AIN SHAMS UNIVERSITY
Faculty of Engineering
Computers and Systems Department

Graduation Project

Vehicle Infrastructure Integration

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بِسۡمِ ٱللهِ ٱلرَّحۡمَـٰنِ ٱلرَّحِيمِ

"وَقَالُواْ ٱلۡحَمۡدُ لِلَّهِ ٱلَّذِى هَدَىٰنَا لِهَـٰذَا وَمَا كُنَّا لِنَہۡتَدِىَ لَوۡلَآ أَنۡ هَدَىٰنَا ٱللَّهُ"

الأعرَاف - 43

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Chapter 1

Overview

➢ **Visibility of the project**

The World Health Organization (WHO) estimates that more than a million people are killed each year worldwide and another 20 million to 50 million injured or disabled in road accidents. About 85 percent of the deaths occur in low- and middle-income countries. Many of the victims are pedestrians, cyclists, motorcyclists and users of public transportation.

Traffic fatalities per capita are highest in Africa, according to a report issued by the WHO and the World Bank. The mortality rate in Africa due to road traffic injuries was 28.3 per 100,000 people, according to the study, the most recent available, which was released in 2002. In contrast, the mortality rate due to traffic accidents reported for the United States was 15.2 per 100,000.

In Egypt, yearly road deaths number 7,000, with 30,000 injured. And according to state statistics published in Al-Ahram Weekly in 2006, every year car accidents kill about 7,500 and injure about 35,000 Egyptians, in addition to about 30,000 damaged cars. Losses caused by traffic accidents are estimated to stretch to LE 2 billion per year.

The situation in Egypt is somewhat serious and getting worse year by year, especially by the progressive density of traffic with an annual increase of about 100,000 vehicles.

The overall goal is to reduce accidents, save lives, prevent injuries on roadways and monitor the traffic status, therefore communication between vehicles and between vehicles and the roadside is required.

Such reduction has many benefits beyond the obvious saving of lives. Even a non-injury accident can significantly increase traffic congestion and result in significant cost, not only to those involved, but also to society as a whole such as through the increased demands on public services.

➢ What is VII?

Vehicle Infrastructure Integration (VII) is an initiative fostering research and applications development for a series of technologies directly linking road vehicles to their physical surroundings, first and foremost in order to improve road safety.

VII specifically covers road transport although similar technologies are in place or under development for other modes of transport. Planes, for example, use ground-based beacons for automated guidance, allowing the autopilot to fly the plane without human intervention. In highway engineering, improving the safety of a roadway can diminish overall efficiency. VII targets improvements in both safety and efficiency

Project Objective

The goal of VII is to provide a communications link between vehicles on the road (via On-Board Equipment, OBE), and between vehicles and the roadside infrastructure (via Roadside Equipment, RSE), in order to increase the safety, efficiency, and convenience of the of the transportation system

Safety

Current active safety technology relies on vehicle-based radar and vision systems. For example, this technology can reduce rear-end collisions by tracking obstructions in front or behind the vehicle, automatically applying brakes when needed. This technology is somewhat limited in that it senses only the distance and speed of vehicles within the direct line of sight. It is almost completely ineffective for angled and left-turn collisions. It may even cause a motorist to lose control of the vehicle in the event of an impending head-on collision.

The rear-end collisions covered by today's technology are typically less severe than angle, left-turn, or head-on collisions. Existing technology is therefore inadequate for the overall needs of the roadway system.

VII would provide a direct link between a vehicle on the road and all vehicles within defined vicinity. The vehicles would be able to communicate with each other, exchanging data on speed, orientation, perhaps even on driver awareness and intent. This could increase safety for nearby vehicles, while enhancing the overall sensitivity of the VII system

In addition, the system is designed to communicate with the roadway infrastructure, allowing for complete, real-time traffic information for the entire network, as well as better queue management and feedback to vehicles

System efficiency

All the above factors are largely in response to safety but VII could lead to noticeable gains in the operational efficiency of a transportation network. As vehicles will be linked together

with a resulting decrease in reaction times, the headway between vehicles could be reduced so that there is less empty space on the road. Available capacity for traffic would therefore be increased.

Real-time traffic data can also be used in the design of new roadways or modification of existing systems as the data could be used to provide accurate origin-destination studies and turning-movement counts for uses in transportation forecasting and traffic operations. Such technology would also lead to improvements for transport engineers to address problems whilst reducing the cost of obtaining and compiling data. Tolling is another prospect for VII technology as it could enable roadways to be automatically tolled. Data could be collectively transmitted to road users for in-vehicle display, outlining the lowest cost, shortest distance, and/or fastest route to a destination on the basis of real-time conditions.

Privacy

The architecture is designed to prevent identification of individual vehicles, with all data exchange between the vehicle and the system occurring anonymously. The network traffic will be sent via encrypted tunnels and will therefore not be decipherable by the VII system.

Although the system will be able to detect signal and speed violations, it will not have the capability to identify the violator and report them. The detection is for the purpose of alerting the violator and/or approaching vehicles, to prevent collisions

Security

Criminals could tamper with VII units, or remove and/or destroy them regardless of whether they are installed inside vehicles or along the roadside. If they are placed inside vehicles, laws similar to those for tampering with an odometer could be enacted; and the units could be examined during inspections or services for signs of tampering. This method has many of the limitations mentioned in relation to the frequency of inspection. It also raises concerns regarding the honesty of vehicle technicians performing the inspections. The ability of technicians to identify signs of tampering would be dependent on their knowledge of the VII systems themselves.

Magnets, electric shocks, and malicious software (viruses, hacking, or jamming) could be used to damage VII systems - regardless of whether units are located inside vehicle or along the roadside. Extensive training and certification would be required for technicians to inspect VII units within a vehicle. Along the roadside, a high degree of security would be required to ensure that the equipment is not damaged and to increase its durability. However, as roadside units could well be placed on the public right-of-way - which is often close to the edge of the roadway - there could be concerns about vehicles hitting them (whether on purpose or by accident). The unit would have to be shielded by a device such as a guardrail, raising safety concerns of its own.

➢ Scope of work

The technology draws on several disciplines, including transport engineering, electrical engineering, automotive engineering, and computer science

There are two phases

1) **Phase 1:**

   Platform software which support all the applications which the Vehicle Infrastructure Integration contains, it will also make a simple simulation for those applications and it will also helps in implementation of the hardware of any of the applications referred.

2) **Phase 2:**

   Implementation of one or more of the applications but with restrictions so as to be applicable.

➢ Project structure

Hardware

Building the hardware kit (OBU) which will be placed in the vehicles.

Software

Implementing prototype software for the six supported application which are:

Simulation

Building a simulation application for the traffic system before and after applying our project so as to prove the feasibility of the project using the GPSS

➢ Customer Requirements

The VII architecture will support a wide range of applications that can occur both in vehicles and in the infrastructure. The architecture will support:

1. **Intersection collision avoidance**
2. **Red sign violation**
3. **Emergency unit**
4. **Congested area**
5. **Blocked area**
6. **Monitoring system**

➢ User Characteristics

Professional users: **Those who can integrate, implement, and maintain the system are also responsible for inserting new features in the system.**

Administrators: **Those who manage the system and control it while it is running.**

End-users: **Those are the car drivers which will use the system and benefit from increased safety, they don't need any professionalism and they only operate the kits in their cars and read instructions on its LCD screen.**

➢ Assumptions

- **There is no traffic lights, only our system are managing the whole traffic system**
- **There is a telephone line with ADSL service in the servers' locations that are dedicated for the system**
- **The kits in the vehicles are standard and all produced by us**
- **Also we assume respect of the user towards these instructions that will appear to him.**

Chapter 2

Technical Issues

➢ Communication Methods

Background in Networking

ISO/OSI Reference Model

Modern computer networks are designed in a highly structured way. To reduce their design complexity, most networks are organized as a series of layers, each one built upon its predecessor. The OSI Reference Model is based on a proposal developed by the International Organization for Standardization (ISO). The model is called ISO OSI (Open Systems Interconnection) Reference Model because it deals with connecting open systems - that is, systems that are open for communication with other systems.

The OSI model has seven layers which are

Layer 1 – Physical

Physical layer defines the cable or physical medium itself, e.g., thin net, thick net, unshielded twisted pairs (UTP). All media are functionally equivalent. The main difference is in convenience and cost of installation and maintenance. Converters from one media to another operate at this level.

Layer 2 - Data Link

Data Link layer defines the format of data on the network. A network data frame packet includes checksum, source and destination address, and data. The largest packet that can be sent through a data link layer defines the Maximum Transmission Unit (MTU). The data link layer handles the physical and logical connections to the packet's destination, using a network interface. A host connected to an Ethernet would have an Ethernet interface to handle connections to the outside world, and a loop back interface to send packets to itself.

Layer 3 - Network

NFS uses Internetwork Protocol (IP) as its network layer interface. IP is responsible for routing, directing datagrams from one network to another. The network layer may have to break large datagrams, larger than MTU, into smaller packets and host receiving the Packet will have to reassemble the fragmented datagram. The Internetwork Protocol identifies each host with a 32-bit IP address.

Layer 4 - Transport

Transport layer subdivides user-buffer into network-buffer sized datagrams and enforces desired transmission control. Two transport protocols, Transmission Control Protocol (TCP) and User Datagram Protocol (UDP), sits at the transport layer. Reliability and speed are the primary difference between these two protocols. TCP establishes connections between two hosts on the network through 'sockets' which are determined by the IP address and port number. TCP keeps track of the packet delivery order and the packets that must be resent. Maintaining this information for each connection makes TCP a stateful protocol. UDP on the other hand provides a low overhead transmission service, but with less error checking. NFS is built on top of UDP because of its speed and statelessness. Statelessness simplifies the crash recovery.

Layer 5 - Session

The session protocol defines the format of the data sent over the connections. The NFS uses the Remote Procedure Call (RPC) for its session protocol. RPC may be built on either TCP or UDP. Login sessions use TCP whereas NFS and broadcast use UDP.

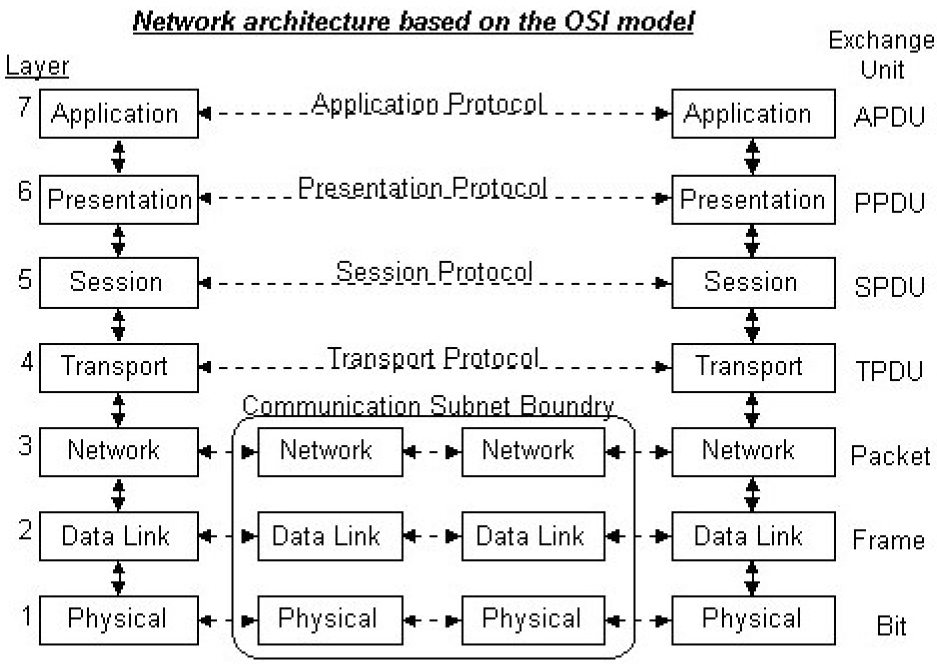
Layer 6 - Presentation

External Data Representation (XDR) sits at the presentation level. It converts local representation of data to its canonical form and vice

versa. The canonical uses a standard byte ordering and structure packing convention, independent of the host.

Layer 7 - Application

Provide network services to the end-users. Mail, ftp, telnet, DNS, NIS, NFS are examples of network applications.



➢ Types of communication methods

In case of Bluetooth

Sending out very weak signals of about 1 mile watt. The low power limits the range of a Bluetooth device to about 10 meters (32 feet). Bluetooth can connect up to eight devices simultaneously.

Due to its very short range it is not recommended to use Bluetooth in our system.

In case of using RFID

RFID (Radio Frequency Identification) is a method of identifying unique items using radio waves. Typical RFID systems are made up of 2 major components: readers and tags

Active RFID Tags are battery powered. They broadcast a signal to the reader and can transmit over the greatest distances (100 feet).

Passive RFID Tags do not contain a battery. Instead, they draw their power from the reader. Passive tags can transmit information over shorter distances (typically 10 feet or less)

Also due to its small coverage area (10m maximum) it is not recommended to be used

- ✓ **Wireless LAN is the one which will be used in our System**

Wireless LAN

What is a Wireless LAN?

A wireless local area network (Wireless LAN) is a computer Network that allows a user to connect without the need for a Network cable. A laptop or PDA equipped with a wireless

LAN card lets a user move around a building with their Computer and stay connected to their network without needing to "plug in" with a cable. The most popular wireless LAN today is called an 802.11b network; the type of wireless LAN referred to is in this section.

Wireless LANs are used in office buildings, on college campuses, or in houses, allowing multiple users shared access to one Internet connection. Some airports also plan to, or already offer wireless LAN access.

Wireless LANs are a successful and popular technology, which is widespread and being incorporated into many new laptops as standard equipment.
Other names for wireless LANs are "802.11", or "Wi-Fi".

Coverage

Wireless LANs require an access point that all the wireless devices connect to, which then connects the users to the wired network. The coverage of a wireless access point can be up to 100 m (330 feet) indoors.

They are typically used in buildings to replace an existing wired Ethernet, or in a home to allow multiple users access to the same Internet connection.

Speed

The 802.11b wireless LAN standard transfers data at speeds of up to 11 Mbps, with typical rates of between 1–4 Mbps, decreasing as more users share the same wireless LAN connection. The next version, 802.11a, is supposed to transfer data at speeds of up to 54 Mbps. However, a potential problem

for throughput is overcrowding of the bandwidth. Many people or businesses using wireless LANs in the same area can overcrowd the frequency band on which they are transmitting. Problems with signal interference are already occurring and airwaves may become overcrowded.

Data Security

Security is one of the most important features when using a wireless network.
802.11b networks have several layers of security, however there are weaknesses in all of these security features.

The first level of security is to have wireless LAN authentication done using the wireless adapter’s hardware (MAC) address. However, this alone is not secure because the MAC address of a wireless client can easily be falsely created.

Security can be increased on wireless LANs by using shared key authentication. This shared key must be delivered through a secure method other than the 802.11 connection. In practice, this key is manually configured on the access point and client, which is not efficient on a large network with many users. This shared key authentication is not considered secure and is not recommended to ensure security.

Another weakness in an 802.11 network is the difficulty in restricting physical access to the network, because anyone within range of a wireless access point can send, receive, or intercept frames. WEP (Wired Equivalency Protocol) was designed to provide security equivalent to a wired network by encrypting the data sent between a wireless client and an access point.

so all wireless access points and clients use the same manually configured WEP. With several wireless clients sending large amounts of data, without changing the WEP key, it is possible to intercept data traffic and determine the WEP key. This would allow a hacker to intercept and decrypt the data traffic.

Another problem that has been reported with wireless LANs is that when the security features are turned on, there are problems with interoperability between wireless LAN modules from one vendor and wireless LAN access points from another vendor.
Wireless LANs were designed specifically to operate in the 2.4 GHz band, which is a globally allocated frequency for unlicensed operation. This means that there is no requirement to be a licensed operator to run a wireless LAN in this frequency.

Hotspots

Hotspots are wireless LANs available to the public in a location, like an airport or city neighborhood.
These (hotspots) enable users to access the network either free of charge, or for a fee paid to the network operator. These networks are being deployed by individuals, wireless LAN operators, and even cellular operators as a way of complimenting their existing cellular networks for data users.

Although the coverage of hotspots is limited, they provide an alternative method of publicly accessing data wirelessly. Obviously security should be a major concern when using a wireless LAN in a hotspot, since there may be no security on the public, shared network.

Costs

Since wireless LANs operate in the unlicensed frequency range, there is no service cost for using a private wireless LAN (such as in a corporate office or home office). There will be a monthly Internet service provider cost for accessing the Internet through your wireless LAN access point (through broadband or cable connection). The other main cost involved is the cost of purchasing and installing the wireless LAN equipment and devices, and the cost of maintaining the network and the users. There are normally fees for using public "hotspot" access.

TCP/UDP protocols

- **TCP** **(Transmission Control Protocol) is a transport protocol that manages the individual conversations between web servers and web client.**

TCP is used extensively by many of the internet's most popular application protocols and resulting applications including the World Wide Web, E-mail, File Transfer Protocol and some streaming media application.

The Internet Protocol (IP) that's used with TCP is the IP, to send" in a form of message units" between computers over the internet. At the same time the IP takes care of handling the actual delivery of the data, the TCP takes care of keeping track of the individual units of data "packets " that the message is divided into for efficient routing through the net.

TCP sometimes incurs relatively long delays (in the order of seconds) while waiting of-out-order messages or retransmissions of lost messages.

Ordered

If two messages are sent along the connection, one after the other, the first message will reach the receiving application first. When data packets arrive in the wrong order, the TCP layer holds the later data until the earlier data can be rearranged and delivered to the application.

Reliable

TCP provides reliable stream delivery service that guarantees to deliver stream of data sent from one host to another without duplication or losing data, making it suitable for applications like file transfer and e-mail. A technique known as positive acknowledgment with retransmission is used to guarantee reliability of packet transfers. This fundamental technique requires the receiver to respond with an acknowledgment message as it receives the data. The sender

keeps a record of each packet it sends, and wait for an acknowledgment before sending the next packet. The sender also keeps a timer from when the packet was sent and retransmits a packet if the timer expires. The timer is needed in case a packet is lost or corrupt. In TCP there is either no missing data, or, in case of multiple timeouts, the connection is dropped.

Connection

It is a Connection Oriented Protocol which means that upon communication it requires handshaking to setup end-to-end connection. A Connection can be made from Client to Server, and from then on any data can be sent along that connection. The Connection is needed to be established before any actual data can be sent.

TCP connection has three phases

1. Connection Establishment.

2. Data Transfer.

3. Connection termination.

Streaming

data is read as a" stream", with nothing distinguishing where one packet ends and another begins. Packets may be split or merged into bigger or smaller data streams arbitrarily

Flow Control

TCP uses an end-to-end Flow Control Protocol to avoid having the sender send data too fast for the TCP receiver to reliably receive and process it.

