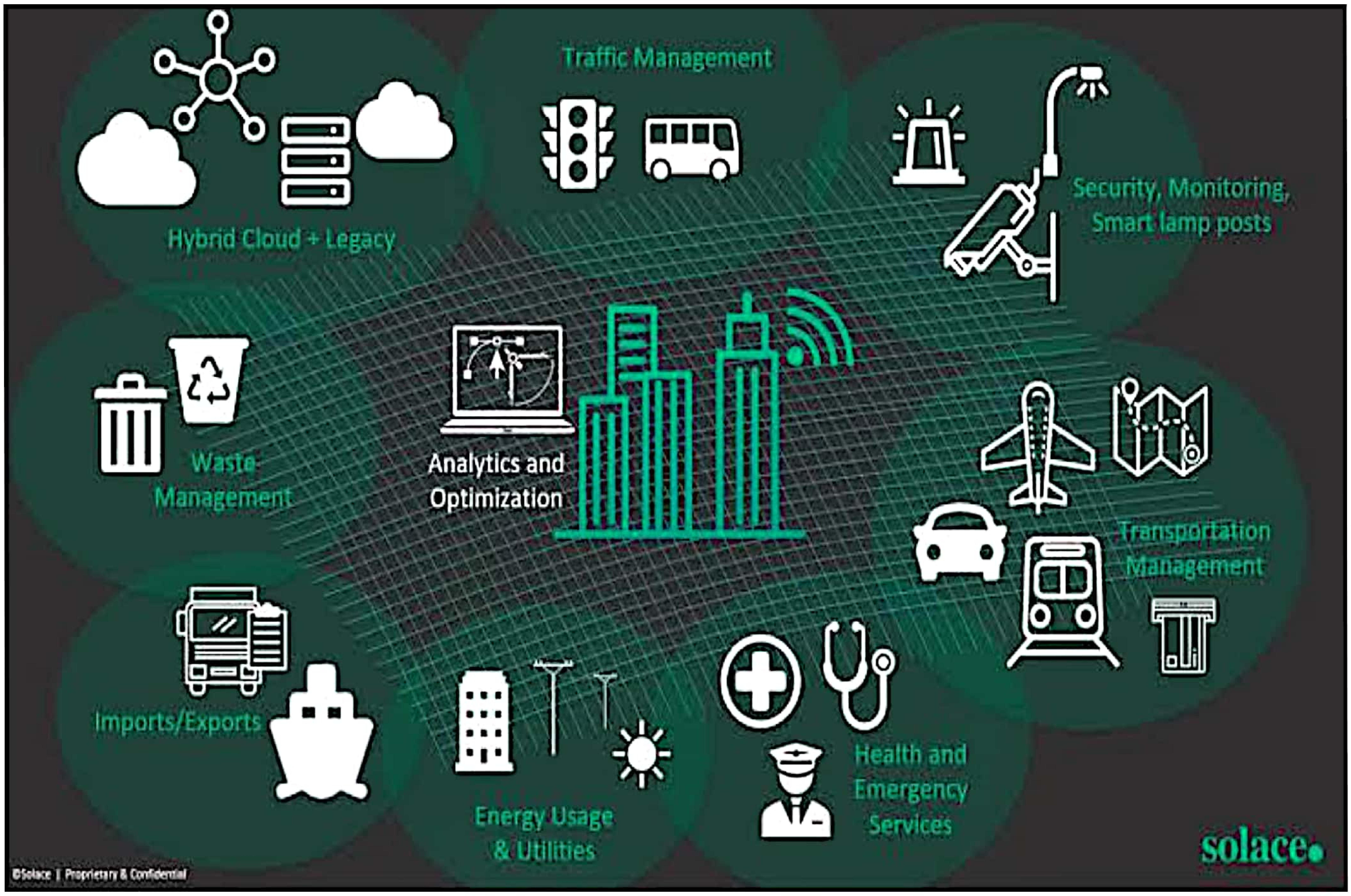
Demand Forecasting: Predictive modeling abstracts future passenger demand, aiding in resource allocation and capacity planning.

Multi-Modal Integration: Abstract frameworks facilitate the seamless integration of different modes of transportation, such as buses, trains, and rideshares.

Ticketing and Fare Optimization: Abstract pricing strategies and fare structures are designed to balance revenue generation with affordability.

Environmental Impact Reduction: Abstract concepts like emission modeling help reduce the carbon footprint of public transportation systems.

Data Analytics: Advanced data analysis and abstract data visualization techniques inform decision-making and allow for real-time adjustments.



Accessibility: Optimization abstracts the design of transit systems to ensure they are inclusive and meet the needs of all passengers, including those with disabilities.

Policy and Governance: Abstract frameworks guide policy decisions, such as zoning and land use, to support efficient public transit development.

In summary, public transportation optimization involves applying abstract models, algorithms, and concepts to create efficient, sustainable, and user-friendly transit systems that benefit both passengers and the environment.

PUBLIC TRANSPORT OPTIMIZATION

```
#define BLYNK_TEMPLATE_ID "TMPL26V4fGv5q"

#define BLYNK_TEMPLATE_NAME "Test"

#define BLYNK_AUTH_TOKEN
"XEHxNF_Ur1Nt2p7wB5B20dNI1ZUwj34P"


#include <WiFi.h>

#include <WiFiClient.h>

#include <BlynkSimpleEsp32.h>


int duration1 = 0;

int distance1 = 0;

int duration2 = 0;

int distance2 = 0;

int dis1 = 0;

int dis2 = 0;
```

```
int dis_new1 = 0;
int dis_new2 = 0;
int entered = 0;
int left = 0;
int inside = 0;
#define LED 2
#define PIN_TRIG1 15
#define PIN_ECHO1 14
#define PIN_TRIG2 13
#define PIN_ECHO2 12
BlynkTimer timer;

char auth[] = BLYNK_AUTH_TOKEN;
char ssid[] = "Wokwi-GUEST";   // your network SSID
(name)
char pass[] = "";
#define BLYNK_PRINT Serial

long get_distance1() {
```

```
  // Start a new measurement:
  digitalWrite(PIN_TRIG1, HIGH);
  delayMicroseconds(10);
  digitalWrite(PIN_TRIG1, LOW);

  // Read the result:
  duration1 = pulseIn(PIN_ECHO1, HIGH);
  distance1 = duration1 / 58;
  return distance1;
}

long get_distance2() {
  // Start a new measurement:
  digitalWrite(PIN_TRIG2, HIGH);
  delayMicroseconds(10);
  digitalWrite(PIN_TRIG2, LOW);

  // Read the result:
  duration2 = pulseIn(PIN_ECHO2, HIGH);
```

```
  distance2 = duration2 / 58;
  return distance2;
}

void myTimer() {
  Serial.println("100");
  dis_new1 = get_distance1();
  dis_new2 = get_distance2();
  if (dis1 != dis_new1 || dis2 != dis_new2){
    Serial.println("200");
    if (dis1 < dis2){
      Serial.println("Enter loop");
      entered = entered + 1;
      inside = inside + 1;
      digitalWrite(LED, HIGH);
      Blynk.virtualWrite(V0, entered);
      Blynk.virtualWrite(V2, inside);
      dis1 = dis_new1;
      delay(1000);
```

```
    digitalWrite(LED, LOW);
   }
   if (dis1 > dis2){
    Serial.println("Leave loop");
    left = left + 1;
    inside = inside - 1;
    Blynk.virtualWrite(V1, left);
    Blynk.virtualWrite(V2, inside);
    dis2 = dis_new2;
    delay(1000);
   }

  }

}

 void setup() {
  Serial.begin(115200);
```

```
  pinMode(LED, OUTPUT);
  pinMode(PIN_TRIG1, OUTPUT);
  pinMode(PIN_ECHO1, INPUT);
  pinMode(PIN_TRIG2, OUTPUT);
  pinMode(PIN_ECHO2, INPUT);
  Blynk.begin(auth, ssid, pass, "blynk.cloud", 8080);
  timer.setInterval(1000L, myTimer);

}

void loop() {
  Blynk.run();
  timer.run();
}
```

