Chapter Three

System Design and Implementation

3.1 General description of System

3.2 In Vehicle device

3.3 Web server

3.4 Monitoring unit

3.5 Software Program

3.6 Advantages and Applications of the system

3.1 General description of System:

The system consists of modern hardware and software components enabling mobile to track vehicles, mainly it consist of three parts, first one is an in-vehicle device which collects data (location and speed using GPS) about vehicle or fleet of vehicles, then uploaded it to the second one which is server made by Mediatek Cloud Sandbox (MCS) over a GPRS or WI-FI connections, then its provides a visualization of the data through the third part. Vehicle information can be viewed on electronic maps via internet using MCS application installed on smartphone. Modern vehicle tracking system commonly use GPS technology for locating the vehicle, but other types of automatic vehicle location can also be used. The block diagram below illustrates how the system works.

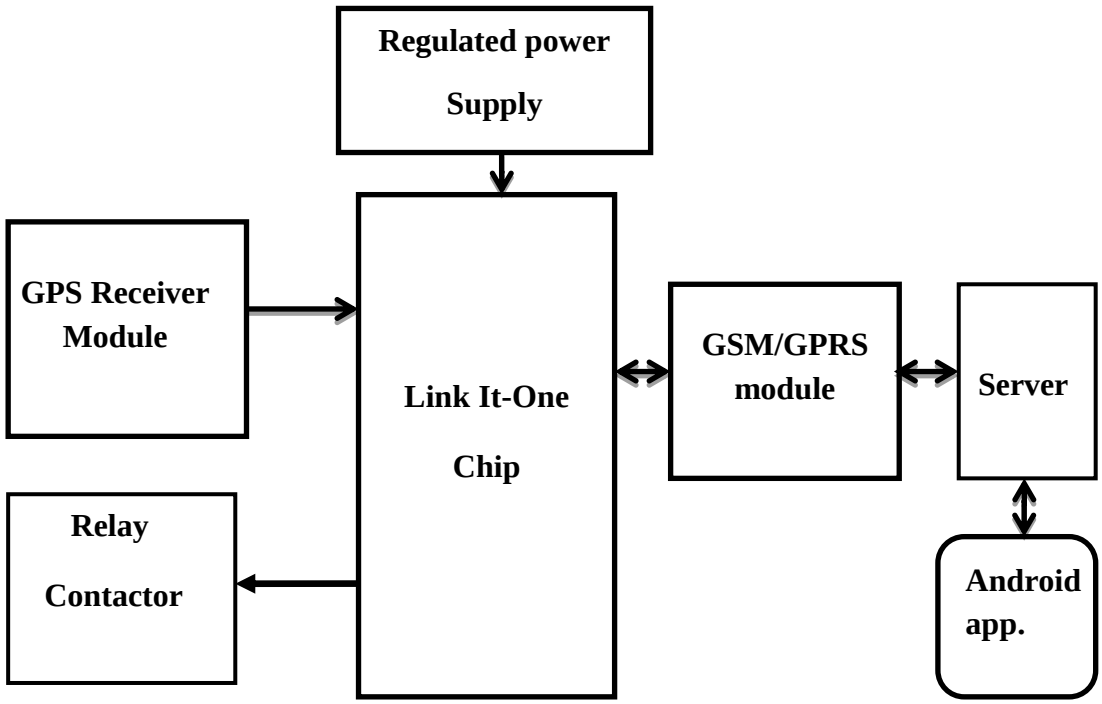

Figure 3.1: System Block Diagram.

As shown as a block diagram above the system consists of seven blocks which are represent the implementation of the system, the first one is in-vehicle device as shown in figure 3.3 in the next section.

3.2 In Vehicle device:

3.2.1 LinkIt-ONE development board:

LinkIt-ONE development board has more features compared to the Arduino board [1].The figure 3.2 illustrates all pin-out configuration of LinkIt ONE.