Congestion Control

TCP uses a number of mechanisms to achieve high performance and avoid congestion collapse This mechanisms control the rate of data entering the network, keeping the data flow below a rate that would trigger collapse.

- **UDP** (User Datagram Protocol) is one of the core protocols of the internet protocol suite. Using UDP, programs on networked computers can send short messages known as datagrams to one another.

  Avoiding the overhead of checking whether every packet actually arrived makes UDP faster and more efficient for applications that do not need guarantee delivery.

Unreliable

UDP does not guarantee reliability or ordering in the way that TCP does. Datagrams may arrive out-of-order, appear duplicated, or go missing without notice. When a message is sent, it can not be known if it will reach its destination; it could be lost along the way there is no concept of acknowledgement, retransmission or timeout.

Not ordered

If two messages are sent to the same recipient, the order in which they arrive cannot be predicted. They may reach their destination out of order.

Connection

UDP is a simpler message-based connectionless protocol. There is no effort made to set up a dedicated end-to-end connection. Communication is achieved by transmitting information in one direction, from source to destination without checking to see if the destination is still there, or if it is prepared to receive the information. With UDP messages (packets) cross the network are independent units.

Datagrams

Packets are sent individually and are guaranteed to be whole if they arrive. Packets have definite bounds and no split or merge into data streams may exist.

✓ **Therefore** the protocol used between the RSU and the vehicle is the UDP, while TCP is used between the RSU and the monitor server to avoid packet loss

GPS tracking

What is a GPS?

A GPS tracking unit is a device that uses the Global Positioning System to determine the precise location of a vehicle, person, or

other asset to which it is attached and to record the position of the asset at regular intervals. The recorded location data can be stored within the tracking unit, or it may be transmitted to a central location data base, or internet-connected computer, using a cellular (GPRS), radio, or satellite modem embedded in the unit. This allows the asset's location to be displayed against a map backdrop either in real-time or when analyzing the track later, using customized software.

How GPS Works:

GPS is a space-based radio navigation system designed to provide worldwide, all-weather, passive, three-dimensional position, velocity, navigation, and time data to a variety of civilian and military users (figure 1). GPS does this by providing a constellation of at least 24 satellites, in an orbit 12,000 miles high and inclined at 55˚, which continuously broadcast their position, a timing signal, and other information. By measuring the time it takes this signal to travel from a given satellite to the user's receiver, the receiver can determine how far from the satellite it is. For a single satellite, the receiver can determine the range, but not the direction, from the satellite. Thus, the receiver has identified a sphere, centered on the satellite, on which the receiver is located. From a second satellite, the receiver could identify such sphere with the receiver location being somewhere on the circular intersection of these spheres. A third satellite provides a third sphere, which reduces the possible receiver location to only two points. A fourth satellite narrows this to a single point. Figure 2 provides a visual interpretation of this process. Thus, by combining the measurements from four different satellites, users can determine their three dimensional position.

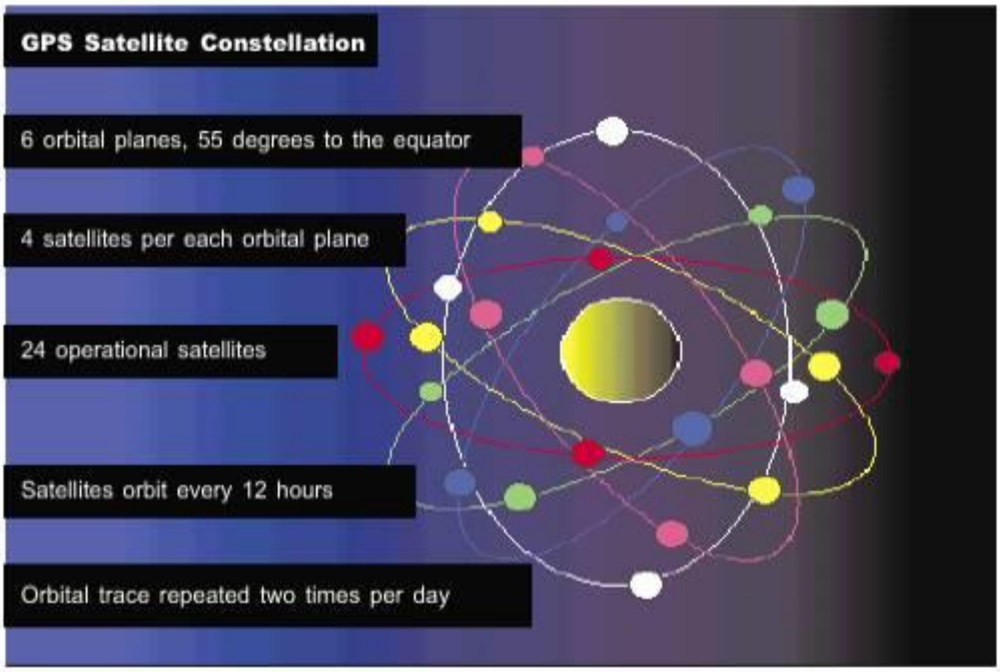


Figure 1. GPS Space Segment

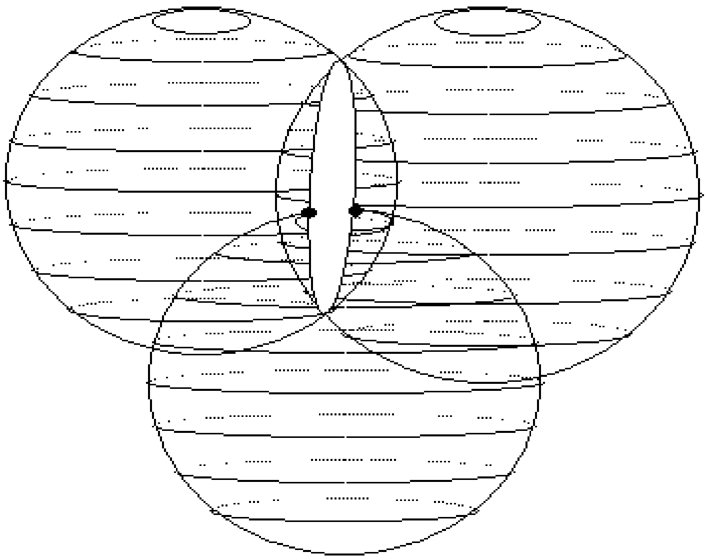


Figure 2. Determining Your Navigation Solution

Types of GPS trackers

- ## Data loggers

A GPS logger simply logs the position of the device at regular intervals in its internal memory. Modern GPS loggers have either a memory card slot, or internal flash memory and a USB port to act as a USB flash drive. This allows easy downloading of the data for further analysis in a computer.

These kinds of devices are most suited for use by sport enthusiasts: They carry it while practising an outdoors sport, e.g. jogging or backpacking. When they return home, they download the data to a computer, to calculate the length and duration of the trip, or to over impose their paths over a map with the aid of GIS software.

In the sport of gliding, competitors are sent to fly over closed circuit tasks of hundreds of kilometres. GPS loggers are used to prove that the competitors completed the task and stayed away from controlled airspace. The data stored over many hours in the loggers is downloaded after the flight is completed and is analysed by computing the start and finish times so determining the fastest competitors.

- ## Data pushers

This is the kind of devices used by the security industry, which pushes (i.e. "sends") the position of the device, at regular intervals, to a determined server, that can instantly analyze the data.

These devices started to become popular and cheaper at the same time as mobile phones. The falling prices of the SMS services, and smaller sizes of phone allowed to integrate the technologies at a fair price. A GPS receiver and a mobile phone sit side-by-side in the same box, powered by the same battery. At regular intervals, the phone sends a text message via SMS, containing the data from the GPS receiver.

The applications of these kind of trackers include:

- **Fleet control. For example, a delivery or taxi company may put such a tracker in every of its vehicles, thus allowing the staff to know if a vehicle is on time or late, or is doing its assigned route. The same applies for armoured trucks transporting valuable goods, as it allows to pinpoint the exact site of a possible robbery.**
- **Stolen vehicle searching. Owners of expensive cars can put a tracker in it, and "activate" them in case of theft. "Activate" means that a command is issued to the tracker, via SMS or otherwise, and it will start acting as a fleet control device, allowing the user to know where the thieves are.**
- **Race control. In some sports, such as gliding, participants are required to have a tracker with them. This allows, among other applications, for race officials to know if the participants are cheating taking unexpected shortcuts or how far apart they are. This use has been featured in the movie "Rat Race", where some millionaires see the position of the racers in a wall map.**
- **Espionage/surveillance. When put on a person, or on his personal vehicle, it allows the person monitoring the tracking to know his/her habits. This application is used by private investigators, and also by some parents to track their children.**

Data pullers

Contrary to a data pusher, that sends the position of the device at regular intervals (push technology), these devices

are always-on and can be queried as often as required (pull technology). This technology is not in widespread use, but an example of this kind of device is a computer connected to the Internet and running GPS

What type of GPS is used in the VII SYSTEM?

Data pushers

In the VII **Data pushers** is the kind of devices used by the security industry, which pushes (i.e. "sends") the position of the device, at regular intervals, to a determined server, that can instantly analyze the data. Automatic vehicle location or AVL is a means for determining the geographic location of a vehicle and transmitting this information to a point where it can be used. Most commonly, the location is determined using GPS, and the transmission mechanism is a Wi-Fi connection from the vehicle to the server at the road side unit. Automatic vehicle location is a powerful tool for managing fleets of vehicles, from service vehicles, emergency vehicles, and construction equipment, to public transport vehicles (buses and trains). It will be also as helpful in our VII as it is a very efficient and reliable technique which is already used in similar projects.

The components of the GPS

- **Barometric altimeter determines current elevation and ascent/descent rate with 10' accuracy**
- **2" x 1" LCD screen with backlight**
- **24MB internal memory with built-in marine point database and Americas basemap**
- **Electronic compass accurate within 2°**
- **WAAS-enabled GPS receiver accurate within 3m**
- **IPX7 waterproof**
- **2" W x 4 7/16" H x 1 3/16" D**
- **Requires 2 AA batteries (not included)**
- **Includes PC interface cable and wrist strap**

GPS formats

GPS receivers are generally capable of transmitting data in several formats. One format, called *Simple*
Text Output protocol, is one of several modes available from GARMIN receivers such as eTrexTM, and the second format is nemea format

1. Text out

In this format, GPS data consists of a simple 7 bit ASCII text string with a constant length of 57 bytes. OneTrex receivers, the string is transmitted about once per second.

The text (ASCII) output contains time, position, and velocity data in the fixed width fields (not delimited) defined in the following table

- ### The format description

@080612165617N3003513E03129343G006+00246E0000N0000U0001

FIELD DESCRIPTION	WIDTH	NOTES
Sentence start	1	Always '@'
Year	2	Last two digits of UTC year
Month	2	UTC month, "01".."12"
Day	2	UTC day of month, "01".."31"
Hour	2	UTC hour, "00".."23"
Minute	2	UTC minute, "00".."59"
Second	2	UTC second, "00".."59"
Latitude hemisphere	1	'N' or 'S'

Latitude position	**7**	**With an implied decimal after the 4th digit**
Longitude hemisphere	**1**	**'E' or 'W'**
Longitude position	**8**	**with an implied decimal after the 5th digit**
Position status	**1**	**'d' if current 2D differential GPS position 'D' if current 3D differential GPS position 'g' if current 2D GPS position 'G' if current 3D GPS position 'S' if simulated position '_' if invalid position**
Horizontal position error	**3**	**EPH in meters**
Altitude sign	**1**	**'+' or '-'**
Altitude	**5**	**Height above or below mean sea level in meters**
East/West velocity direction	**1**	**'E' or 'W'**
East/West velocity magnitude	**4**	**Meters per second in tenths, ("1234" = 123.4 m/s)**
North/South velocity direction	**1**	**N' or 'S'**
North/South velocity magnitude	**4**	**Meters per second in tenths, ("1234" = 123.4 m/s)**
Vertical velocity direction	**1**	**'U' (up) or 'D' (down)**
Vertical	**4**	**Meters per second in hundredths,**

velocity magnitude		("1234" = 12.34 m/s)
Sentence end	2	Carriage return, '0x0D', and 3 line feed, '0x0A'

Notes

- If a numeric value does not fill its entire field width, the field is padded with leading '0's (eg. an altitude of 50 meters above MSL will be output as"+00050").
- Any or all of the data in the text sentence (except for the sentence start and sentence end fields) may be replaced with underscores to indicate invalid data.

2. Nemea format

Most computer programs that provide real time position information understand and expect data to be in NMEA format. This data includes the complete PVT (position, velocity, time) solution computed by the GPS receiver. The idea of NMEA is to send a line of data called a sentence that is totally self contained and independent from other sentences.

Each sentence begins with a '$' and ends with a carriage return/line feed sequence and can be no longer than 80 characters of visible text (plus the line terminators). All of the standard sentences have a two letter prefix that defines the device that uses that sentence type. (For GPS receivers the prefix is GP.) which is followed by a three letter sequence that defines the sentence contents.

- ## The format description

RMC - NMEA has its own version of essential GPS PVT (position, velocity, time) data. It is called RMC, The Recommended Minimum, which will look similar to:

$GPRMC,165728,A,3003.5124,N,03129.3429,E,0.0,82.0,120608,3.2,E,A*25

Where:

RMC	Recommended Minimum sentence C
165728	Fix taken at 16:57:28 UTC
A	Status A=active or V=Void.
3003.5124,N	Latitude 30 deg 03.5124' North
03129.3429,E	Longitude 31 deg 29.3429' East
0.0	Speed over the ground in knots
82.0	Track angle in degrees True
120608	Date - 12 of June 2008
003.1,W	Magnetic Variation
A*25	The checksum data

RMB - The recommended minimum navigation sentence is sent whenever a route or a go to is active. On some systems it is sent all of the time with null data. Note the use of leading zeros in this message to preserve the character spacing.

$GPRMB,A,0.01,L,003,004,2935.240,N,03217.349,E,50.392,124.0, 000.5,V,A*782

Where:

RMB	Recommended minimum navigation information
A	Data status A = OK, V = Void (warning)
0.01,L	Cross-track error (nautical miles, 9.99max), steer Left to correct (or R = right)
003	Origin waypoint ID

004	Destination waypoint ID
2935.240,N	Destination waypoint latitude 29 deg.35.240 min. North
03217.349,E	Destination waypoint longitude 32 deg. 17.349 min. West
50.392	Range to destination, nautical miles (999.9 max)
124.0	True bearing to destination
000.5	Velocity towards destination, knots
V	Arrival alarm A = arrived, V = not arrived
A*782	checksum

GGA - essential fix data which provide 3D location and accuracy data. This is the only sentence that reports altitude.

$GPGGA,165754,3003.5140,N,03129.3425,E,1,07,1.9,245.6,M,16.4,M,,*46

Where:

GGA	Global Positioning System Fix Data
165754	Fix taken at 16:57:54 UTC
3003.5140,N	Latitude 30 deg 03.5140' North
03129.3425,E	Longitude 31 deg 29.3425' East
1	Fix quality: 0 = invalid 1 = GPS fix (SPS) 2 = DGPS fix 3 = PPS fix 4 = Real Time Kinematics 5 = Float RTK 6 = estimated (dead reckoning) (2.3 feature) 7 = Manual input mode 8 = Simulation mode
07	Number of satellites being tracked
1.9	Horizontal dilution of position
245.6,M	Altitude, Meters, above mean sea level
16.4,M	Height of geoid (mean sea level) above WGS84 ellipsoid

(empty field)	time in seconds since last DGPS update
(empty field)	DGPS station ID number
*46	the checksum data, always begins with *

GSV - **Satellites in View shows data about the satellites that the unit might be able to find based on its viewing mask and almanac data. It also shows current ability to track this data. Note that one GSV sentence only can provide data for up to 4 satellites and thus there may need to be 3 sentences for the full information.**

$GPGSV,3,2,12,12,31,280,32,15,50,215,37,17,41,045,42,18,00,276,00*7C

Where:

GSV	Satellites in view
3	Number of sentences for full data
2	sentence 1 of 2
12	Number of satellites in view
12	Satellite PRN number
31	Elevation, degrees
280	Azimuth, degrees
00*7C	SNR - higher is better

GLL - Geographic Latitude and Longitude is a holdover from Loran data and some old units may not send the time and data active information if they are emulating Loran data. If a gps is emulating Loran data they may use the LC Loran prefix instead of GP.

$GPGLL,3003.5124,N,03129.3429,E,165728,A,A*4F

Where:

GLL	Geographic position, Latitude and Longitude
3003.5124,N	Latitude 30 deg. 03.5124 min. North
03129.3429,E	Longitude 31 deg. 29.3429 min. West
165728,	Fix taken at 16:57:28 UTC
A	Data Active or V (void)
*4F	checksum data

BOD - Bearing - Origin to Destination shows the bearing angle of the line, calculated at the origin waypoint, extending to the destination waypoint from the origin waypoint for the active navigation leg of the journey.

$GPBOD,124.0,T,120.8,M, DEST, START *7F

Where:

BOD	Bearing - origin to destination waypoint
124.0,T	bearing 124.0 True from "START" to "DEST"
120.8,M	bearing 120.8 Magnetic from "START" to "DEST"
DEST	destination waypoint ID
START	origin waypoint ID
*7F	checksum

RTE - **RTE is sent to indicate the names of the waypoints used in an active route. There are two types of RTE sentences. This route sentence can list all of the waypoints in the entire route or it can list only those still ahead. Because an NMEA sentence is limited to 80 characters there may need to be multiple sentences to identify all of the waypoints. The data about the waypoints themselves will be sent in subsequent WPL sentences which will be sent in future cycles of the NMEA data.**

$GPRTE,1,1,c,*37

<u>Where:</u>

RTE	Waypoints in active route
1	total number of sentences needed for full data
1	this is sentence 1 of 2
c	Type c = complete list of waypoints in this route w = first listed waypoint is start of current leg
0	Route identifier
*37	checksum

Accuracy and error sources

Accuracy

Accuracy is defined as the degree of conformance between the estimated or measured position and velocity of a platform at a given time and its true position or velocity

Errors

Sources of User Equivalent Range Errors (UERE) Source effect

Ionospheric effects	**± 5 m**
Ephemeris errors	**± 2.5 m**
Satellite clock errors	**± 2 m**
Multipath distortion	**± 1 m**
Tropospheric effects	**± 0.5 m**
Numerical errors	**± 1 m**

Note

To measure the delay, the receiver compares the bit sequence received from the satellite with an internally generated version. By comparing the rising and trailing edges of the bit transitions,

Atmospheric effects

Inconsistencies of atmospheric conditions affect the speed of the GPS signals as they pass through the Earth's atmosphere, especially the ionosphere. Correcting these errors is a significant challenge to improving GPS position accuracy. These effects are smallest when the satellite is directly overhead and become greater for satellites nearer the horizon since the path through the atmosphere is longer. Once the receiver's approximate location is known, a mathematical model can be used to estimate and compensate for these errors.