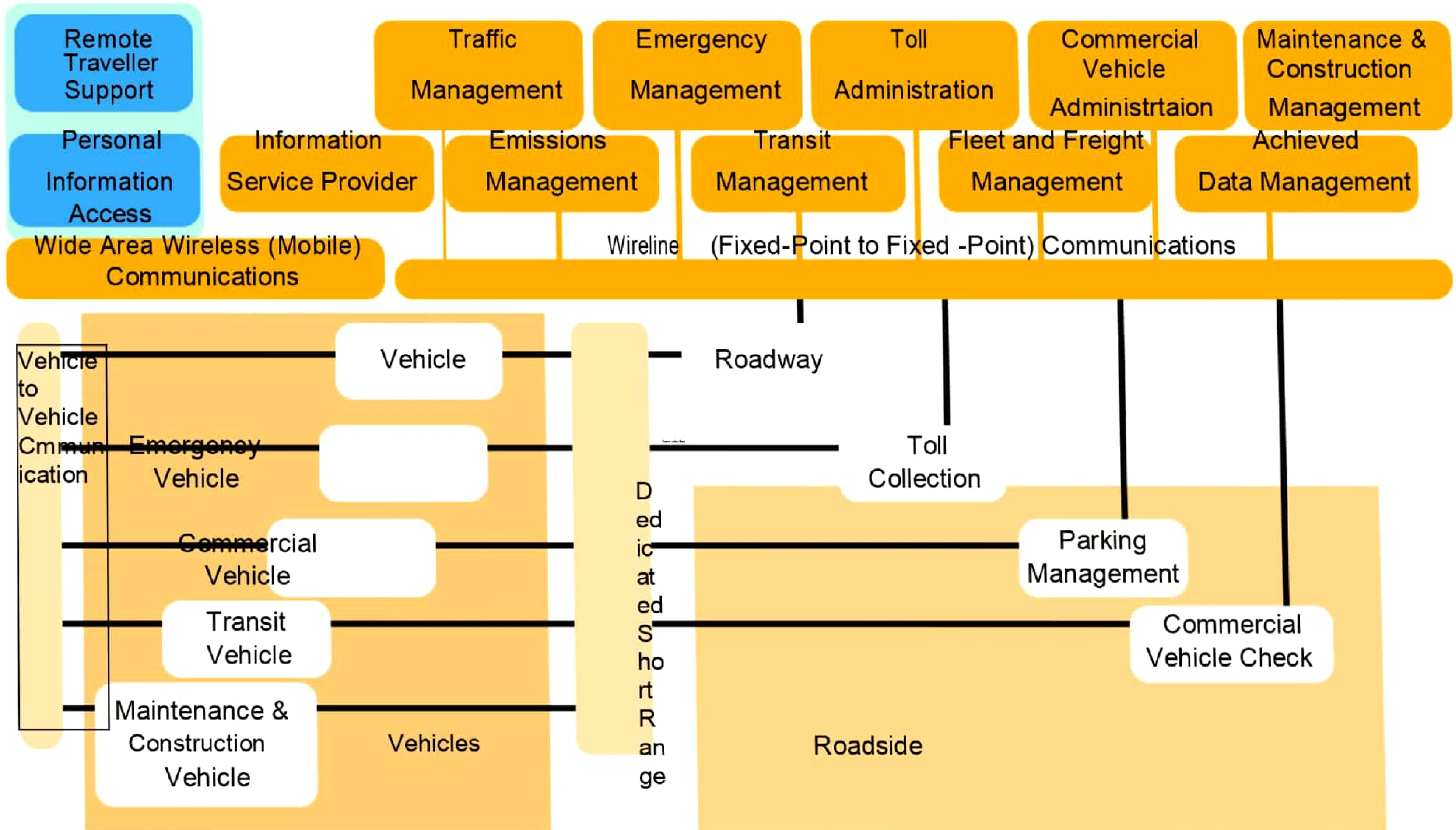
Public Transportation Optimization Using IOT

TRANSPORTATION

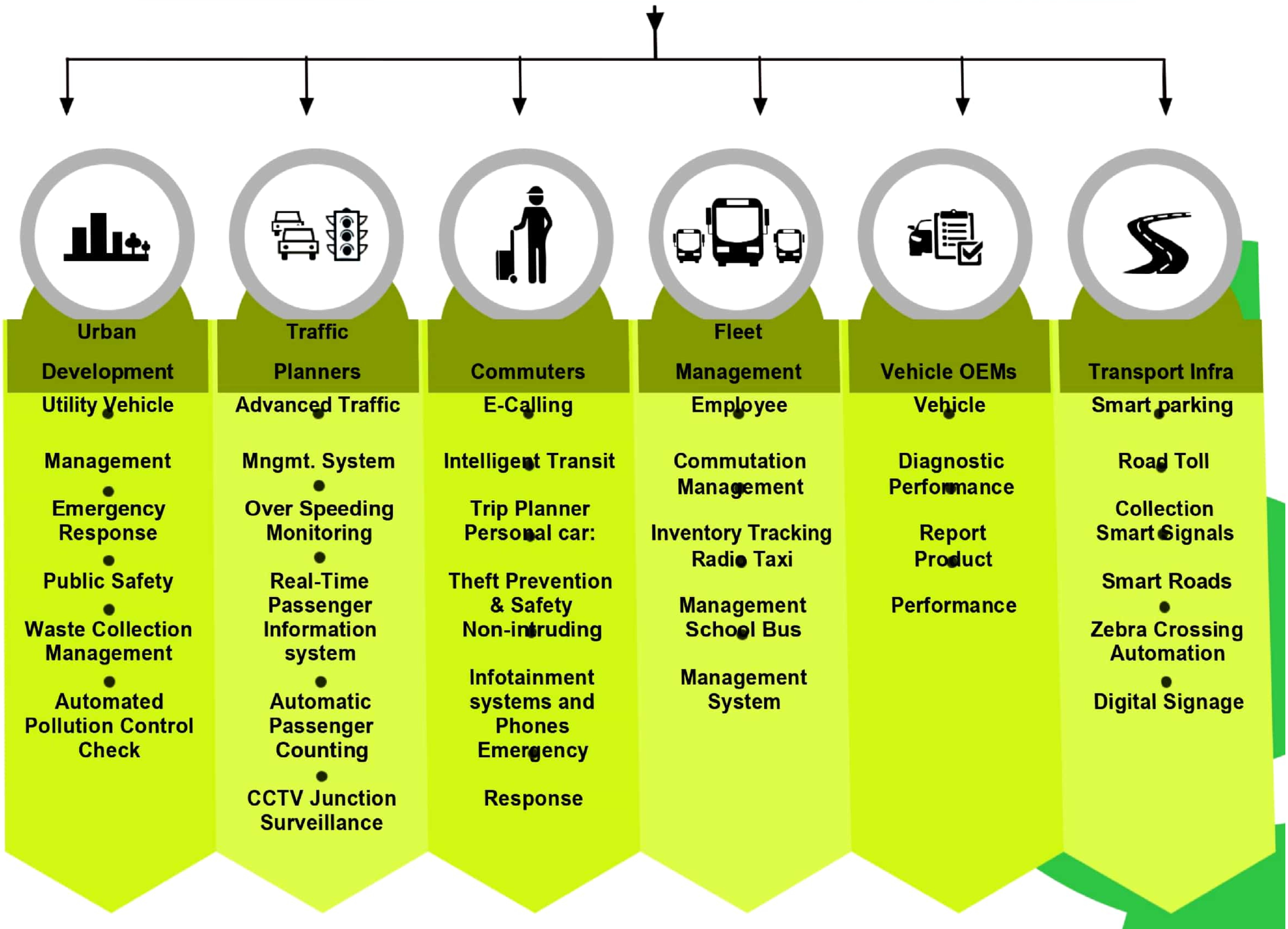
Easing traffic congestion by deploying ICT.
We rely on the vast web of transportation networks in our cities, yet so many metro areas struggle with congestion. Advanced analytics and instrumentation can provide cities with the information they need to minimize it.