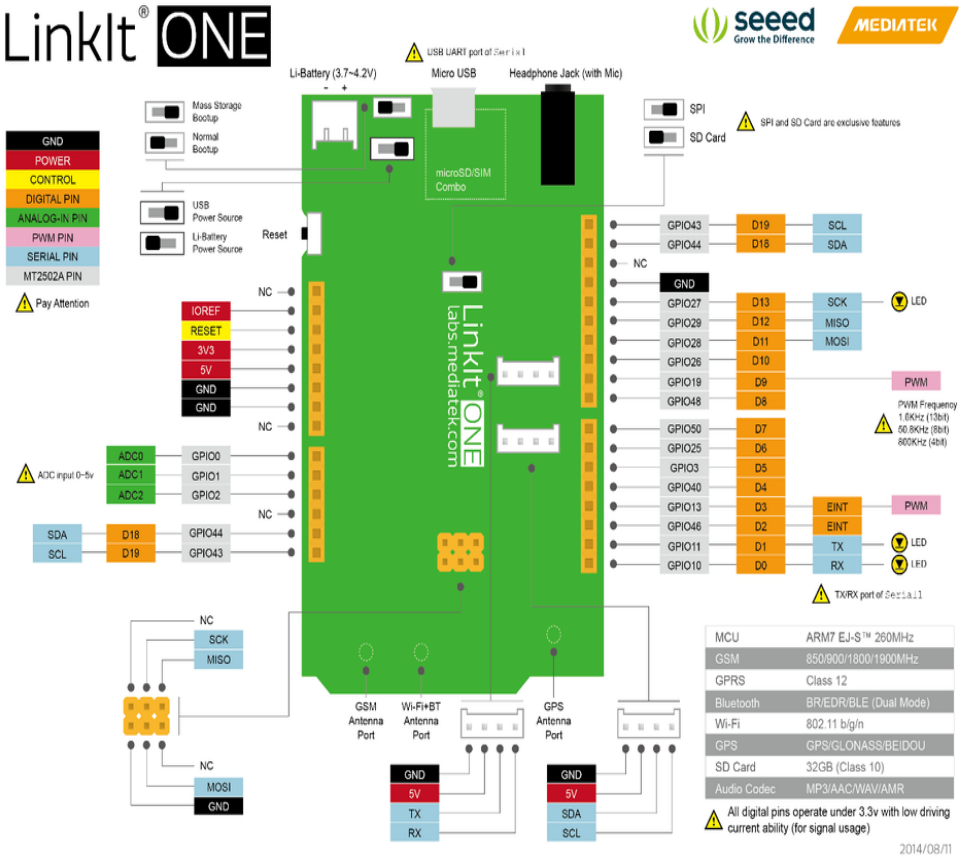

Figure 3.2: the pin-out configuration of LinkIt ONE source [19].

All smart implementation have a chip or circuit acts as main processor [2] of the system. At this implementation LinkIt-ONE

Development board's assigned by number (1) illustrated in figure3.3 was used as main processor of In-vehicle device.

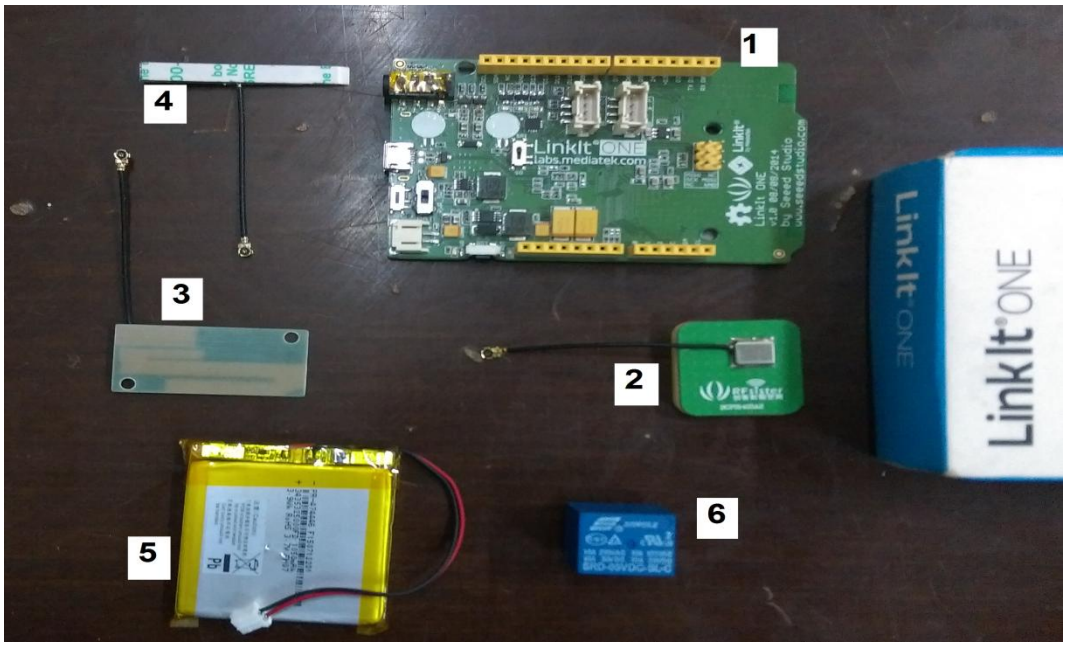

Figure 3.3: sub modules of the system.