Humidity also causes a variable delay, resulting in errors similar to ionospheric delay, but occurring in the troposphere. This effect both is more localized and changes more quickly than ionospheric effects, and is not frequency dependent. These traits make precise measurement and compensation of humidity errors more difficult than ionospheric effects.

Changes in receiver altitude also change the amount of delay, due to the signal passing through less of the atmosphere at higher elevations. Since the GPS receiver computes its approximate altitude, this error is relatively simple to correct, either by applying a function regression or correlating margin of atmospheric error to ambient pressure using a barometric altimeter.

Techniques to improve accuracy

Augmentation

Augmentation methods of improving accuracy rely on external information being integrated into the calculation process. There are many such systems in place and they are generally named or described based on how the GPS sensor receives the information. Some systems transmit additional information about sources of error (such as clock drift, ephemeris, or ionospheric delay), others provide direct measurements of how much the signal was off in the past, while a third group provide additional navigational or vehicle information to be integrated in the calculation process.

Examples of augmentation systems include the Wide Area Augmentation System, Differential GPS, Inertial Navigation Systems and Assisted GPS.

Differential Global Positioning System (DGPS) is an enhancement to Global Positioning System that uses a network of fixed, ground-based reference stations to broadcast the difference between the positions indicated by the satellite systems and the known fixed positions. These stations broadcast the difference between the measured satellite pseudoranges and actual (internally computed) pseudoranges, and receiver stations may correct their pseudoranges by the same amount.

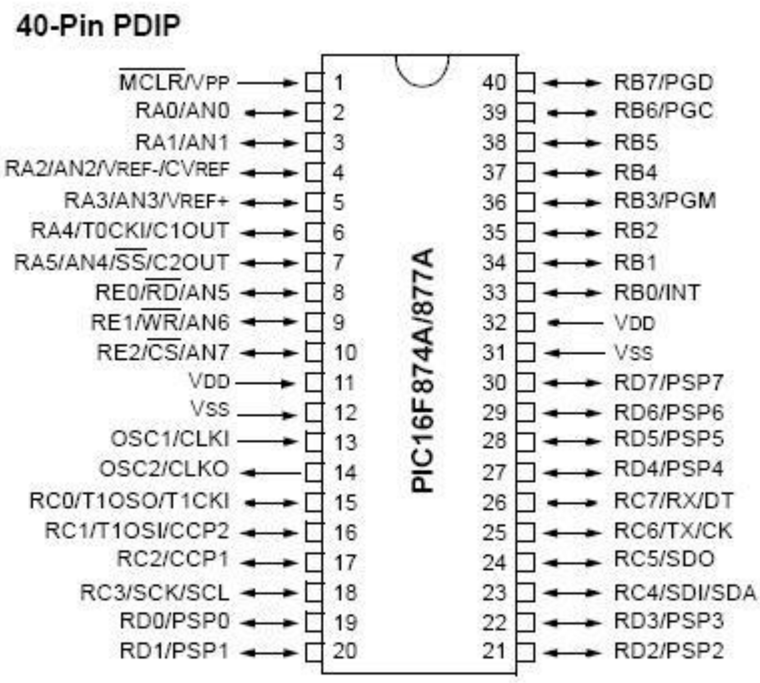
3. Microcontroller

Microcontroller is used for data gathering, processing, and preparing the data to be sent in a way that will be understood by the program in the microcontroller or computer in the other end (server end)
To the microcontroller a TRX will be connected, so that the data can be transmitted from the car to the Roadside unit and vice versa.

Special Microcontroller Features

- 100,000 erase/write cycle Enhanced Flash program memory typical
- 1,000,000 erase/write cycle Data EEPROM memory typical
- Data EEPROM Retention > 40 years
- Self-reprogrammable under software control
- In-Circuit Serial Programming™ (ICSP™) via two pins
- Single-supply 5V In-Circuit Serial Programming
- Watchdog Timer (WDT) with its own on-chip RC oscillator for reliable operation
- Programmable code protection
- Power saving Sleep mode
- Selectable oscillator options
- In-Circuit Debug (ICD) via two pins

Pin configuration of PIC16F87



Pin configuration of PIC18F87

INTERFACE

1.Serial Interface

What Is Serial?

Serial is a device communication protocol that is standard on almost every PC. Most computers include two RS232-based serial ports. Serial is also a common communication protocol for instrumentation in many devices, and numerous GPIB-compatible devices come with an RS232 port. Furthermore, you can use serial communication for data acquisition in conjunction with a remote sampling device.

The concept of serial communication is simple. The serial port sends and receives bytes of information one bit at a time. Although this is slower than parallel communication, which allows the transmission of an entire byte at once, it is simpler and you can use it over longer distances. For example, the IEEE 488 specifications for parallel communication state that the cabling between equipment can be no more than 20 m total, with no more than 2 m between any two devices; serial, however, can extend as much as 1200 m.

Also serial is used to transmit ASCII data. They complete communication using three transmission lines -- ground, transmit, and receive. Because serial is asynchronous, the port can transmit data on one line while receiving data on another. Other lines are available for handshaking but are not required. The important serial characteristics are baud rate, data bits, stop bits, and parity. For two ports to communicate, these parameters must match:

1. **Baud rate is a speed measurement for communication that indicates the number of bit transfers per second. For example, 300 baud is 300 bits per second. When engineers refer to a clock cycle, they mean the baud rate, so if the protocol calls for a 4800 baud rate, the clock is running at 4800 Hz. This means that the serial port is sampling the data line at 4800 Hz.**

2. **Data bits are a measurement of the actual data bits in a transmission. When the computer sends a packet of information, the amount of actual data may not be a full 8 bits. Standard values for the data packets are 5, 7, and 8 bits. Which setting you choose depends on what information you are transferring. For example, standard ASCII has values from 0 to 127 (7 bits). Extended ASCII uses 0 to 255 (8 bits). If the data you are transferring is simple text (standard ASCII), sending 7 bits of data per packet is sufficient for communication. A packet refers to a single byte transfer, including start/stop bits, data bits, and parity. Because the number of actual bits depends on the protocol selected, you can use the term "packet" to cover all instances.**

3. **Stop bits are used to signal the end of communication for a single packet. Typical values are 1, 1.5, and 2 bits. Because the data is clocked across the lines and each device has its own clock, it is possible for the two devices to become slightly out of sync. Therefore, the stop bits not only indicate the end of transmission but also give the computers some room for error in the clock speeds. The more bits used for stop bits, the greater the lenience in synchronizing the different clocks, but the slower the data transmission rate.**

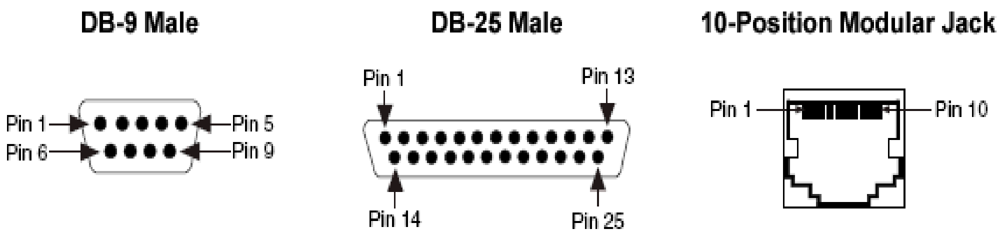
4. Parity is a simple form of error checking used in serial communication. There are four types of parity -- even, odd, marked, and spaced. You also can use no parity. For even and odd parity, the serial port sets the parity bit (the last bit after the data bits) to a value to ensure that the transmission has an even or odd number of logic-high bits. For example, if the data is 011, for even parity, the parity bit is 0 to keep the number of logic-high bits even. If the parity is odd, the parity bit is 1, resulting in 3 logic-high bits. Marked and spaced parity does not actually check the data bits but simply sets the parity bit high for marked parity or low for spaced parity. This allows the receiving device to know the state of a bit so the device can determine if noise is corrupting the data or if the transmitting and receiving device clocks are out of sync.

RS232 Overview

RS232 is the serial connection found on IBM-compatible PCs. It is used for many purposes, such as connecting computers to sensors and modems, or for instrument control. RS232 hardware permits communication at distances up to 50 ft. RS232 is limited to point-to-point connections between PC serial ports and devices.

National Instruments offers RS232 serial interfaces on a variety of platforms, including PCI, USB, PCMCIA, Express Card, PXI, and Ethernet. Depending on the platform, NI Serial interfaces are available in 1, 2, 4, 8, and 16 port versions. In addition, NI RS232 serial interfaces offer increased functionality, such as high speed baud rates up to 1 Mb/s, minimal CPU usage through DMA transfers, optional 2000 V port-to-port isolation, and configurable non standard baud rates. All National Instrument Serial interfaces include NI-Serial driver software, which implements the entire RS232 protocol and provides high-level, easy-to-use functions for rapid application development

Pin outs for NI Serial Interface Connectors



DB-9 Male			DB-25 Male			10-Position Modular Jack		
Pin	RS232	RS485/RS422	Pin	RS232	RS485/RS422	Pin	RS232	RS485/RS422
1	DCD	GND	2	TXD	RTS+ (HSO+)	1	No Connect	No Connect
2	RXD	CTS+ (HSI+)	3	RXD	CTS+ (HSI+)	2	RI	TXD-
3	TXD	RTS+ (HSO+)	4	RTS	RTS- (HSO-)	3	CTS	TXD+
4	DTR	RXD+	5	CTS	TXD+	4	RTS	RTS- (HSO-)
5	GND	RXD-	6	DSR	CTS- (HSI-)	5	DSR	CTS- (HSI-)
6	DSR	CTS- (HSI-)	7	GND	RXD-	6	GND	RXD-
7	RTS	RTS- (HSO-)	8	DCD	GND	7	DTR	RXD+

8	CTS	TXD+	20	DTR	RXD+	8	TXD	RTS+ (HSO+)
9	RI	TXD-	22	RI	TXD-	9	RXD	CTS+ (HSI+)
-	-	-	-	-	-	10	DCD	GND

What Is Handshaking?

This RS232 communication method allows for a simple connection of three lines -- Tx, Rx, and ground. However, for the data to be transmitted, both sides must be clocking the data at the same baud rate. Although this method is sufficient for most applications, it is limited in responding to problems such as overloaded receivers. This is where serial handshaking can help. Three of the most popular forms of handshaking with RS232 are software handshaking, hardware handshaking, and X modem.

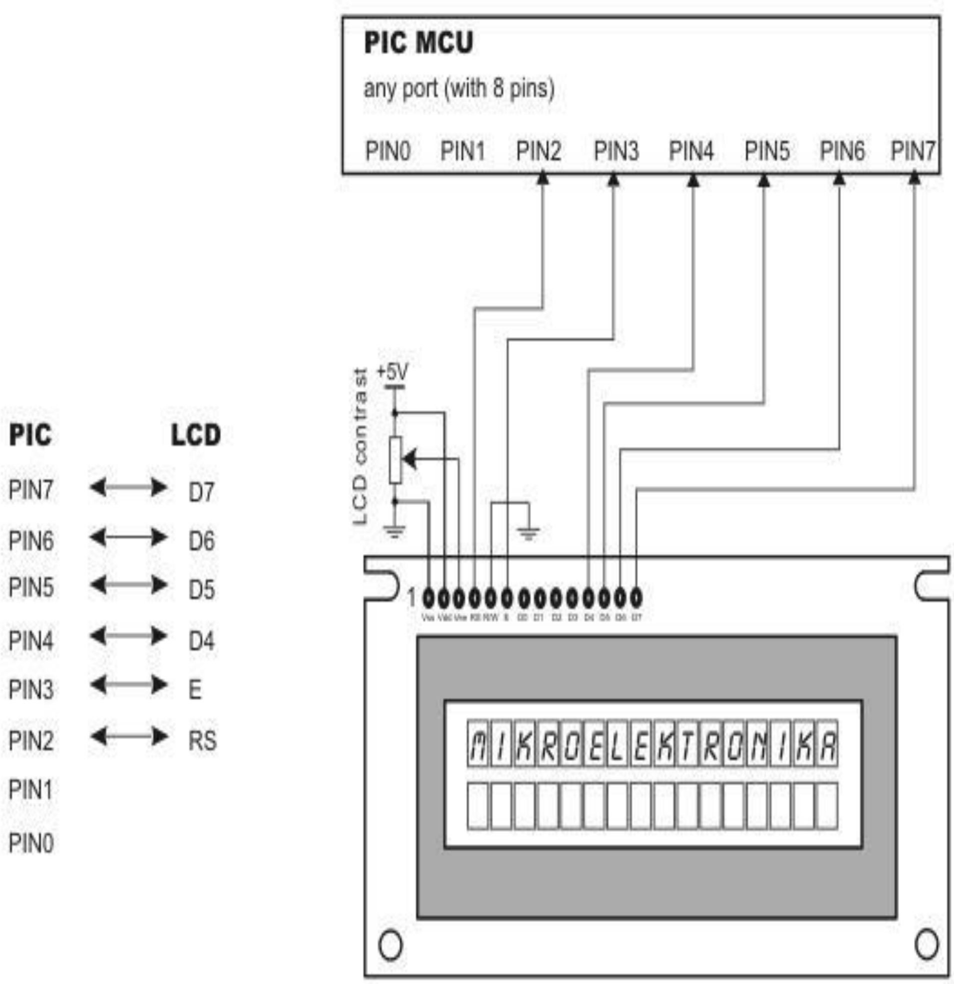
2. LCD interface

Any port with 8 pins will send 1 byte sequentially.

LCD will convert ASCI (8 bits) to aspecial character

Ex: 0x41-→0100 0001

it'll appear on LCD a character 'A'



3. SPI Interface

The Serial Peripheral Interface Bus or SPI bus is a synchronous serial data link standard named by Motorola that operates in full duplex mode. Devices communicate in master/slave mode where the master device initiates the data frame. Multiple slave devices are allowed with individual slave select (chip select) lines. Sometimes SPI is called a "four wire" serial bus, contrasting with three, two, and one wire serial buses. It has the advantage over SCI (Serial Communication Interface) or UART for its very bit rate since its clock may be as high as 70 MHz while the maximum data rate of UART is about 100 kbps only.

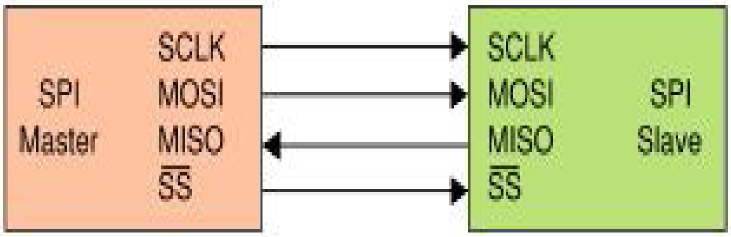


Figure SPI bus: single-master single-slave.

The SPI supports:

- Full duplex
- Synchronous serial transmission
- Serial Communication with peripheral devices

The SPI has two modes of operations

Master Mode

In this mode the SPI generates the synchronizing clock and initiates the transmissions. The SPI operates in Master Mode by setting the MSTR bit in SPICR1.In our system, we use this mode to

Slave Mode

In which the SPI depends on the Master peripheral to generate the synchronizing clock and initiates transmissions

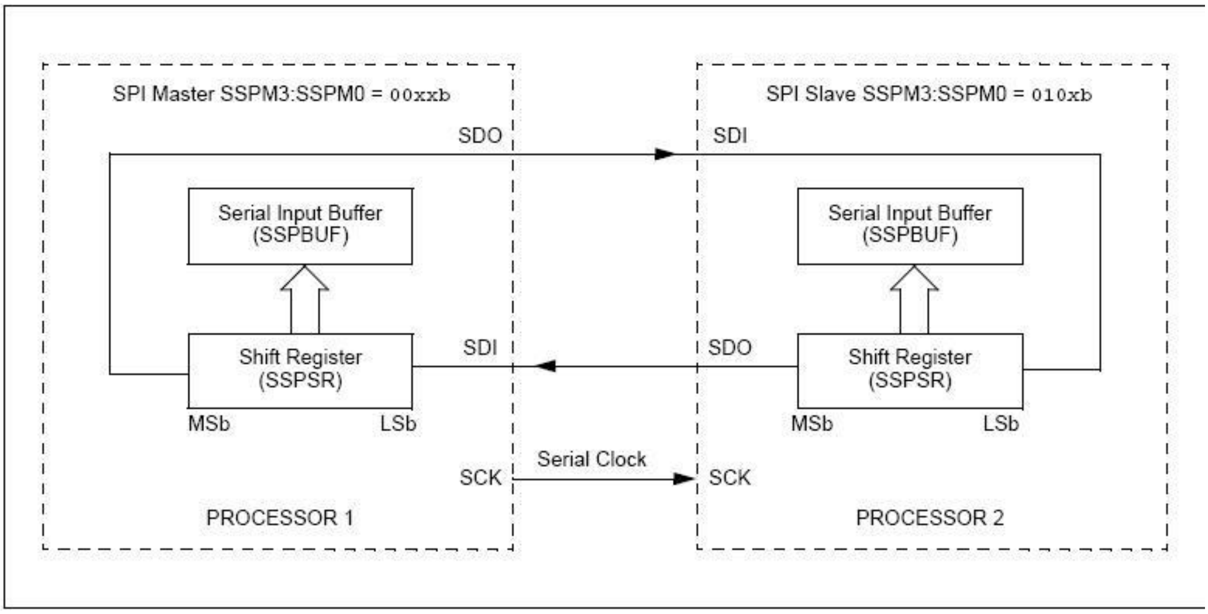


Figure SPI MASTER/SLAVE CONNECTION

This Figure shows a typical connection between two microcontrollers. The master controller (Processor 1) initiates the data transfer by sending the SCK signal. Data is shifted out of both shift registers on their programmed clock edge and latched on the opposite edge of the clock. Both processors should be programmed to the same Clock Polarity (CKP), then both controllers would send and receive data at the same time. Whether the data is meaningful (or dummy data) depends on the application software.