Figure 7.2

Broad Overview of Intelligent Transport System



Intelligent transport system – Real Life Use Case Scenarios



Intelligent Road Transport System Scenario - A Detailed Analysis

Public transportation is reducing energy consumption and harmful carbon dioxide (CO_2) greenhouse gas emissions that damages the environment. Traveling by public transportation uses less energy and produces less pollution as compared to travel in private vehicles. To make progress in reducing our dependence on foreign oil and impacting climate change, public transportation must be part of our M2M solution.

State Transport system in India is inefficient and slack. Lots of buses are involved in the public transport; they run on the scheduled time every day. The system has many problems that could be resolved by implementing M2M solutions. We have discovered some the problems that could be considered for Indian scenario.

Note:

The Use Case is prepared by considering the Indian scenario rather than referring other countries' systems. Some of the recommendations would be for green field and some of them could be adopted by the existing system.

Objectives:

To develop a Smart system that could benefit RTC (Road Transport Corporation) as well as the passengers

To develop a business model where operator can act as an Enterprise Service Provider

To encourage the passenger to use public transport for commuting there by reducing traffic congestion, air pollution etc.

Problems:

Overloaded buses

Less frequency of buses

Breakdown of buses (e.g. proper maintenance & BCP)

Planning and priority on the basis of availability and urgency of the service provision
(e.g. traffic system and priority management system integration)

Accidents by public transport vehicles due to rash driving

Requirements:

GPS devices

Wheel speed sensors

Torque sensors

Sensors measuring the health of the vehicle

Basic Infrastructure Requirement:

- Wi-Fi at each bust stop and each bust depot

Planning and managing the buses:

The basic requirements for the use case is that all the Bus depot are connected to each other and all the small bus stands will be connected to the respective depots of the town. The source depot will update the departure time of the bus to all the bus stands and the destination depot. GPS tracking and tracing systems will provide the information about how far the bus is from the destination and the estimated time of arrival. The number of the passengers waiting at the respective bus stand will be updated frequently.