This leads to three scenarios for data transmission:

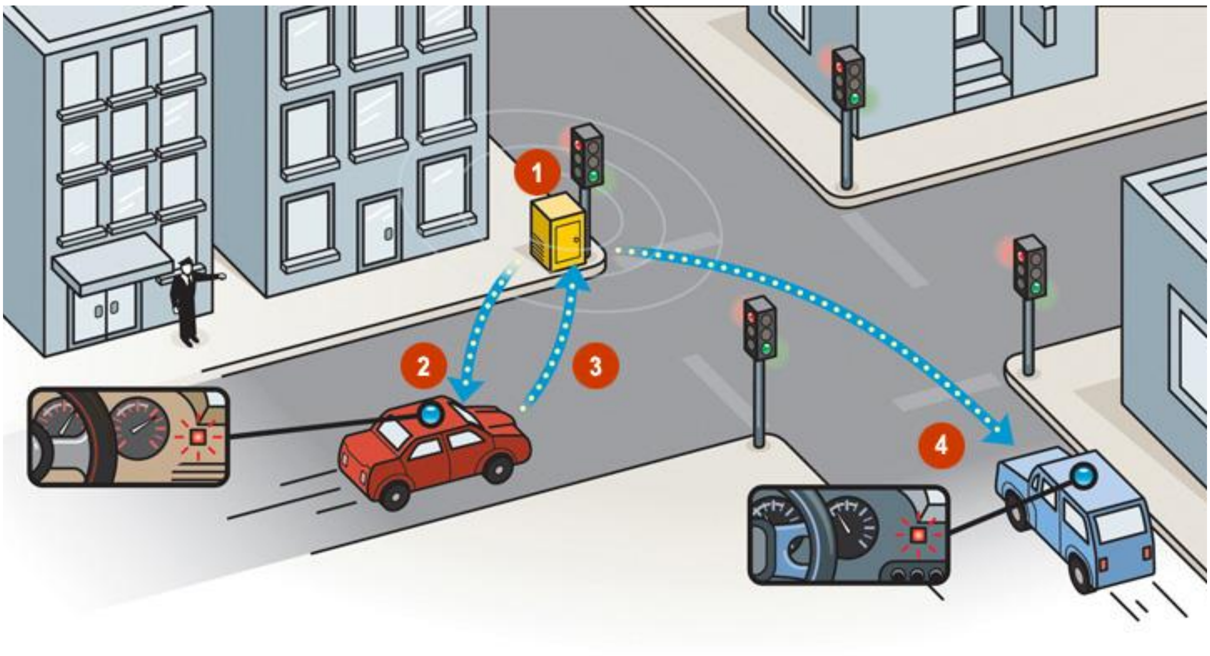
- **Master sends data – Slave sends dummy data**
- **Master sends data – Slave sends data**
- **Master sends dummy data – Slave sends data**

Chapter 3

System components

Required

This project aims to build two main units, road side unit (RSU) and on board unit (OBU), the RSU acts as a client which communicate with the OBU which acts as a server through wireless connection to be able to interchange data



On-Board Equipment (OBEs)

OBUs provide the communications both between the vehicles and the RSUs and between the vehicle and other nearby vehicles. The OBUs may regularly transmit status messages to other OBUs to support safety applications between vehicles. At intervals, the OBEs may also gather data to support public applications. The OBEs will accommodate storage of many snapshots of data, depending upon its memory and communications capacity. After some period of time, the oldest data is overwritten. The OBEs also assembles vehicle data together with GPS data as a series of snapshots for transmission to the RSU.

Prototype Onboard equipment (OBE)

The OBE consists of:

1. GPS tracking unit

The OBE uses GPS-derived information to verify that information from the RSE or other vehicles is relevant and to determine if the driver should be alerted to potentially hazardous trajectories of approaching vehicles.

It receives the coordinates and the speed of the vehicle from the satellite to specify the location of the vehicle

2. Wireless communication unit

It sends the captured data from the GPS receiver and sends it to the roadside unit through the wireless connection and it receives the signals from the Roadside unit.

3. LCD

It displays the received signals and data from the Roadside unit

4. Microcontroller

The vehicles contain microcontrollers that can enter to the wireless network and process the coming data from the Roadside unit and to control the whole operation.

It is connected wireless to the computer where according to the output of the software installed in computer ,it will send signal to LCD screen connected to it indicated whether to produce red or green light

Roadside Equipment (RSEs)

RSEs may be mounted at interchanges, intersections, and other locations providing the interface to vehicles within their range.
The RSE manage the prioritization of messages to and from the vehicle

1. GPS unit

To get the coordinates of the road intersection to be able to get the distance between the vehicles and the intersection.

2. Wireless communication unit

To receive data from the vehicles and to send them signals according to the processed data received from them.

3. Wireless router

A vehicle can be equipped with a router, a bridge, and an access point. The bridge provides wireless communications with the municipal LAN. The access point communicates with devices that would otherwise be out of range of a fixed hot spot. The router manages fast, reliable communications between the local devices and the municipal LAN.it is used to connect all the vehicles in the intersection with the Roadside unit.

4. Computer

To act as a server which receive data and process it and transmits the processed data back to the vehicle equipment

5. Software

JAVA based software to process data and to manage the connection with the vehicle equipments.

Chapter 4

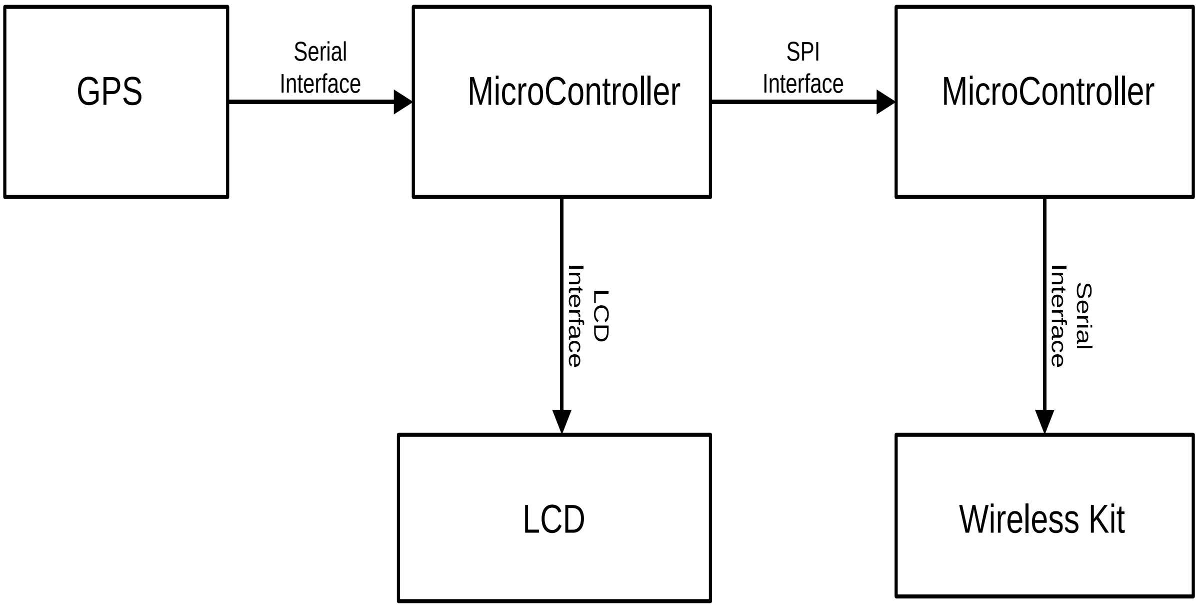
Hardware description

➢ Description

The hardware of the project is concentrated mainly in the OBU,Our tool to be used consists of some main parts which are:

GPS, Two Microcontrollers, LCD and Wireless Communication

(wireless kit or LapTop).



- **Circuit connection**

Two microcontroller circuits are used

1st microcontroller:

C program is used to:

1. **Read data from the GPS and reformat it in a certain way and get the required lines from the TextOut Format ,which they are the coordinates and the velocity of the vehicle.**
2. **Send data read from the GPS to the 2nd microcontroller through SPI module which will be discussed later.**
3. **Receive data from the 2nd microcontroller and send it directly to LCD.**

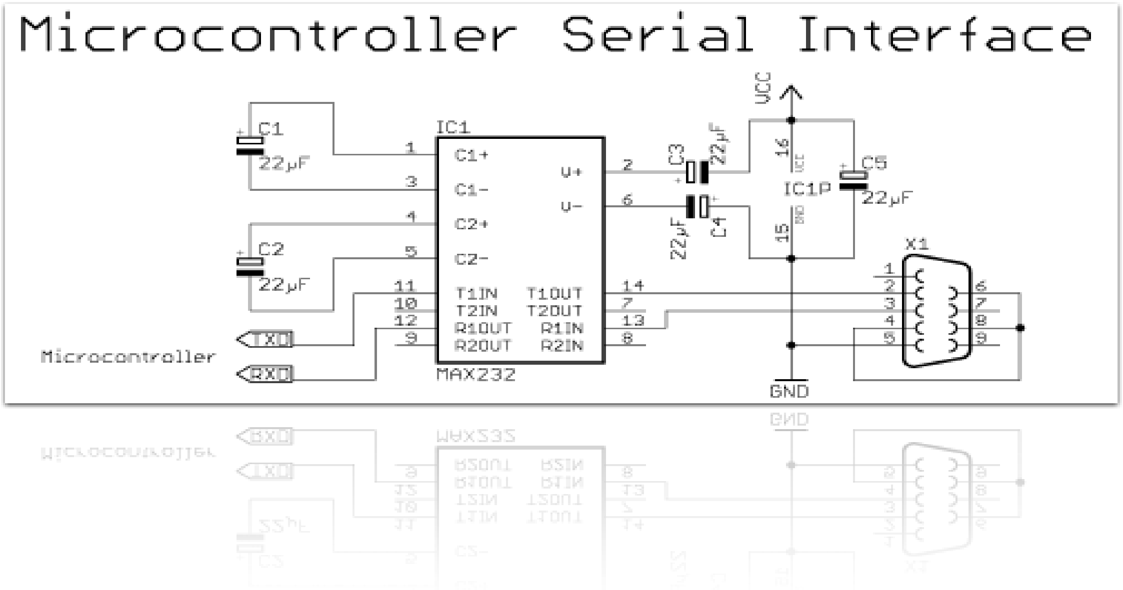
2nd microcontroller:

C program is used to

1. **Receive data from the 1st microcontroller and send it to the wireless kit through serial interface.**
2. **Receive data from the RSU and send it back to the 1st microcontroller.**

- <u>**Hardware Interface**</u>

1. **Microcontroller has serial interface Protocol that will be used in our communication.**



2. **The two microcontrollers will be able to send/receive data to each other through SPI module.**
3. **The 1st microcontroller will send the data to the LCD through LCD interface**

Chapter 5

Applications

➢ Introduction

The VII concept allows for the development and deployment of new applications and services that can enhance safety, mobility, and convenience for motorists. These applications take advantage of the unique security, privacy, performance and real-time nature of the communications built into the VII systems.

These applications are:

➢ Intersection collision avoidance

Roadway intersections are areas of potential conflict that increase risk exposure for vehicles attempting to pass through these locations. The varying nature of intersection geometries and the number of vehicles approaching and negotiating through these sites result in a broad range of crash configurations. Preliminary estimates by the National Highway Traffic Safety Administration (NHTSA) indicate that crossing path crashes occurring at intersections represent approximately 26 percent of all police reported crashes each year. This proportion translates into 1.7 million crashes. When non-police reported crashes of this type are also considered, the total number of crossing path crashes increases to approximately 3.7 million each year.

The Intersection Collision Avoidance was developed to address the intersection crash problem and apply technology to prevent or reduce the severity of intersection crashes.
By providing warning to the driver when the potential for collision exists at an intersection.

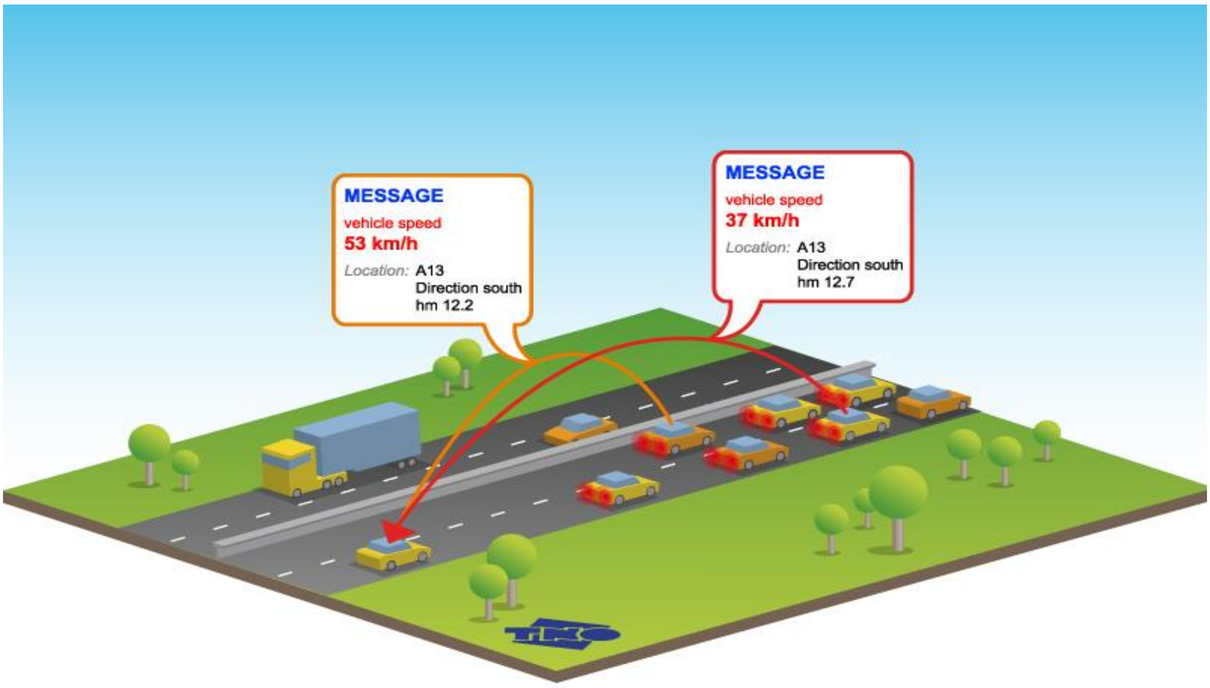
Description

When the vehicle is approaching an intersection, the Coordinates and speed of each vehicle calculated by the GPS (located at the vehicle) is sent to the server which is located at the road side unit. The server process this data by calculating relative velocity and relative distance between the two vehicles and according to this calculation it will decides which vehicle will pass and send it message to pass and sends the other vehicles to stop it (not to pass) . The server will send these actions to the microcontroller of each vehicle which will appear as messages to the driver on the LCD.

The concept of the application

1. **The GPS connects with the satellite and determine its location (coordinates)**
2. **The data in the GPS receiver which is the coordinates of the car will be sent to the microcontroller**
3. **The OBU inside the vehicle asks for establishing a connection with the RSU to be able to send its data (coordinates, ID of vehicle, etc...)**
4. **The microcontroller will send the data (coordinates and the speed) that's received from the GPS receiver to RSU ,this data will be transmitted wirelessly to the RSU**
5. **The Server at the RSU will receive the data (the coordinates and the speed of the vehicle) from the OBU of the vehicles that they are about to pass the intersection and process it through Real time software so as to take a certain action, the RSU will send back to the OBU in the vehicles to inform each of them which one will pass the intersection and which one will stop**
6. **The microcontroller will receive the decision message from the RSU and display the decision (whether to pass or stop) received from the RSU on the LCD screen**

   Note: Communications links provide the means for transmitting information to and from the vehicle through Wi-Fi connection and a transceiver circuit with the car unit.



Red sign violation

This application is to check if the vehicle which the server sent it a stop message ignored this message and passed the intersection or not.

The server receive the ID and the coordinate of the vehicle sent to it by the GPS and then compare the coordinates of the car with the coordinates of the intersection and determine whether the vehicle passed the intersection or not and if so it will record its ID to give it an Intersection Breaking ticket

The server sends the records of cars which break the red traffic light to a public sector site every 24 hours using VPNs

➢ Emergency unit

This application is to send a message from the emergency vehicle to the RSU (server) to inform it that there is an ambulance coming, this is done after connecting the ambulance with the network region of the RSU
Once ambulance is connected to the RSU, the OBU sends an emergency message to the RSU informing it that an emergency vehicle wants to pass, this message containing the ID of the ambulance, then the server authenticate this ID to ensure that it is an ambulance

Once server receives an emergency pass request from the OBU of an emergency vehicle, it sends an emergency message to all the surrounding vehicles containing the ambulance coordinates

➢ Congested area

This application is concerned with knowing the percentage of the traffic in the server ranged area and auto detect any congestion can happen.

The server calculates the number of cars communicating with it and detects their positions and also determines the capacity of the road they (the cars) are in so it can tell if this road has congestion or not.

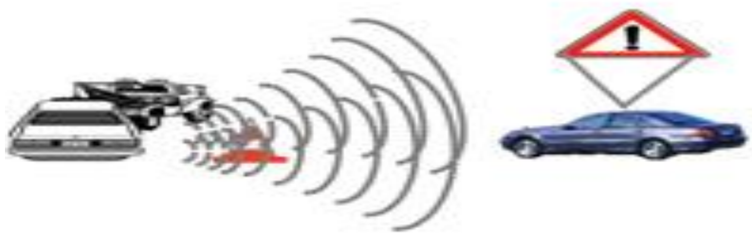
In this function the server tries to know and identify the servers that are near and their roads that would affect its area by knowing the position of the neighbour servers and the server location which are managing those roads.

As the server knows the IPs of its neighbours it can easily create congestion message which contains a request to redirect the cars away from its area and sends it to these neighbours.

When the server receives a message from another one and be sure it is congestion message, each server has a database for all the other servers and their IP's and locations, it can easily determine the server location from its IP so it easily informs the cars in its range that this location is temporarily blocked. Simply it redirect the cars in its range away from that server.

➢ Blocked area

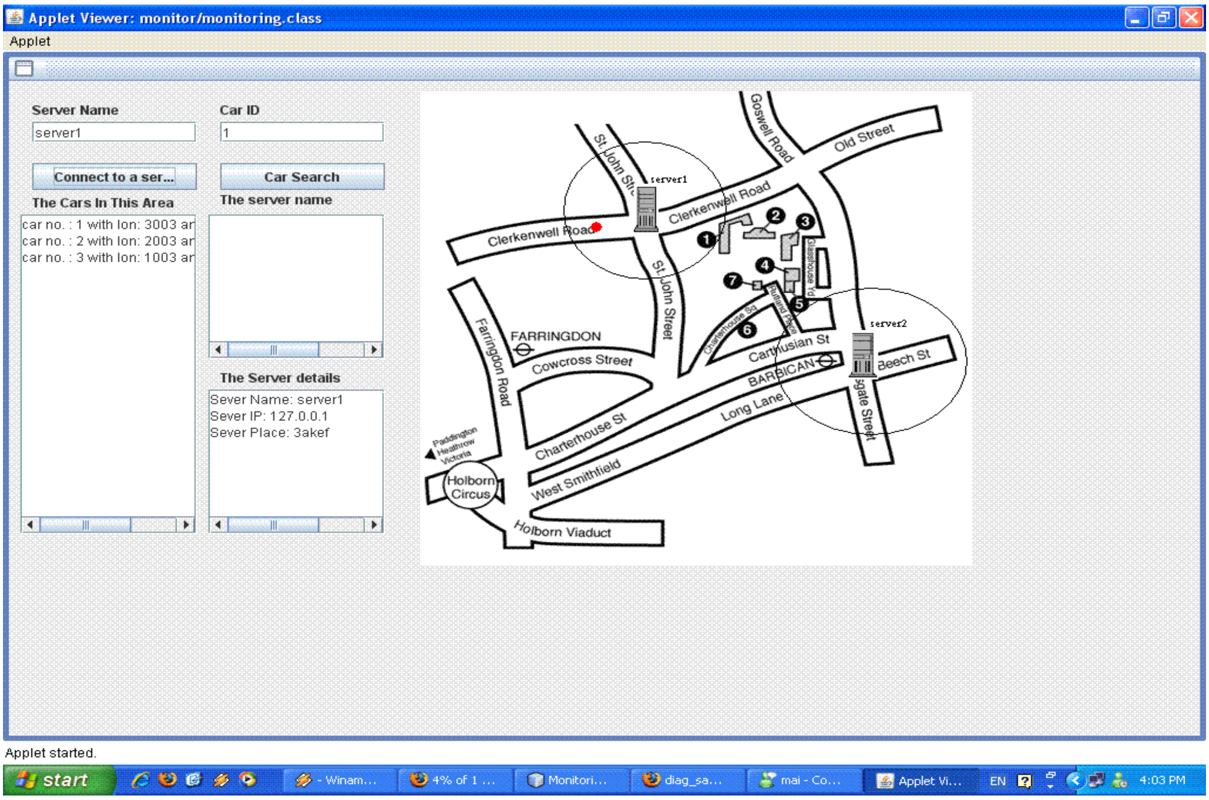
This application is to inform the drivers to slowdown in certain places like schools, hospitals, construction zone etc……
As the vehicle approaches the construction zone, its OBE receives a message and performs a relevance check. Once the OBE knows the message is relevant, it warns the driver at predetermined distances approaching the construction zone. For instance, the driver will hear a voice warning as his car approaches within 100 yards of the worksite. He will receive another voice warning when he is about to enter the construction zone, and potentially another when he has cleared the zone. Likewise, if he is driving through the construction zone faster than the broadcast speed limit, he will also be alerted to slow down for the safety of nearby road workers.



➢ Monitoring system

This application is to know the status of the traffic and sending it to the traffic centre

When the server receives the coordinates of the cars in its area, it sends this coordinates to the traffic centre so as to know the traffic status