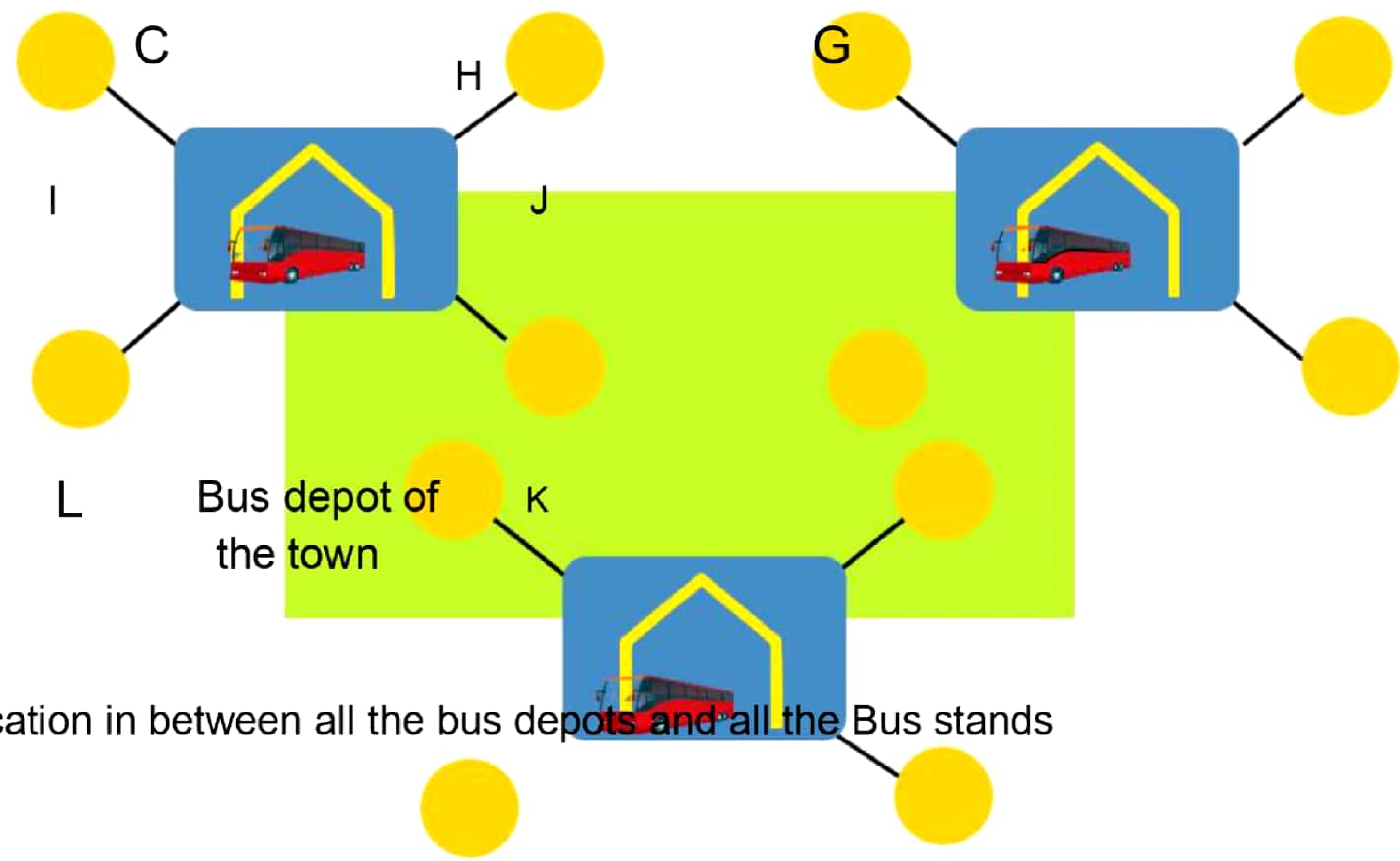
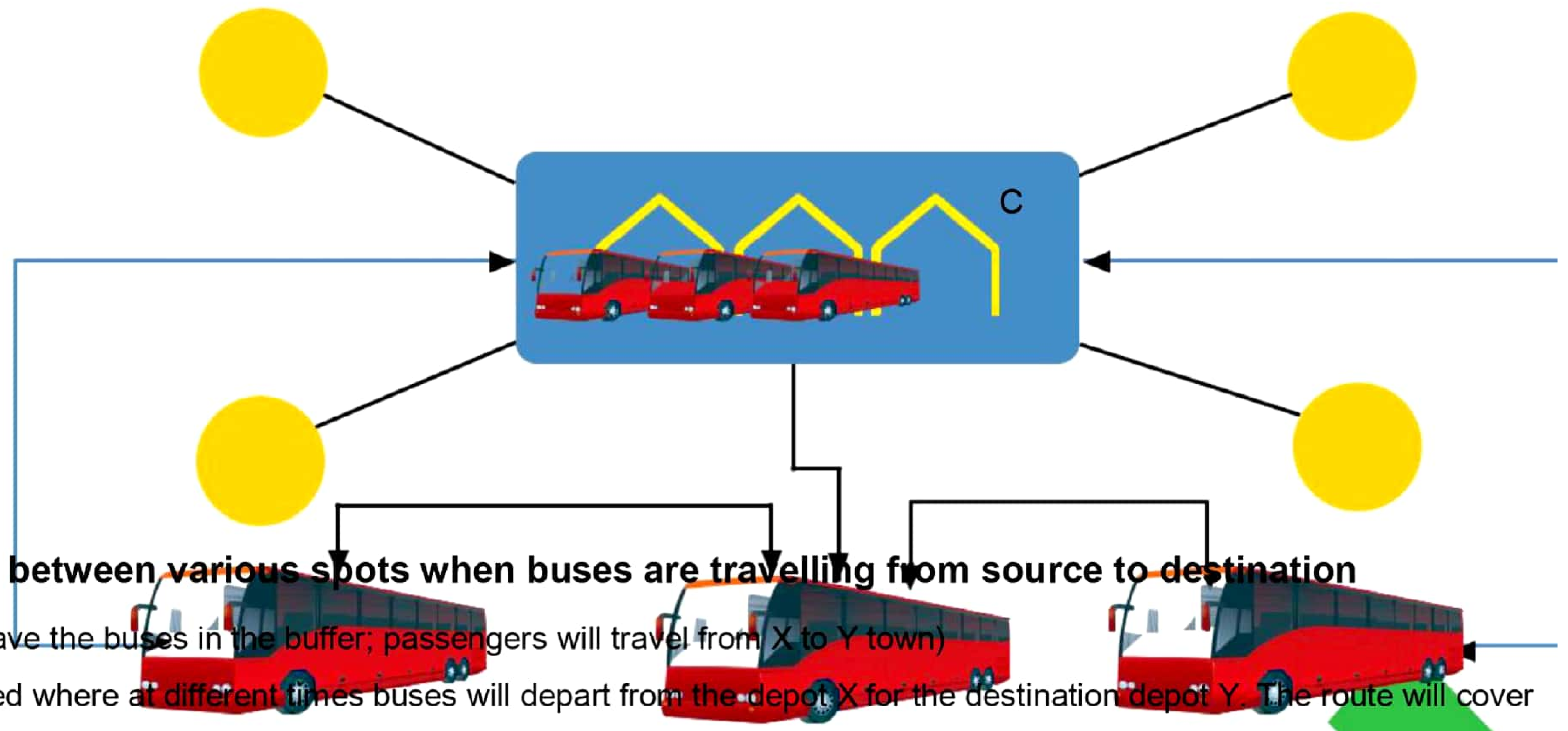


Figure 1 Communication in between all the bus depots and all the Bus stands



Communication between various spots when buses are travelling from source to destination

(Assumption: Bus depot will have the buses in the buffer; passengers will travel from X to Y town)

Here, one scenario is discussed where at different times buses will depart from the depot X for the destination depot Y. The route will cover all the bus stops in between and bus timings are already predefined.

Bus will depart from X depot with 50 vacant seats.

It will pick up 30 passengers from 1st bus stop then the dashboard at the bus stop will display the information as shown in the below diagram.

After filling up the seats at the 2nd bus stop the bus will communicate with the bus depot X and also with all the bus stop regarding no vacant seats.

Bus depot will make the arrangement of another bus and it will send the notification to all the bus stop about the departure and arrival time of the bus.

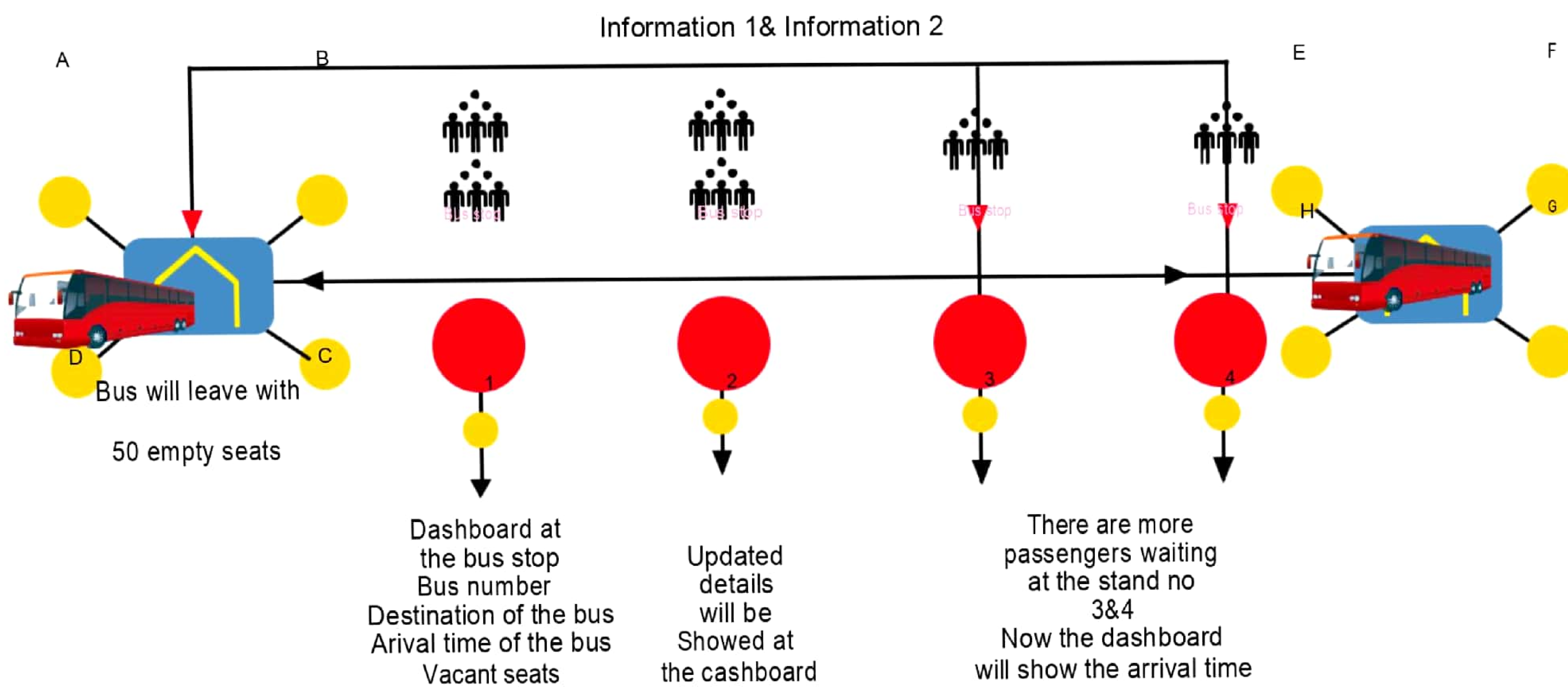
At the same time bus will be notified about the passengers waiting at the 3rd and 4th bus stop.