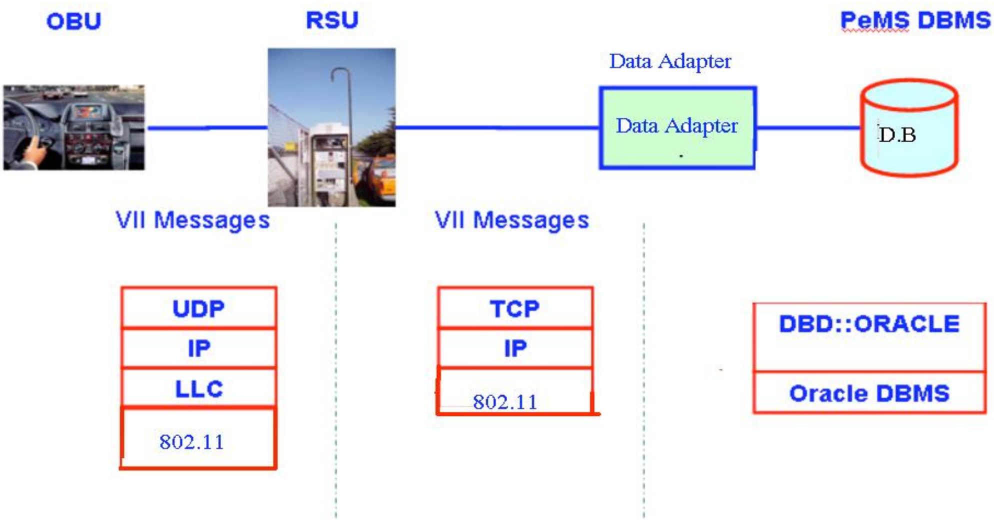
Chapter 6

System Design

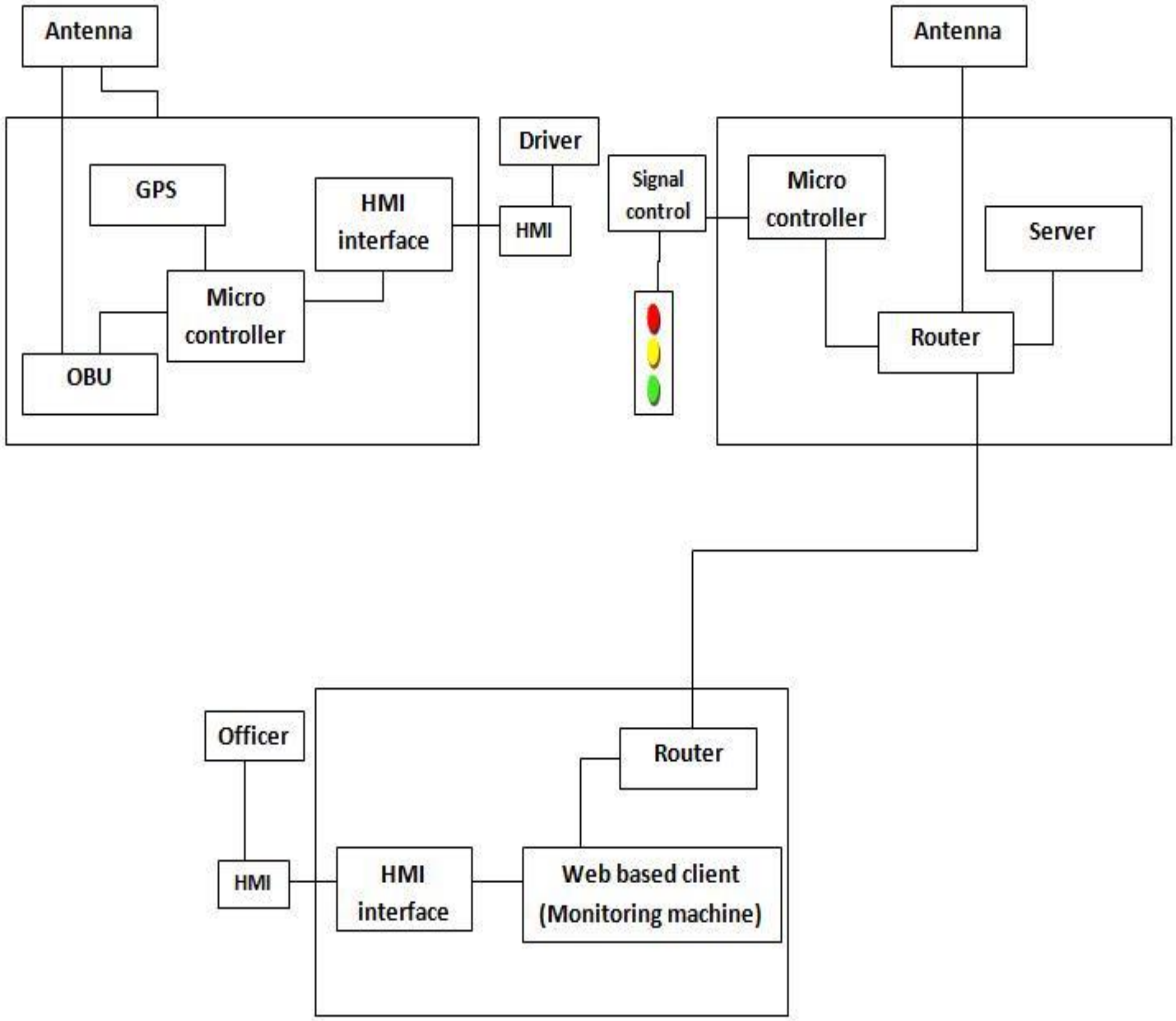
➢ System Architecture

Overview architecture design

Protocol Stack

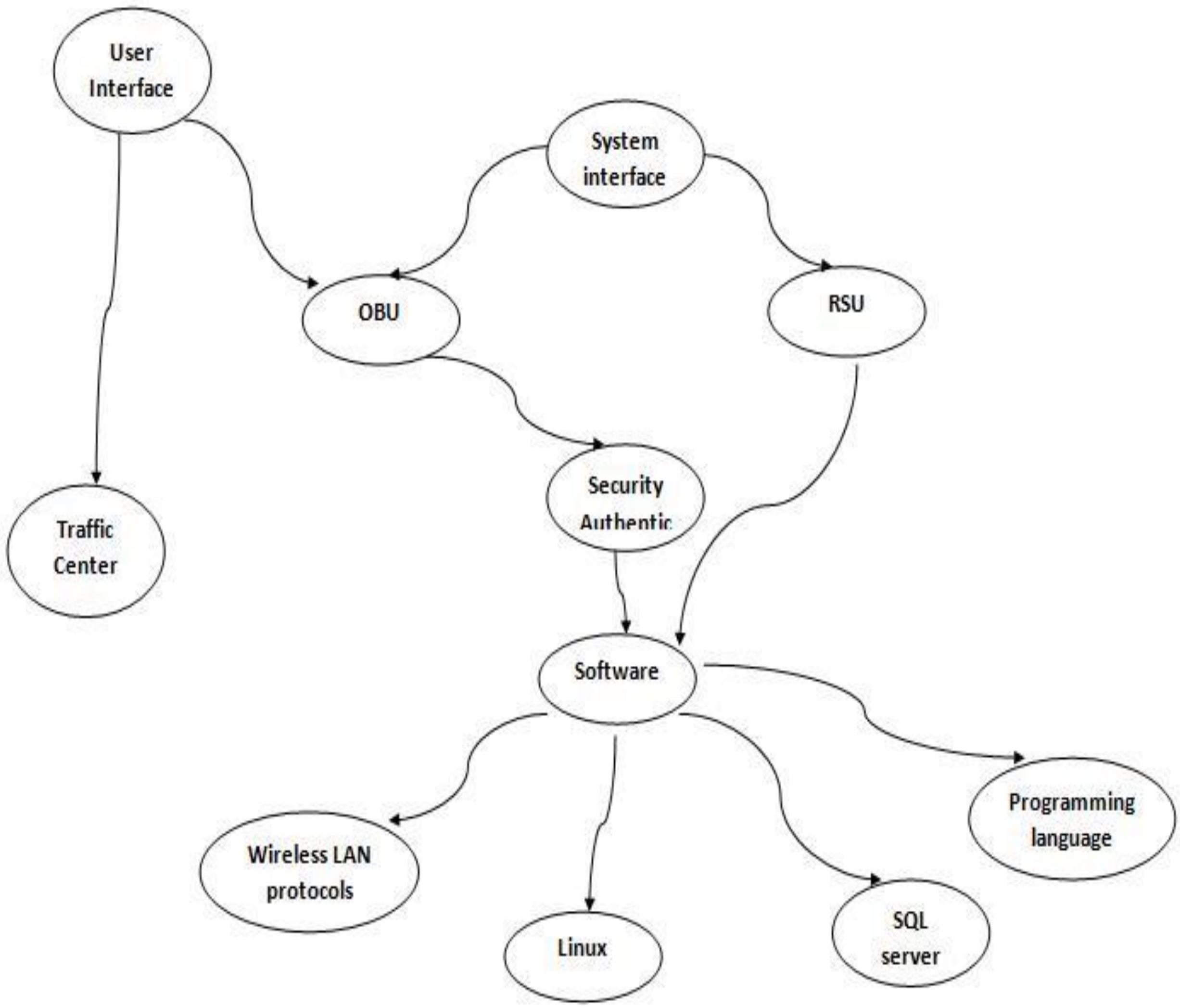


Architecture Design



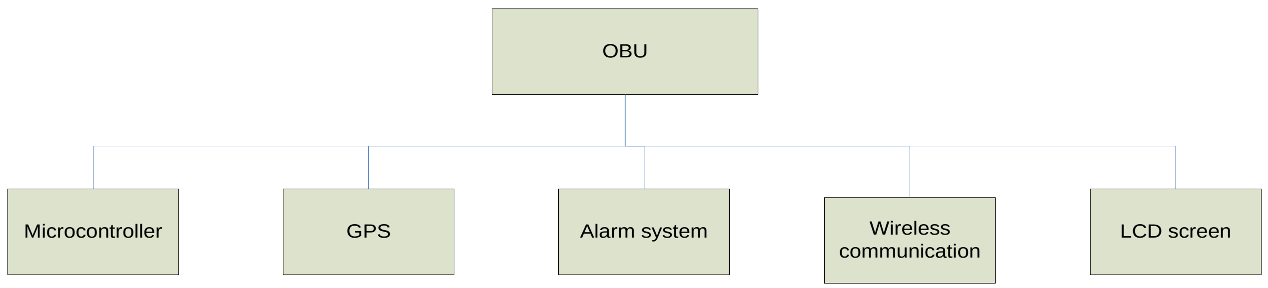
➢ System Domain Design

System Domain Chart

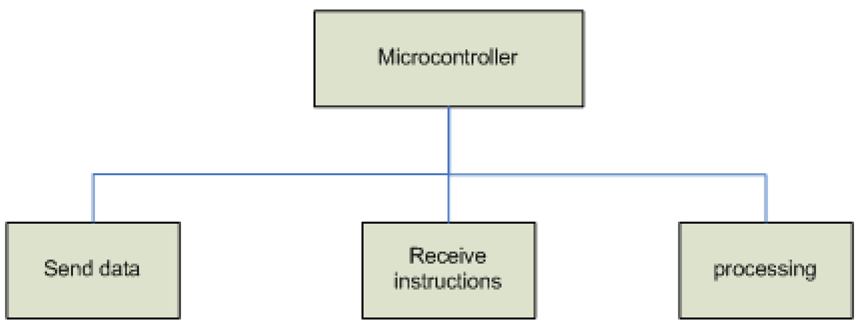


System Domains

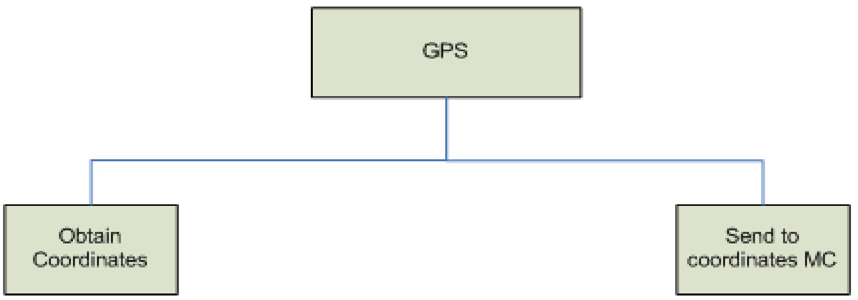
1. OBU



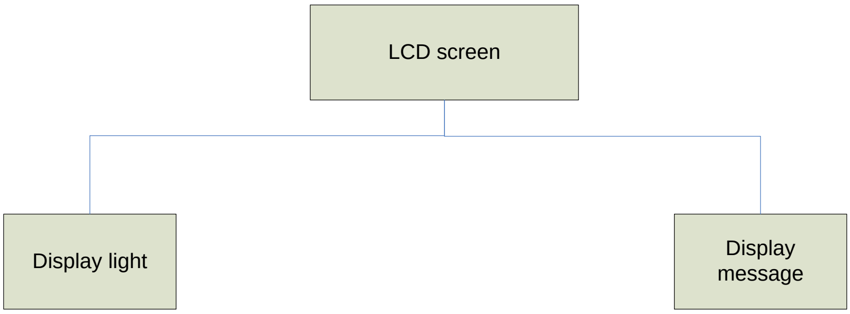
1.1 Microcontroller



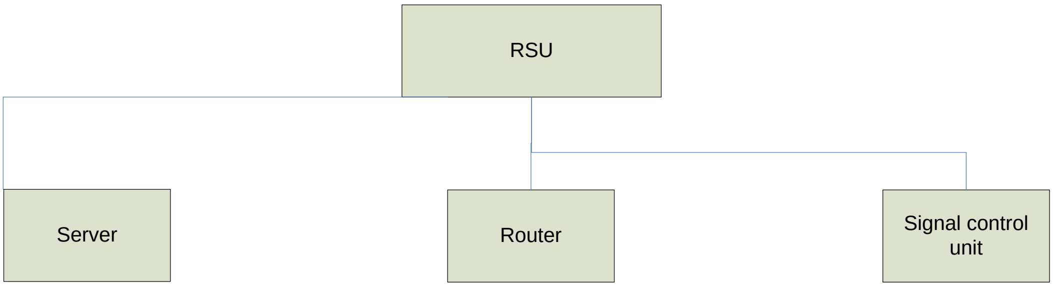
1.2 GPS



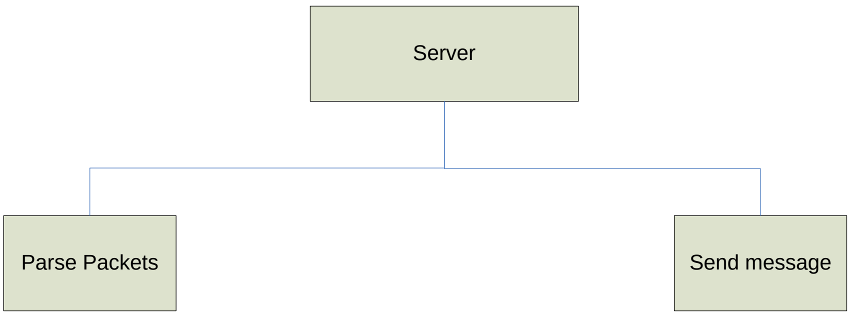
1.3 LCD screen



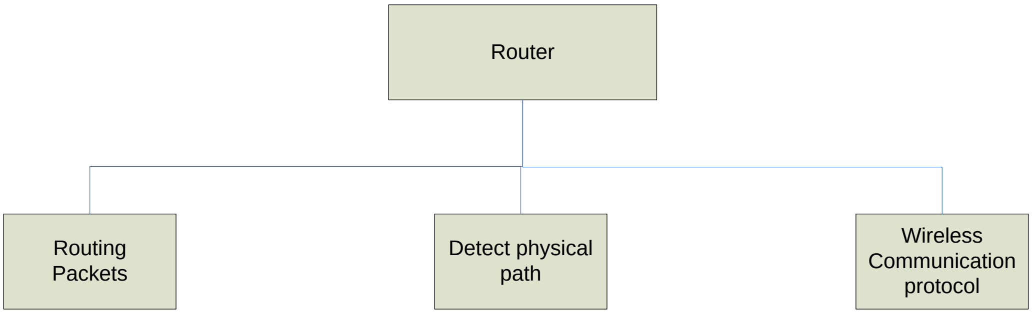
2. RSU



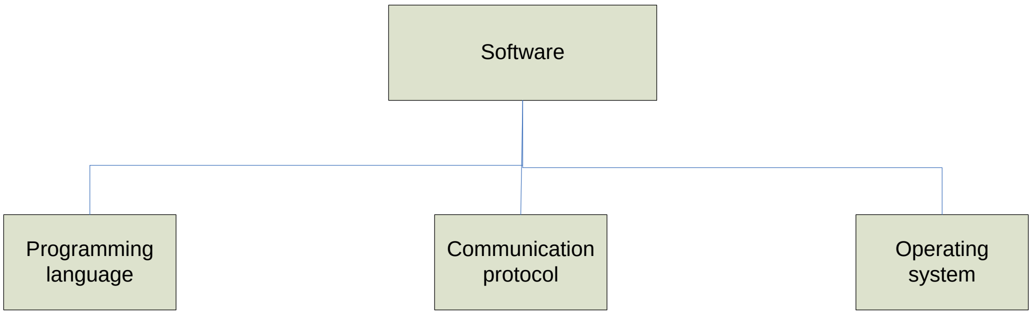
2.1 Server



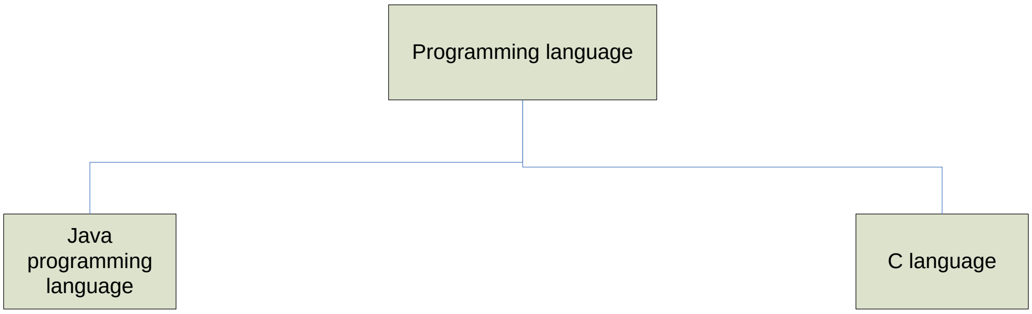
2.2 Router



3. Software



3.1 Programming language

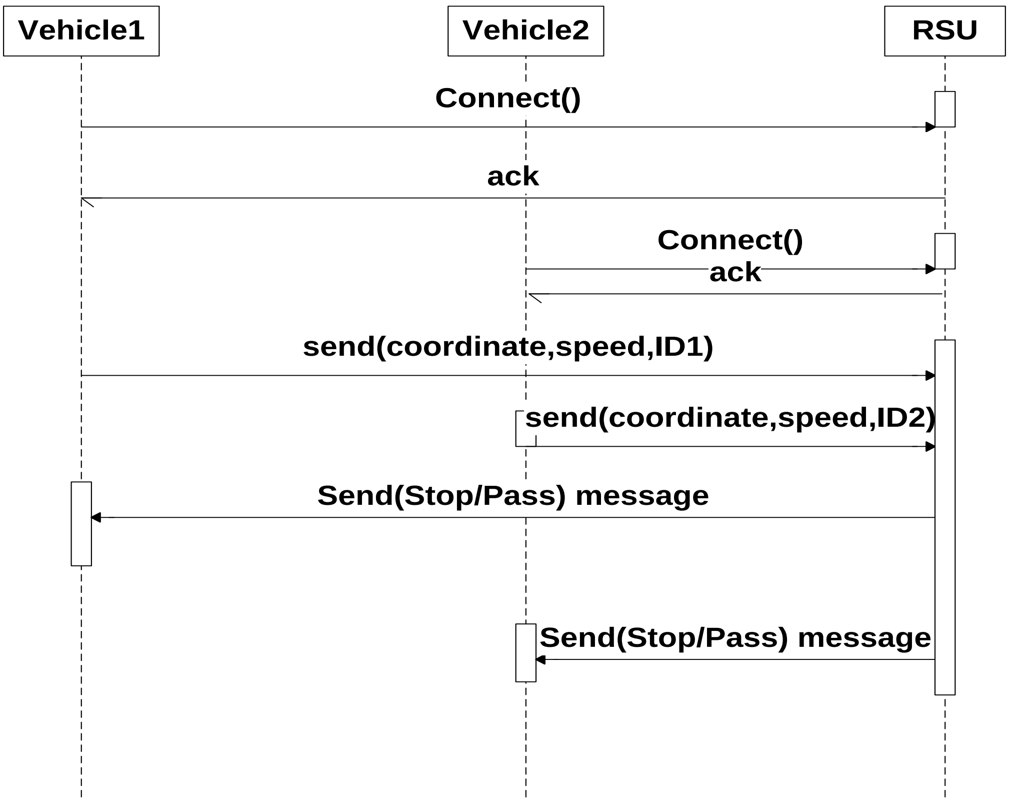


Chapter 6

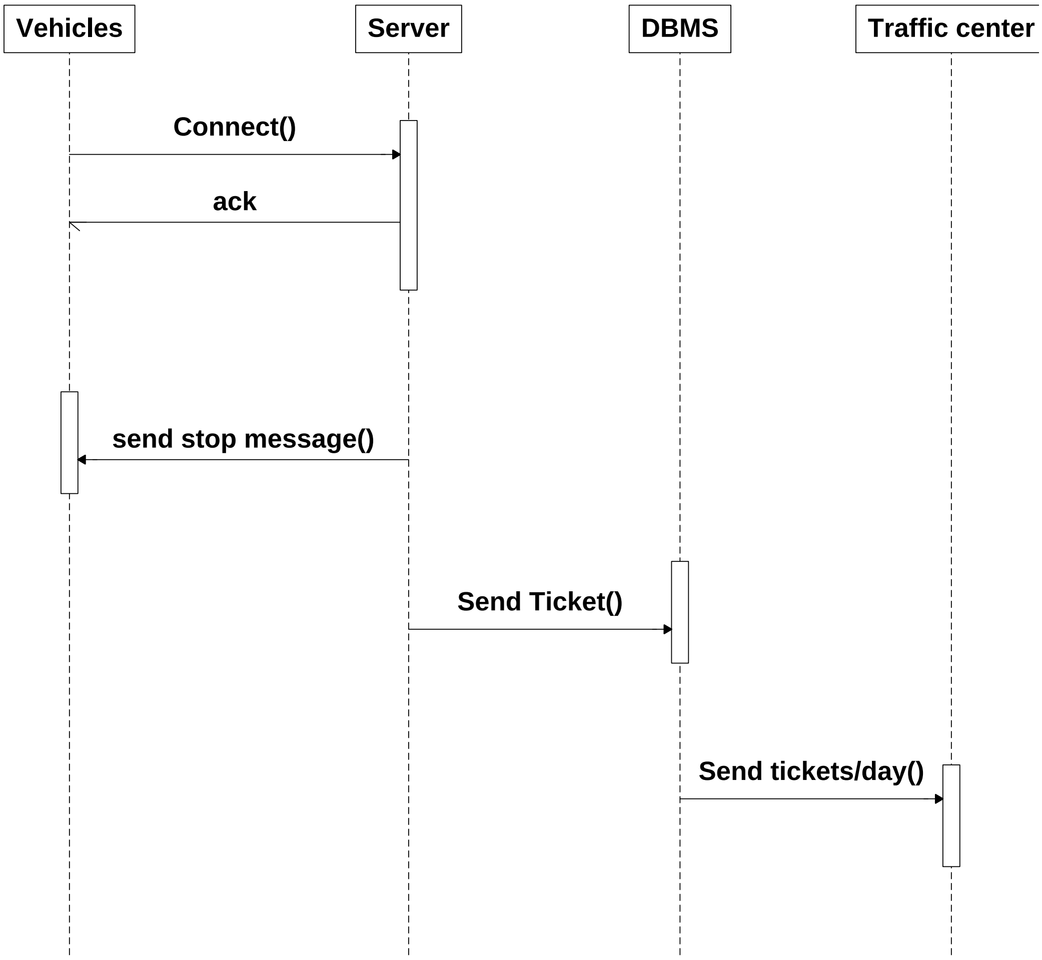
Software

➢ Scenarios

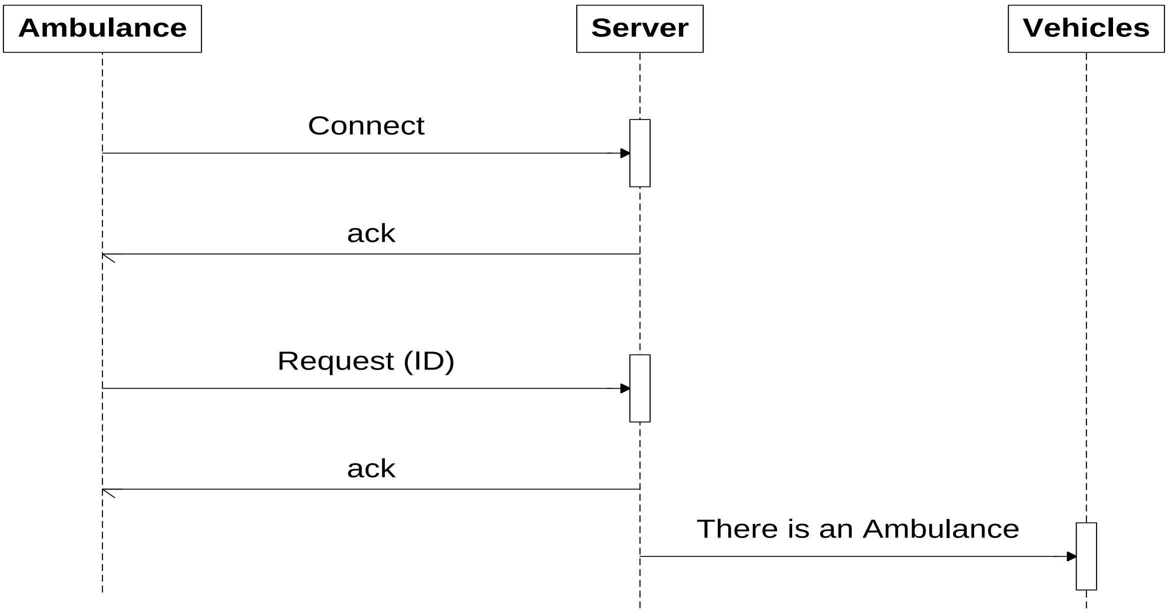
1. Intersection collision avoidance



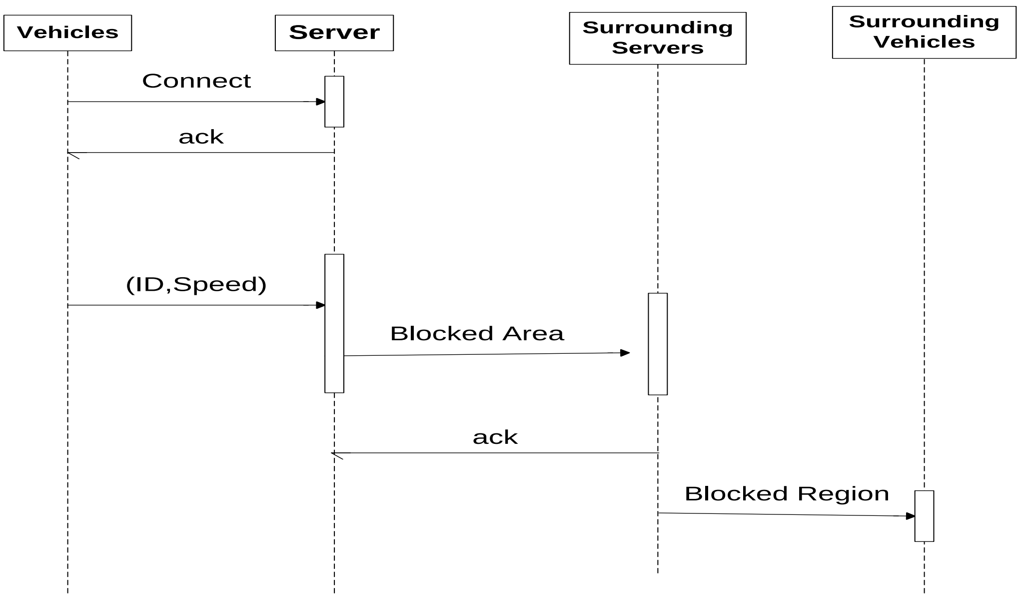
2. Red sign violation



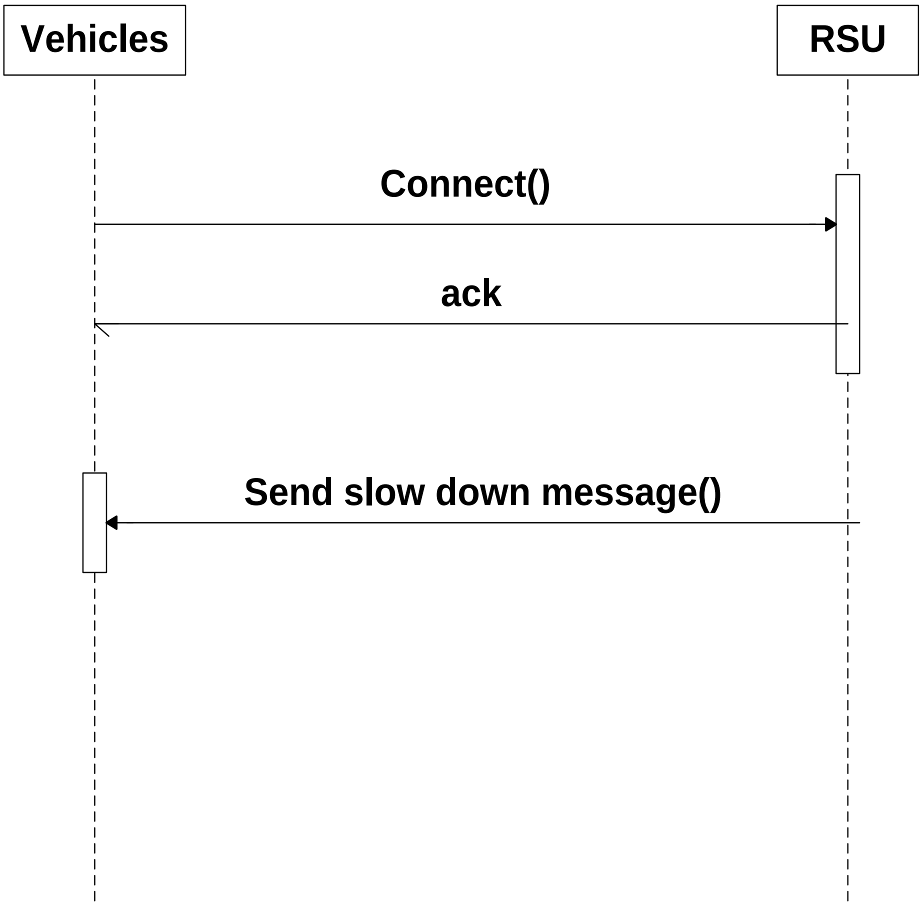
3. Emergency System



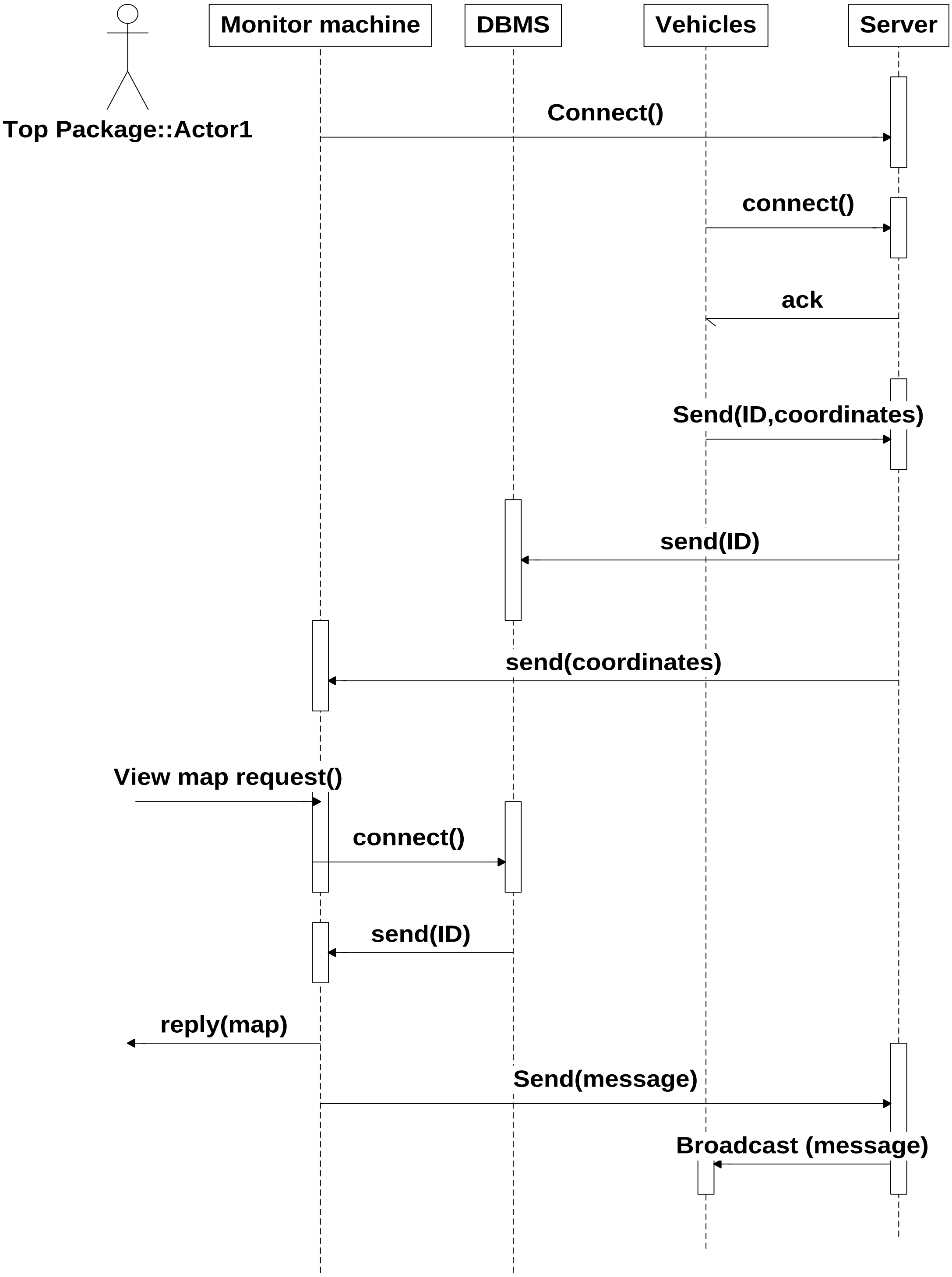
4. Congested Area



5. Slow Down Zone



6. Monitoring system



➢ Simulation

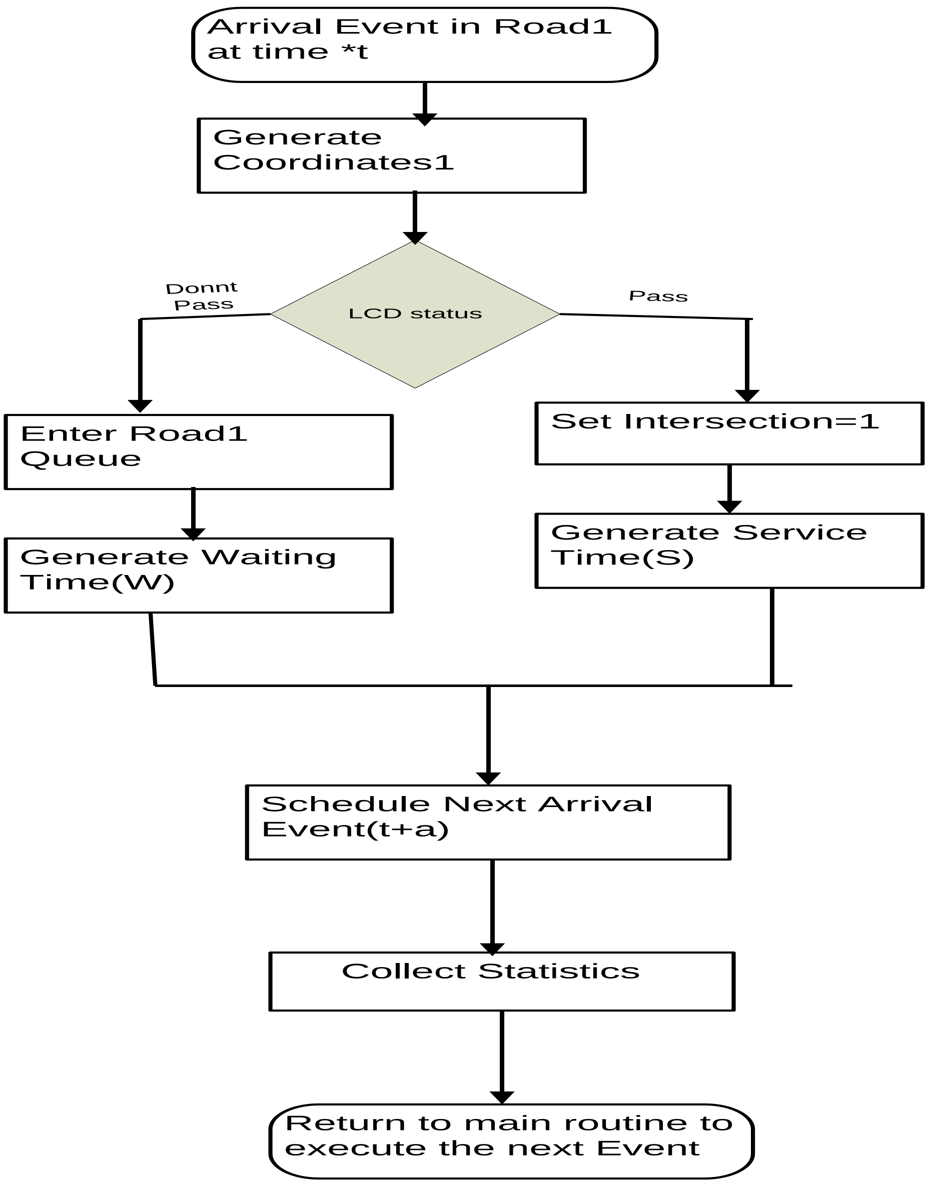
Using the GPSS

1. Intersection Avoidance System

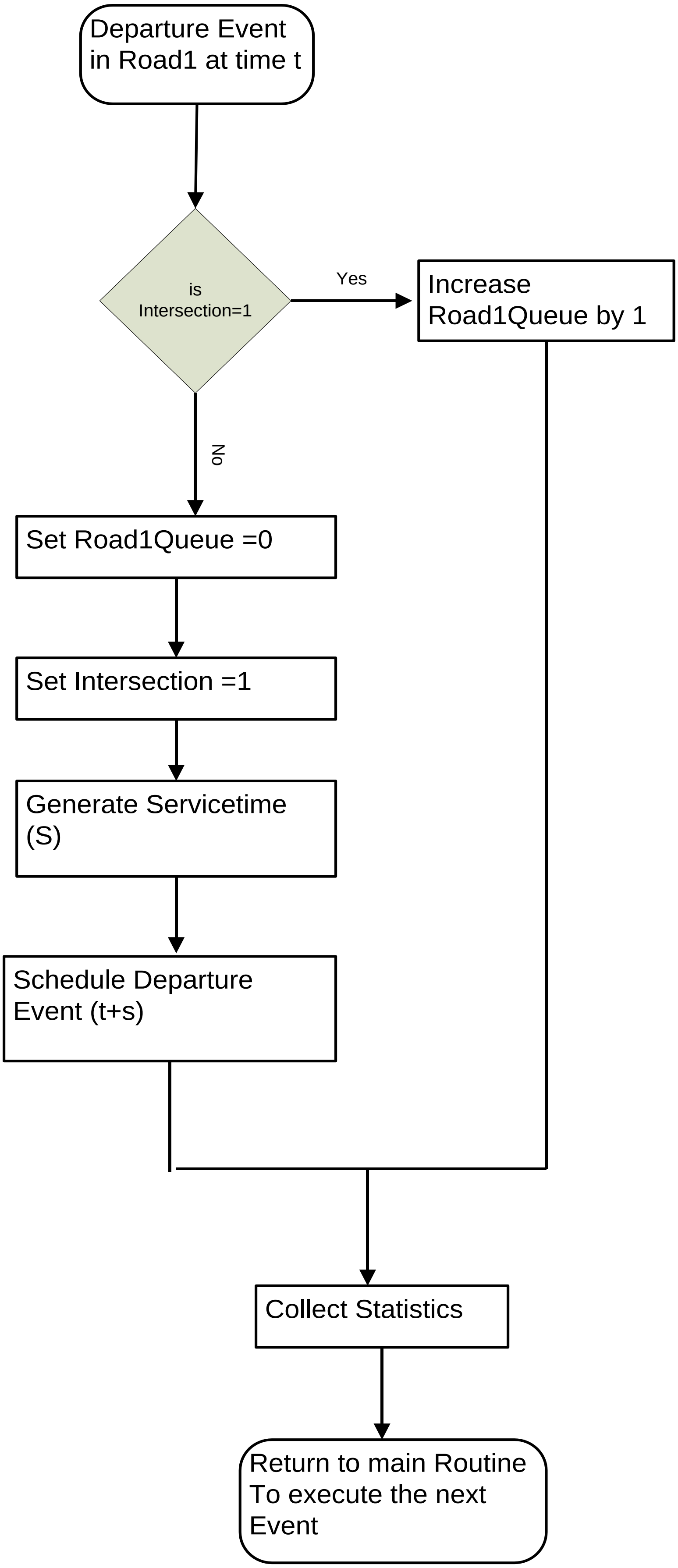
Statistics measured here is number of accidents occur before and after applying our system.

Accident Queue is used which is increased every time an accident occur, it'll be used to compare the number of accidents happened before and after applying the system.

Arrival Event



Departure Event



The code before applying the new application

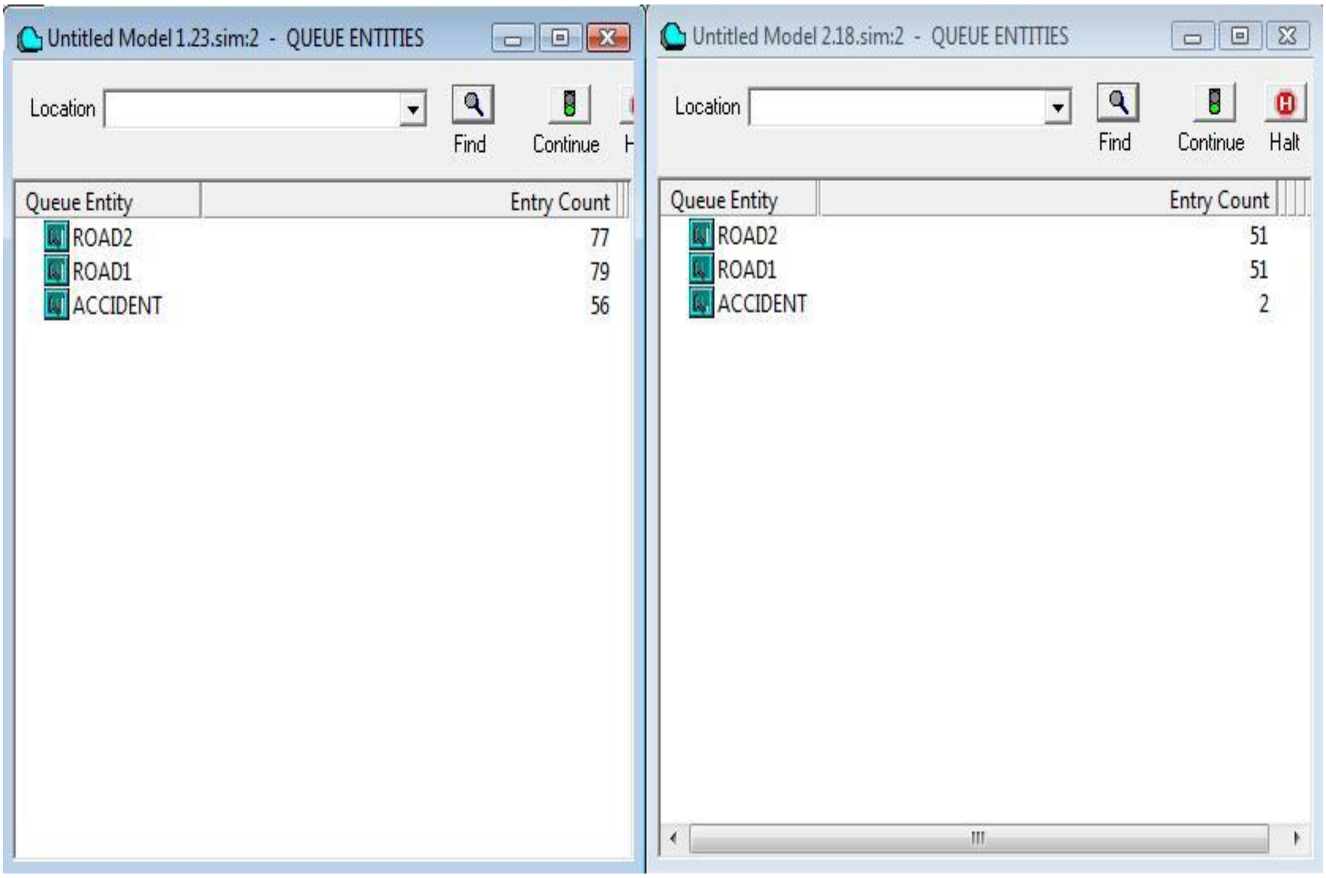
```
Intersection Storage 1
GENERATE  30,10            ;Create next automobile.
QUEUE    Road1
TEST E   0,F$Intersection,Again1
SEIZE    Intersection
DEPART   Road1             ;End queue time.
ADVANCE  10                ;Cross the intersection.
RELEASE  Intersection
TERMINATE 1

GENERATE  30,10            ;Create next.
QUEUE    Road2
TEST E   0,F$Intersection,Again1
SEIZE    Intersection
DEPART   Road2             ;End queue time.
ADVANCE  10                ;Cross the intersection.
RELEASE  Intersection
TERMINATE 1

Again1   TRANSFER 0.8,AGAIN2
AGAIN2   QUEUE accident
```

The code after applying the new application

```
Intersection STORAGE 1
 coor1 function RN1,D6
 0.1,5/0.3,10/0.6,15/0.85,20/0.95,25/1,30
 coor2 function RN1,D6
 0.1,5/0.3,10/0.6,15/0.85,20/0.95,25/1,30

 GENERATE  30,10     ;Create an AutoMobile
 SAVEVALUE coor1,FN$coor1
 QUEUE    Road1     ;Enter Road1Queue
 TEST E    1,F$Intersection,pass1
 TEST GE   coor2,coor1,Again1
pass1   SEIZE     Intersection ;Enter Intersection
 DEPART    Road1       ;Leave Road1Queue
 ADVANCE   10        ;Spend Time
 RELEASE   Intersection ;Leave Intersection
Again1   TRANSFER    0.98,AGAIN2
 TERMINATE 1                        ;Destroy Token
 GENERATE  30,10       ;Create an Automobile
 SAVEVALUE coor2,FN$coor2
 QUEUE    Road2       ;Enter Road2Queue
 TEST E    1,F$Intersection,pass2
 TEST GE    coor1,coor2,Again1
```

```
pass2  SEIZE     Intersection ;Enter Intersection
       DEPART    Road2        ;Leave Road2
       ADVANCE   10           ;Spend time
       RELEASE   Intersection ;Leave intersection
       TERMINATE 1            ;Destroy Token
AGAIN2   QUEUE accident
```

The Result



Before **After**

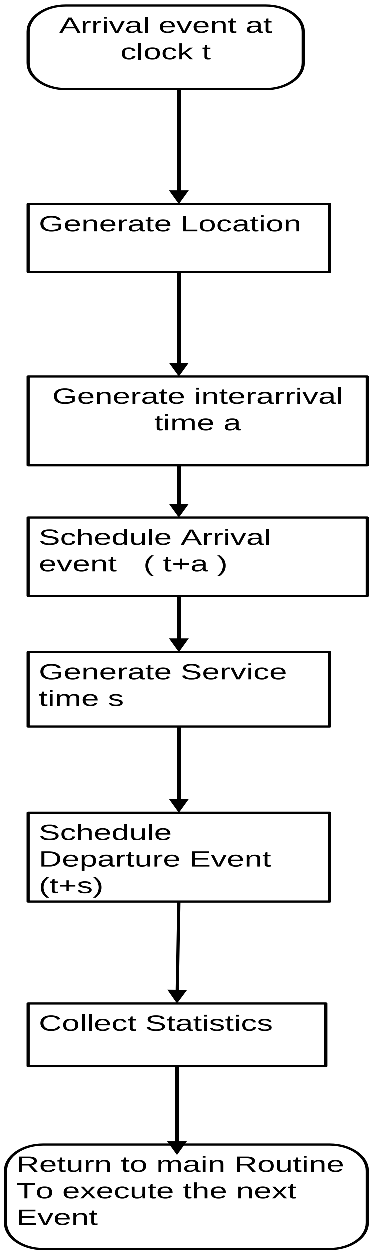
The Percentage of Accident = 35.89% **The Percentage of Accident=1.96%**

2. Emergency unit

The statistic measured here is the time taken by the ambulance from where it starts to move until it reaches its target

A facility called timer is used to compare the average time which the ambulance takes before applying the new application and after applying it

Arrival Event



The code before applying the new application

; considering that the ambulance is in road 2 and
; By default we pass road 1 first without taking into
; Consideration if there is ambulance in the other road or not

```
 GENERATE 50,10                          ;Create an ambulance.
 loc EQU 2                               ; the location of the
*                                          ambulance is in road2
 TEST E loc,2,go1
 SEIZE timer                             ; start going to the target
 QUEUE Road2                             ;enter queue
 TEST E   X$Road2light,F$Intersection    ;Block until green, and
 *                                         the intersection is free
 SEIZE    Intersection
 DEPART   Road2                          ;End queue time.
 ADVANCE  10                             ;Cross the intersection.
 RELEASE  Intersection                   ; leave the intersection
 ADVANCE 50                              ; the time from leaving the
 RELEASE timer                           ; reach the target
 TERMINATE 1                             ; the ambulance leaves

 go1     SEIZE timer
 QUEUE    Road1
 TEST E   X$Road1light,F$Intersection    ;Block until green and the
*                                          intersection is free

SEIZE    Intersection
DEPART   Road1                              ;End queue time.
ADVANCE  10                                 ;Cross the intersection.
 RELEASE  Intersection
 ADVANCE 50
 RELEASE timer
 TERMINATE 1                                ;Auto leaves intersection.
```

```
 GENERATE ,,,1                          ;here we pass road1 first without
*                                       considering the location of the
*                                         ambulance
Begin1    SAVEVALUE Road2light,Red       ;road2 light turns red, this to
pass road1 first
 SAVEVALUE Road1light,Green              ;road1 light turns green
 ADVANCE   Greentime                     ;Light is green
 SAVEVALUE Road2light,Green              ;road2 light turns green
 SAVEVALUE Road1light,Red                ;road1 turns red
 ADVANCE   Redtime                       ;Light is red
 TRANSFER  ,Begin1

Greentime EQU    400
Green    EQU     0
Red      EQU     100
Redtime  EQU     200
```

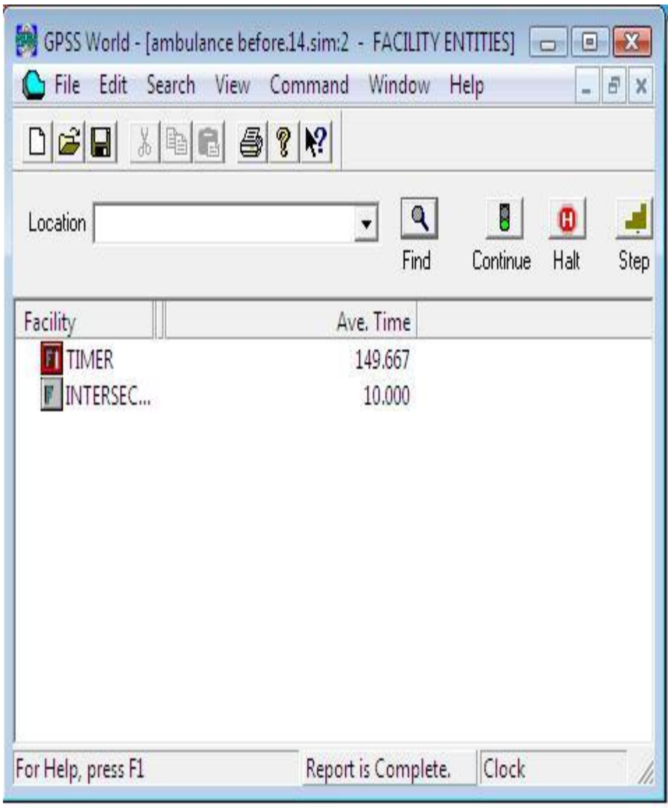
The code after applying the new application