Scenario when the bus travels from source to destination

Information 1: The bus will update the source bus depot regarding the no space in the bus and the depot will get the information about the number of passengers waiting at all the bus stand

Information 2: Depot will notify the bus stand 3 & 4 about the arrival timing of the bus.

Scenario when the bus travels from source to destination



Fuel monitoring and efficiency measurement system, control of air pollution & tracking of the driver's driving behavior: The fuel prices are rising day by day. It's been necessary to monitor the vehicle's fuel consumption/usage and the efficiency, so that the frauds can be avoided and the efficiency of the vehicle could be maintained

Sensors required

Fuel level measurement sensors

Fuel flow meters (measures the flow of the meter with the travelled distance)

Torque Sensors

Speed measurement sensors

Air monitoring sensors

Whenever the fuel is filled or the level of the fuel changes the information regarding the same will be sent to the bus depot. The efficiency is measured by the fuel flow meters as it will send the information about the distance travelled and the fuel consumption in the meantime. Now, the driving behavior can be analyzed through the sensors (speed measurement and torque sensors) which would be fitted in the bus' tires. The sensors will measure the torque of the tires and the data regarding the same will be sent to the hub where the data will be analyzed and the driver should be punished for the same.The air monitoring sensor will guide the hub about the content of the air pollution made by the bus.

Payment methodology

NFC: The passenger details would be recorded and the amount will be deducted from his account.

Smart Card: Passenger need to recharge that card and payment will be made by swiping it.

M-wallet, Google Wallet will be the other modes of payments

Figure 4 Bus Maintenance System

Bus Maintenance System

Here, the scenario of 'The Bus Breakdown' is discussed just to get the idea how the NOC can take care of the buses. The bus breakdown occurs while in the route from X to Y. Please consider the below events & actions in chronological order:

Pre-assumption:
The transport corporation will be having collaboration with various garage parties

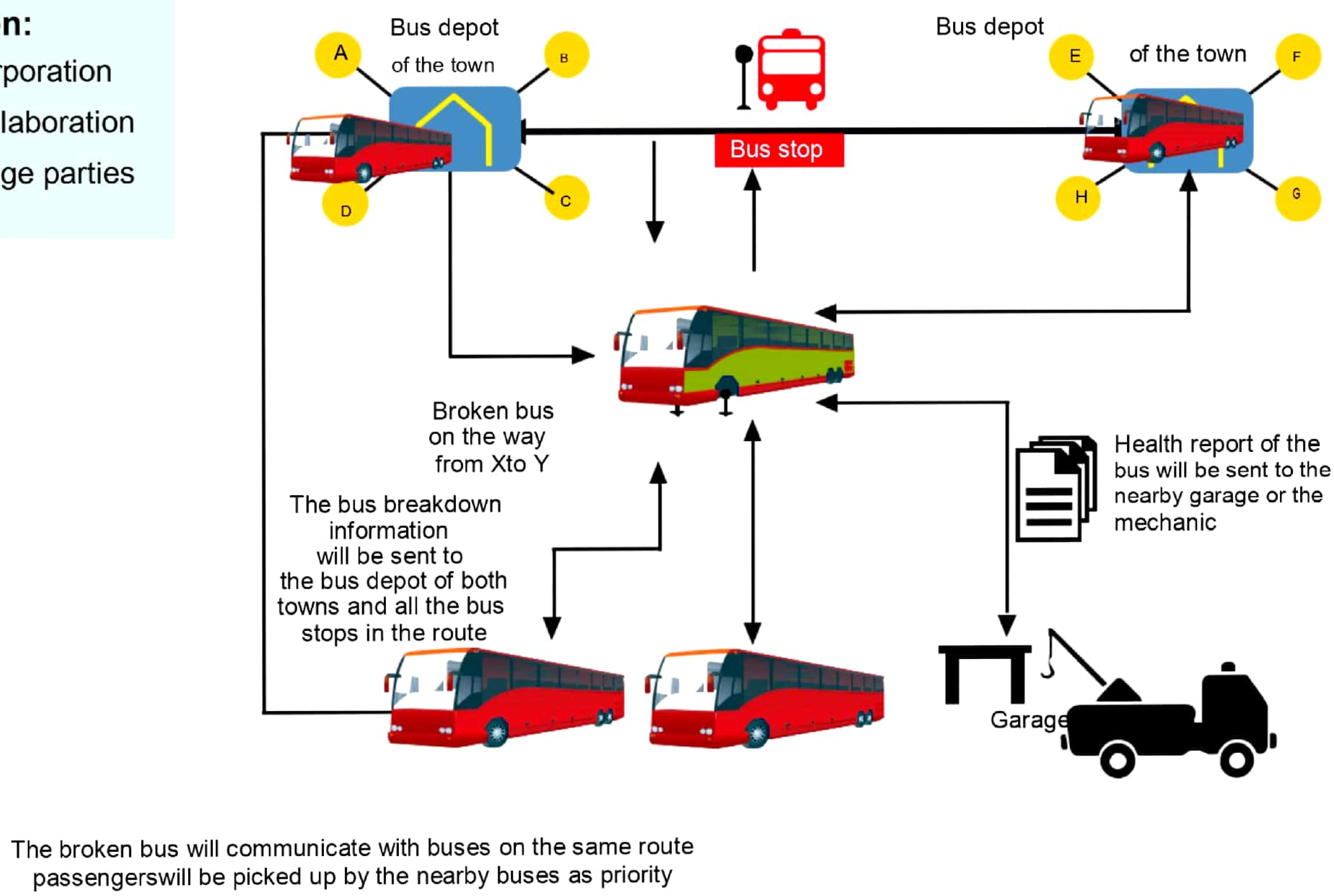


Figure 4 Bus Maintenance System

Profiling of the customers using CRM

State Road Transport System already has some limited Customer data that is taken during issue of a monthly pass. This customer data if could be extended to all other customers in more detailed fashion could be of great use for the implementation of CRM. Assuming that Telecom operator will act as a leader in the system, its customer data might be useful for the profiling of the customers. Once all the customer data is captured the mapping of users could be done using parent ID's and Child ID's. This mapping is useful to have authentication for parents to track their child safety. Usage patterns of the passengers could be analyzed and accordingly loyalty points could be added in the smart card provided to customer. Also CRM helps in getting proper timely feedback about the services offered to passengers.

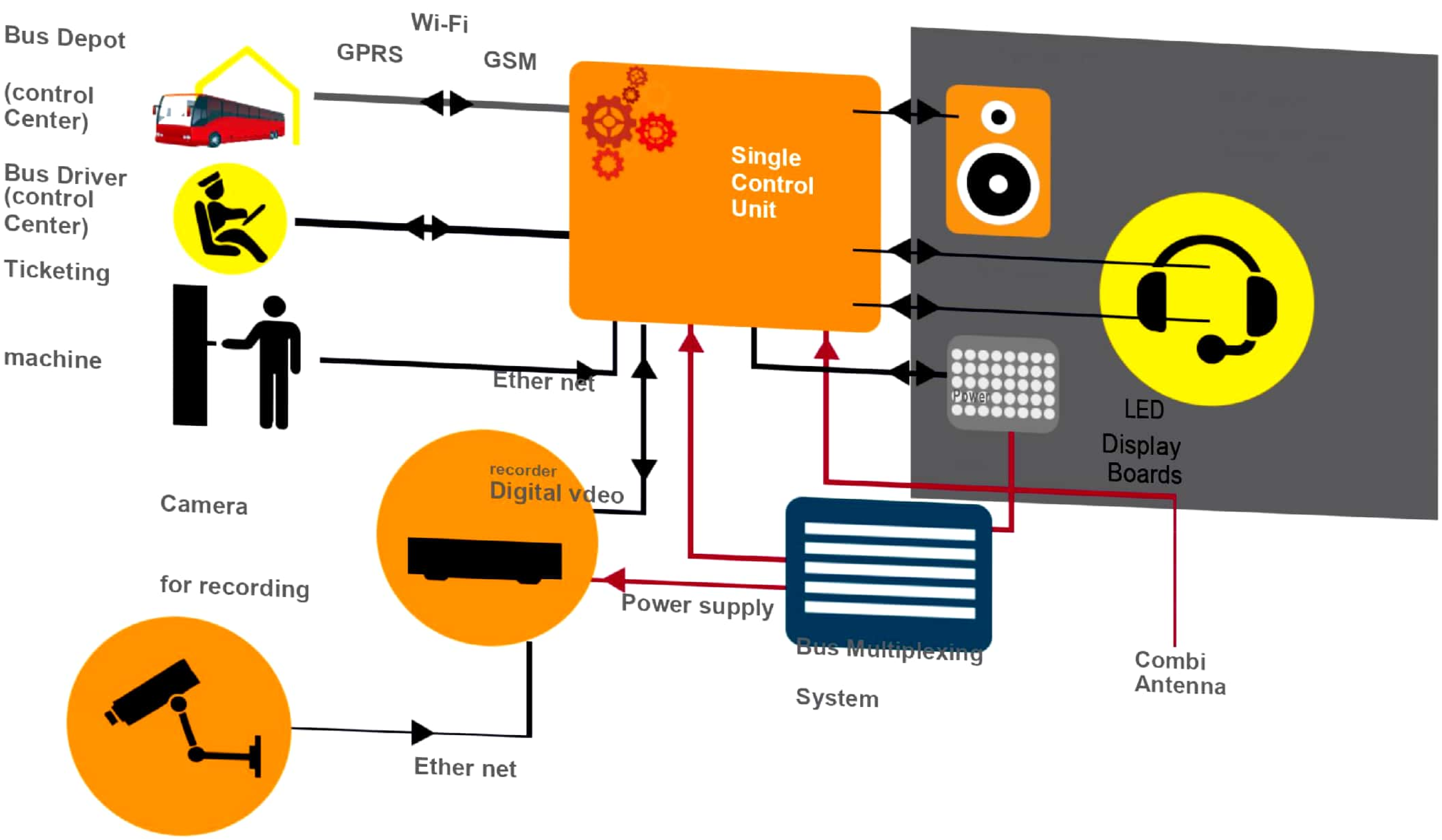
Tracing and tracking of special passengers like kids and woman for the safety purpose

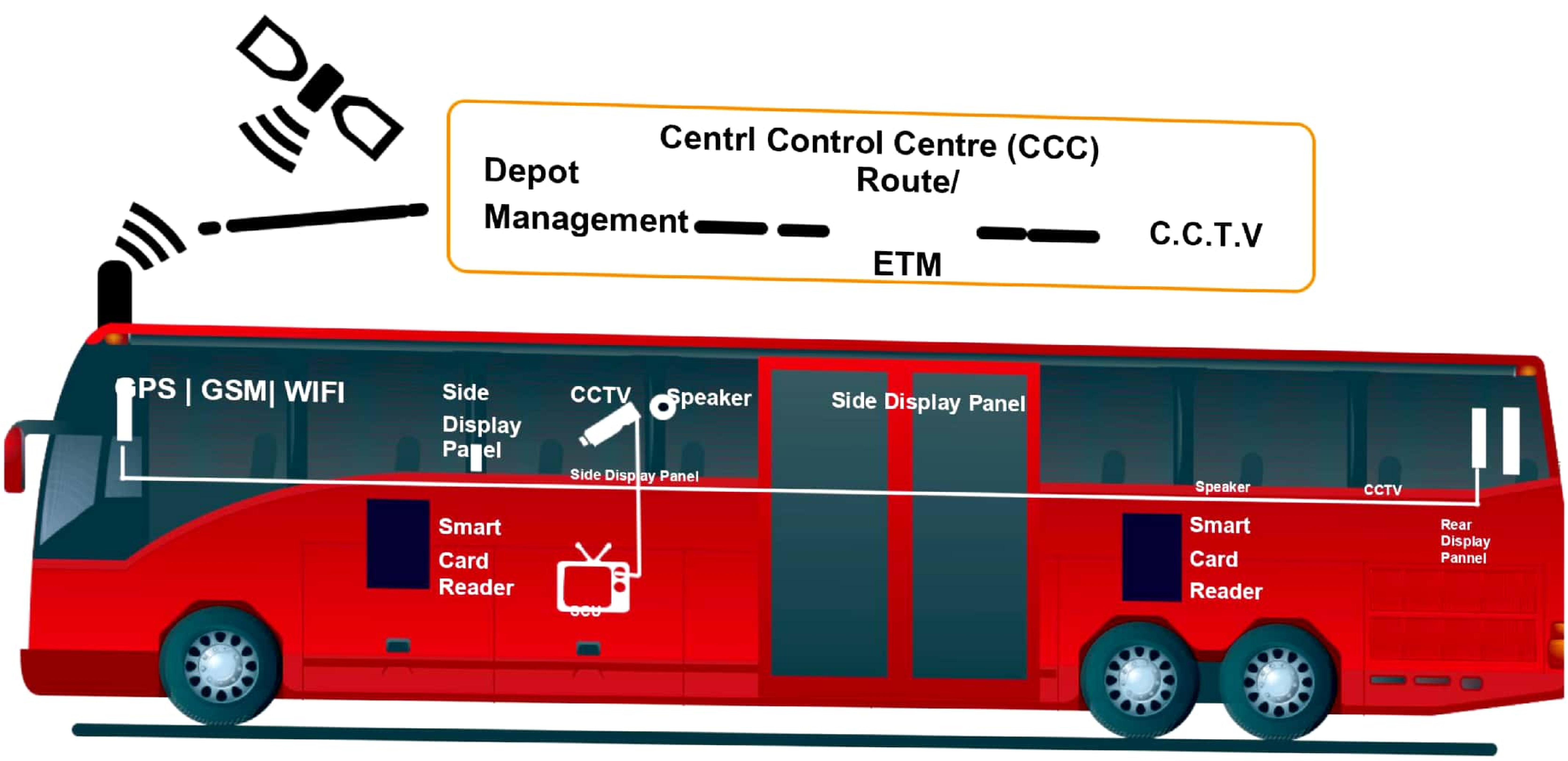
Once we have captured the customer details and mapping of profiles is done. Only people who have the authority predefined can track and trace (using RFID tags or NFC) their kids and also for better women safety.