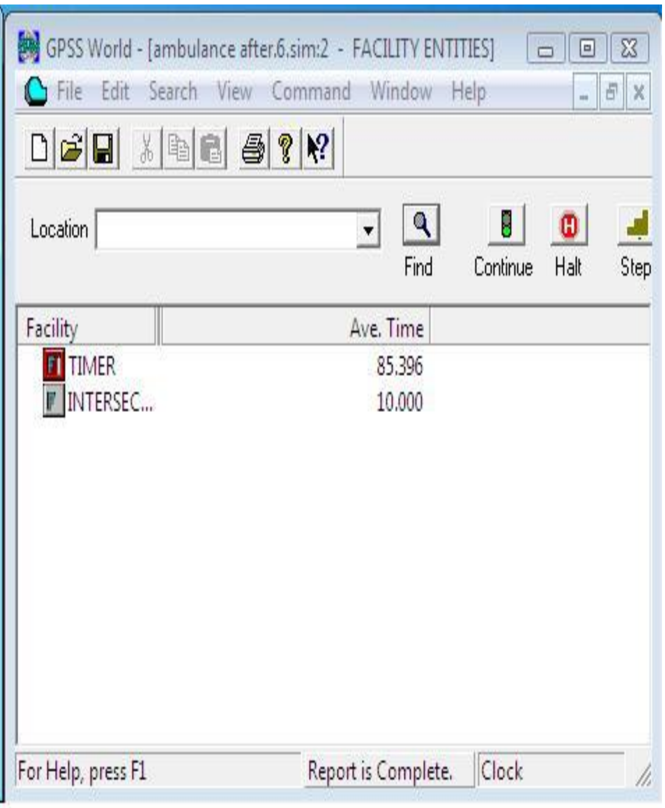
```
; we examine first the location of the ambulance and
;according to its location we will pass the road containg the
ambulance, here the ambulance is in road 2
;by this way the ambulance will reach its target faster and in less
time


GENERATE 50,10                  ;Create an ambulance
 loc EQU 2
 TEST E loc,2,go1
 SEIZE timer                    ;begin to go towards the target
 QUEUE Road2                    ;enter queue of road 2
 TEST E   X$Road2light,F$Intersection   ;Block until green, and the
intersection is free
 SEIZE    Intersection
 DEPART   Road2                 ;End queue time.
 ADVANCE   10                   ;Cross the intersection.
 RELEASE  Intersection
 ADVANCE 50                     ; the time from leaving the road until
```

```
*                                        reaching the target
  RELEASE timer                    ; reach the target
  TERMINATE 1                      ; the ambulance leaves

go1   SEIZE timer
      QUEUE    Road1                   ; enter queue of road 1
      TEST E   X$Road1light,F$Intersection    ;Block until green and the
     *                                             intersection is free
      SEIZE    Intersection
      DEPART   Road1                  ;End queue time.
      ADVANCE   10                   ;Cross the intersection.
      RELEASE   Intersection
      ADVANCE 50
      RELEASE timer
      TERMINATE 1



              GENERATE  ,,,1
begin1        TEST E Loc,2,road1pass              ;here we test the location of
road2pass   SAVEVALUE Road2light,Green        ;road2 light turns green,this to
*                                              pass road 2 first and stop road 1
             SAVEVALUE Road1light,Red          ;road1 light turns red
             ADVANCE   Greentime               ;Light is green
            SAVEVALUE Road2light,Red           ;road2 light turns red
            SAVEVALUE Road1light,Green         ;road1 light turns green
            ADVANCE   Redtime                 ;Light is red
            TRANSFER  ,Begin1

road1pass   SAVEVALUE Road2light,Red           ;road2 light turns red, this to
*                                               pass road1 first
            SAVEVALUE Road1light,Green         ;road1 light turns green
            ADVANCE   Greentime                ;Light is green
           SAVEVALUE Road2light,Green          ;road2 light turns green
           SAVEVALUE Road1light,Red            ;road1 turns red
           ADVANCE   Redtime                  ;Light is red
          TRANSFER  ,Begin1
```

Greentime EQU 400
Green EQU 0
Red EQU 100
Redtime EQU 200

The Result





Before after

The average time taken by the The average time taken by the ambulance is
149.666 ambulance is 85.396

Chapter 7

Future Work

DSRC

Various forms of wireless communications technologies have been proposed for intelligent VII system. In selecting a communications technique, it must be remembered that the information must be location based. This is one reason that Dedicated Short Range Communications (DSRC) is commonly recommended. Short-range communications (less than 500 yards) can be accomplished using IEEE 802.11 protocols, specifically WAVE or the standard (DSRC).

Theoretically the range of these protocols can be extended using Mobile ad-hoc networks or Mesh networking. Longer range communications have been proposed using infrastructure networks such as WiMAX (IEEE 802.16), Global System for Mobile Communications (GSM) or 3G. Long-range communications using these methods are well established, but, unlike the short-range protocols, these methods require extensive and very expensive infrastructure deployment. There is lack of consensus as to what business model should support this infrastructure.

What is DSRC

DSRC is a short to medium range wireless protocol specifically designed for automotive use. It offers communication between the vehicle and roadside server The access point on the server is a regular IEEE 802.11 wireless network that uses the Dedicated Short Range Communications (DSRC) standard protocol

How DSRC works

Road- Side Unit

Announces to On-Board Equipment OBUs the applications it supports on which channel 10 times per second

On-Board Unit

- Listens on Channel 172
- Authenticates RSU digital signature
- Executes safety applications first
- Then Switches channels
- Executes non-safety applications
- Returns to Channel 172 and listens

This protocol is dedicated for this type of applications due to the need for extremely fast response and sensitivity to the exact relative positions of the vehicles involved, also it works on a very high band (5.89 GHz) but we were not able to use it as it is not used in EGYPT.

WIRELESS KIT

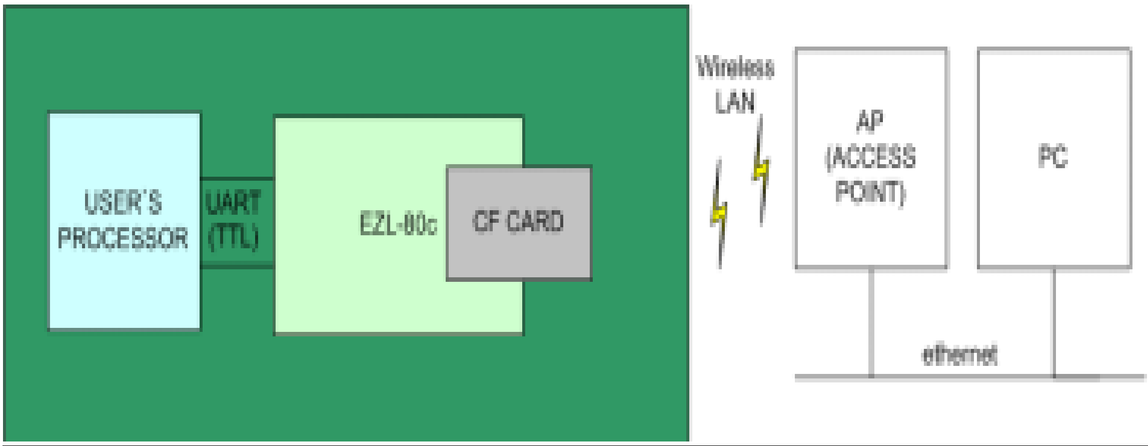
EZL-80C BODY

What is EZL-80c?

EZL-80 is a small-sized, modular product that provides TCP/IP communication through IEEE802.11b (wireless LAN) among the ezTCP product group and has a CF card socket and requires a 16-bit CF wireless LAN card.
EZL-80 performs the TCP/IP processing on data from the serial port and sends them to the wireless LAN, while playing the same role on data from the wireless LAN toward the serial port.
EZL-80 supports infrastructure networks through an access point (AP) and also provides ad-hoc network function performing communication without an AP.

The EZ-TCP series, serial-to-TCP/IP protocol converter product group of Sollae Systems, provides TCP/IP (Internet) communication function “simply by connecting to a serial port” and allows any device to communicate through the Internet. The series performs the TCP/IP processing on data coming in from the serial port and sends them to the Internet network, while it performs the

TCP/IP processing on data from the Internet network and transmits actual data to the serial port.



HARDWARE INTERFACE

Wireless LAN Interface

EZL-80, a modular product, should insert a CF wireless LAN card into CF socket..
For the wireless LAN card, use a 3.3V 16-bit PC card (PCMCIA) or a CF card, compatible with Intersil's Prism 2.5 or Prism 3.0.

Serial Interface

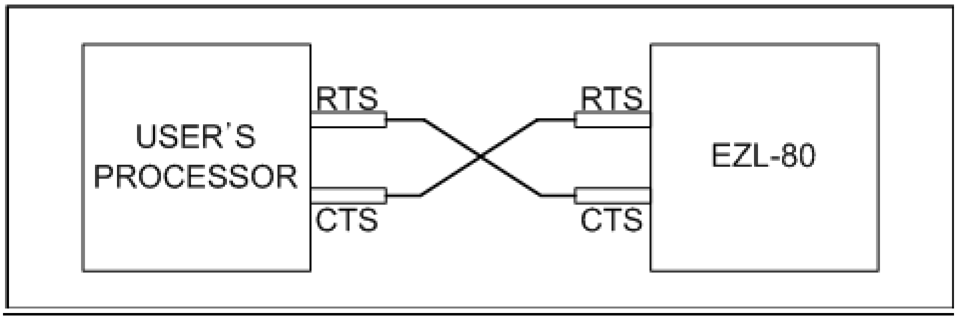
The serial port is implemented on 3.3V TTL level and can communicate with a UART (Universal Asynchronous Receiver and Transmitter).

Flow Control

Flow control is used to avoid loss of data if there is an excessive amount of data. For instance, if the network causes delay in data transmission when the user device sends a large

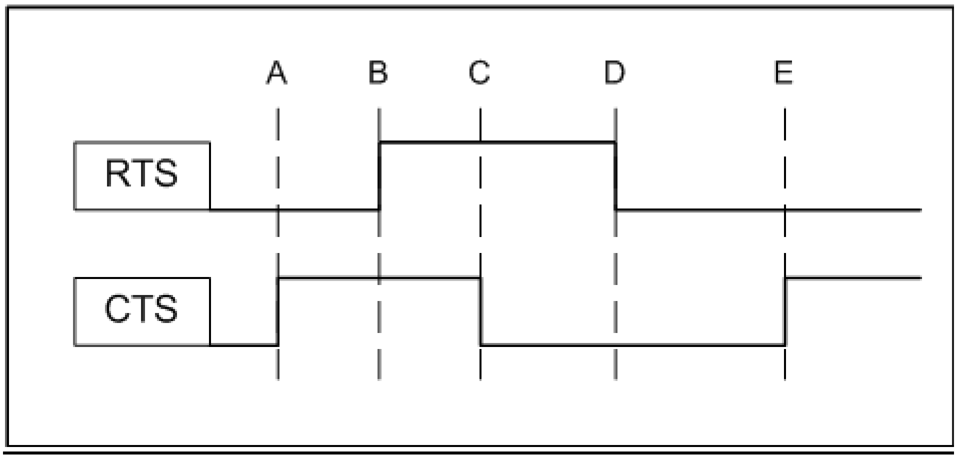
amount of data continuously, the buffer in the serial port may be full, resulting in loss of data.
(The EZL-80 serial port has a 1-kbytes reception buffer and 512 bytes transmission buffer.)
The serial port flow control of EZL-80 is implemented RTR(ready to receive)/CTS (clear to send) protocol. The RTS port (RTR is called RTS in EZL-80 for convenience) is an output port that becomes 'active low' if storage space is available in the reception
buffer of EZL-80. Meanwhile, the CTS port is an input port, which takes the active or inactive state of the RTS pin on the communication counterpart to which the CTS pin is connected.

The interconnection between the user's processor and EZL-80 should be done as follows.



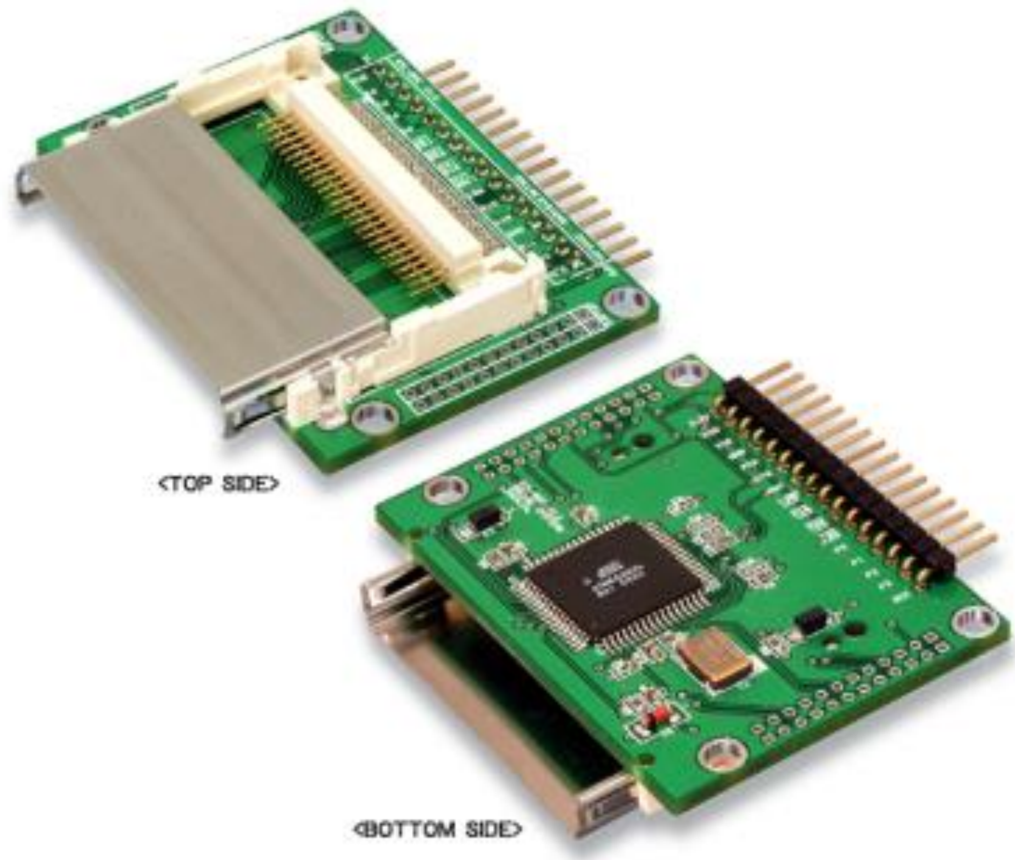
Flow Control Scenario

The following is a flow control scenario.



- Initially, EZL-80 is ready to receive and transmit data, since RTS and CTS are both low.
- At position ‘A’ the counterpart processor sends a signal that it is not ready to receive data. Then, EZL-80 stops sending data.
- At position ‘B’ EZL-80 sends a signal that it is not ready to receive data. Then, neither party is ready to send or receive data.
- At position ‘C’ the counterpart sends a signal that it is ready to receive data. At this time, EZL-80 has any data to send, it sends the data to the user’s processor.
- At position ‘D’ EZL-80 sends a signal that it is ready to receive data. Now both the parties send and receive data.
- At position ‘E’ EZL-80 receives a signal from the user’s processor that the latter is not ready to receive data and holds any data to transmit until CTS becomes active

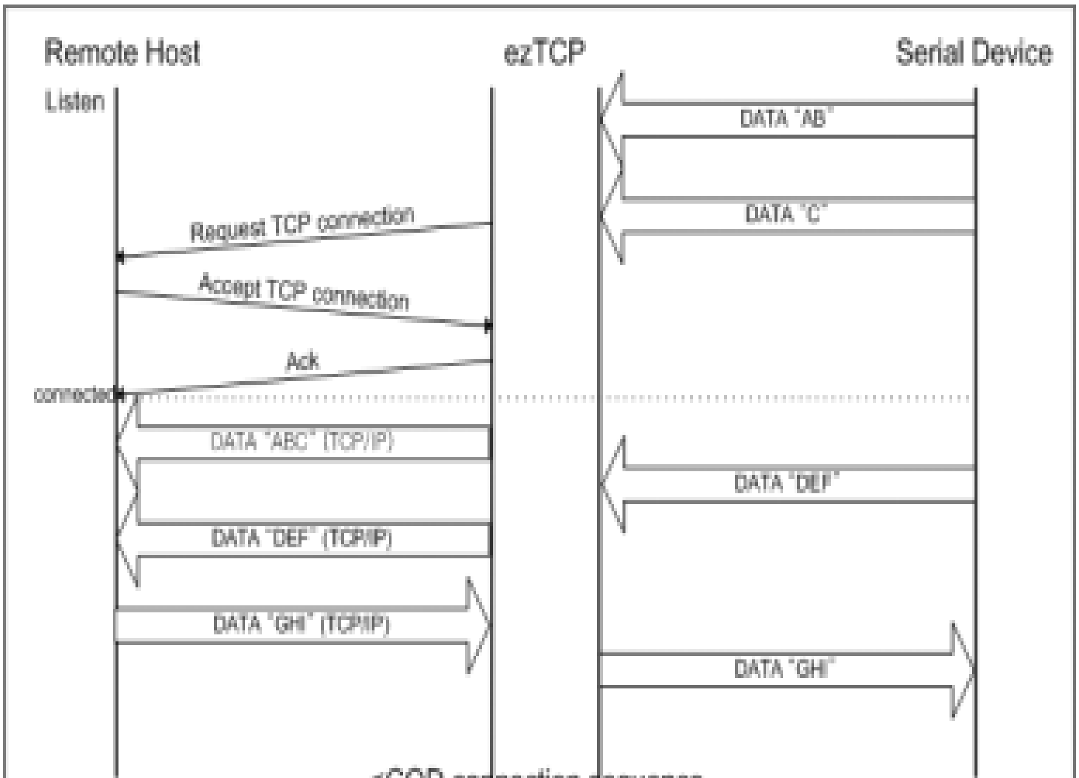
- **EZL-80c body**



MODE OF OPERATION

COD(Connect On Demand)

In COD mode, the EZ-TCP functions as a client.
When data of the pre-specified size comes to the serial port, the EZ-TCP attempts a TCP connection to the TCP port of the preset host IP. If the remote host accepts the TCP connection, TCP connection will be established. Data coming to the serial port after connection establishment is TCP/IP-processed and transmitted to the remote host. And, data coming from the remote host is TCP/IP-processed and transmitted to the serial port for data communication.



<COD connection sequence - WATERMARK: 3>

Chapter 9

Obstacles

➢ Electronic Devices

1. There was a lack of the electronic kits and devices in Egypt and also it was very difficult to obtain it from other countries

The kit which was required and was not available

The wireless kit EZL-80 that provides TCP/IP communication through IEEE802.11b to let the microcontroller at the On board unit able to communicate with the Roadside unit
Also the CF wireless LAN card required for this kit was not available

- ✓ We solved this problem by using wireless LAN connection between the OBU and the RSU

2. Obtaining the GPS was also very difficult as it require a permission to enter EGYPT but

- ✓ We were able to acquire it from our college

3. Also we found difficulty in the efficiency of the chips used to make the hardware circuits as most of the chips bought was not working well

➢ Communication Protocols

DSRC protocol is highly recommended for our system due to the need for extremely fast response and sensitivity to the exact relative positions of the vehicles involved, also it works on a very

high band (5.89 GHz) but we were not able to use it as it is not used in EGYPT.