Infotainment:

A personalized smart screen is provided to each passenger in green field buses. As these are value added services offered, Telecom operators can charge passengers according to their usage. Different infotainment facilities such as streaming videos, preloaded content, real time gaming and information services could be provided. These screens can also be used for advertising based on Location of the bus; content could be loaded through wifi at bus stops. And there by affordable infotainment services could be provided to passengers.

Jawaharlal Nehru National Urban Renewal Mission (JnNURM)
Basic Block Diagram with Key Features





PUBLIC TRANSPORTATION OPTIMIZATION

Abstract:

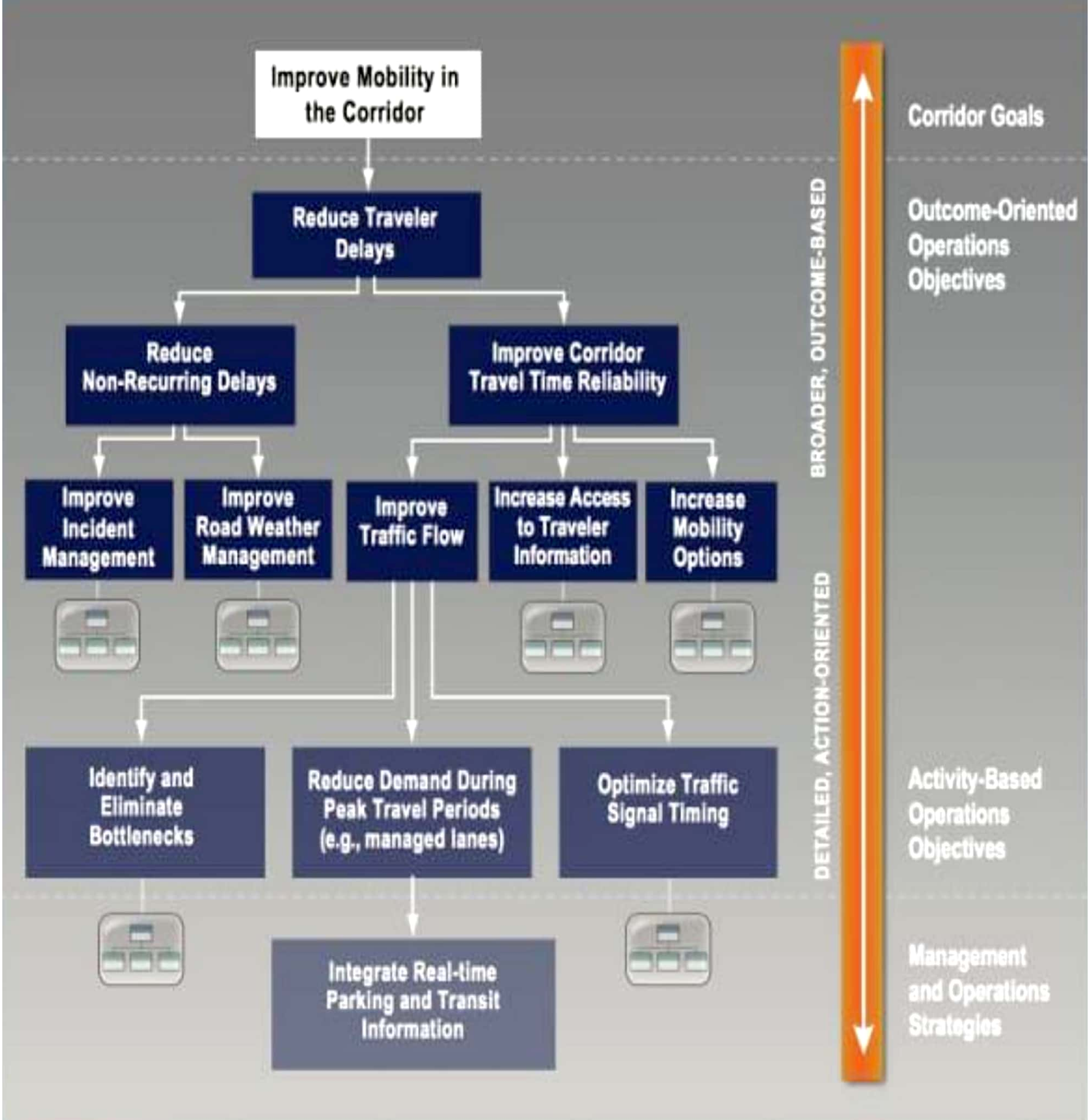
For better sustainable development of cities and urbantraffic, in 2011,China launched a national "bus city" project[1]. ,ere were more cities that took part in this project suchas Beijing, Shanghai, Hangzhou, and Suzhou. With theemergence of shared transportation, public transportationsystems face more challenges. In order to better connect withbike-sharing, car-sharing, and other modes of trans-portation, public transportation will carry out importantreforms, among which the optimization of line network isone of the most important tasks. At the same time, the actionof remolding theground bus network successively appearedin many major cities around the world, such as Seoul,Barcelona, Sydney, Berlin, Houston, Baltimore, Dallas,Portland, Los Angeles, New York, Paris, and London .

As people's travel demand becomes higher and higher, busnetwork reliability plays a very important role in people'sbus service experience [8] due to the influence of variousfactors on bus operation. ,erefore, it is necessary tocombine the reliability of bus network with the optimized

setting of bus network for analysis and research. It provides acomprehensive decision-making method for improving thenetwork topology structure and actual operation of publictransit network [9].

Research on the structure of public bus network andthe optimization of network stations mainly focuses onthe network organization forms of bus lines, such as radialand square grid [10, 11]. As early as 1989, Wang Wei putforward a simple and practical method of "laying out bus

lines one by one and optimizing them into a network,"which was based on the optimization of single bus lines[12]. Later, some scholars proposed the classification andlayering of bus routes according to different passengerflow transportation to be completed, including the radi-

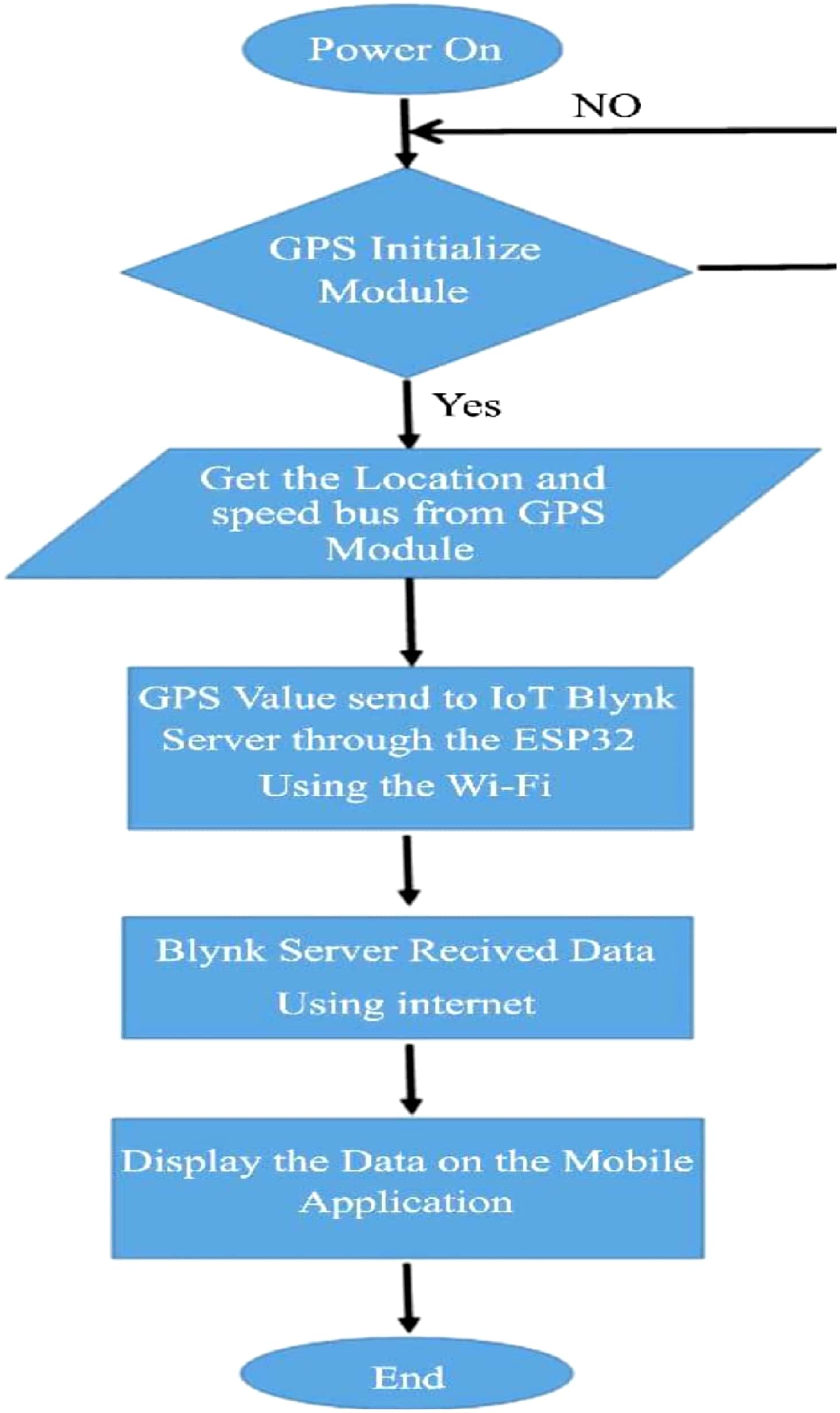


Improve Mobility in the Corridor
Reduce Traveler Delays
Reduce Non-Recurring Delays
Improve Corridor Travel Time Reliability
Improve Incident Management
Improve Road Weather Management
Improve Traffic Flow
Increase Access to Traveler Information
Increase Mobility Options
Identify and Eliminate Bottlenecks
Reduce Demand During Peak Travel Periods (e.g., managed lanes)
Optimize Traffic Signal Timing
Integrate Real-time Parking and Transit Information
BROADER, OUTCOME-BASED
DETAILED, ACTION-ORIENTED
Corridor Goals
Outcome-Oriented Operations Objectives
Activity-Based Operations Objectives
Management and Operations Strategies

ation-type network system [13], the design of bus corri-dors, and the radiation-shaped long-distancetransportation network. Some scholars proposed thestructure of mixed bus network, such as the main network,secondary network, and transfer network [14, 15]. Basedon the concept of hierarchical network, multimode net-work design method [16], fuzzy logic design method, andsystematic method are proposed [17]. Another scholarproposed sensitivity analysis of the bus network andestablished three types of bus networks: transfer guidancenetwork, transfer avoidance network, and direct con-nection network.

Block Diagram :

Furthermore, the growing amount of data generated through IoT also requires more efficient solutions to support the day-to-day operations in smart cities. To improve transportation management, Dai and Ma [39] optimized the traffic in smart cities by analyzing different road traffic problems. Huang and Nazir [40] presented the method of analytic network process for evaluating smart cities. Hossain et al. [41] considered the concept of edge computing in IoT for minimizing the latency of edge devices that generate data for cloud transfer and proved that the processing of these huge data can greatly increase the performance indicators of smart cities. Bellini et al. [42] provided a survey on IoT-enabled smart cities, as well as a review of the main smart city approaches and frameworks to highlight the main trends and open challenges of adopting IoT technologies for the development of sustainable and efficient smart cities



Software Used:

The State of Public Transportation Post-Pandemic

How can public transportation software help mass transit recover?

List of Best Public Transportation Software

The State of Public Transportation Post-Pandemic

In 2019, there were approximately 6,800 organizations providing public transport in the United States (The Census Bureau, 2021). In that same year, the American Community Survey (ACS) reported that about 5% of all workers are public transportation commuters (Burrows et al., 2021). When the pandemic hit, however, the shelter-in-place orders induced a drop in ridership. This affected public transit agencies. While ridership was up by 200 million from April 2020 to June 2021, the figures are still nowhere near where they were prior to the pandemic (The Census Bureau, 2021).

us public transportation:

As of June 2022, the average national weekly demand for public transit in the U.S. was at 52% of actual pre-pandemic ridership (TransitApp/APTA, 2022). When the pandemic led to an increase in remote work, transit agencies lost a large share of their riders. Prior to the COVID-19 pandemic, almost 12% of workers in the largest metropolitan areas were mass-transit commuters (Bloomberg, 2021). Today, only 45% of ridership is back nationally.

Post-pandemic Ridership:

There are many factors affecting the hesitation of commuters in taking public transit. While major business hubs have eased restrictions and most employers are encouraging employees to

return to the office, still, the public transport sector is experiencing a slow return to pre-pandemic ridership levels.