Car Tracker utilizes the LinkIt-ONE development board's GNSS features to acquire the position and the speed of a vehicle. LinkIt-ONE development board is an all-in-one prototyping board for IoT/wearable devices, Integrating GSM, GPRS, Wi-Fi, GPS and Bluetooth features .It was used because of high performance techniques, low cost compared to Arduino board and all implementation modules are embedded on it. These techniques were implemented for collecting data from the vehicle, to be visualized on digital map, and to control the vehicle.

Flow chart show how system works:

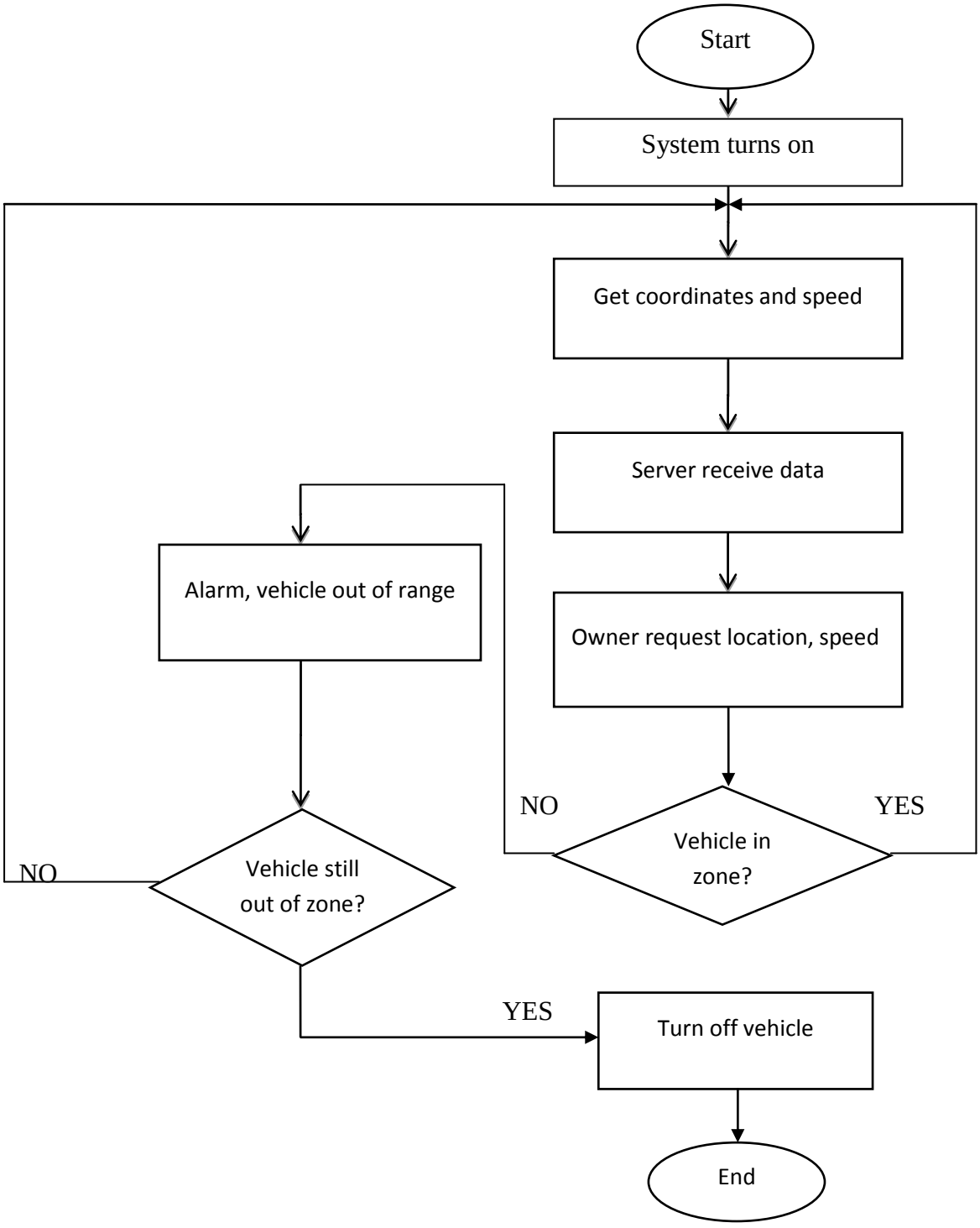

Figure 3.4: Flow chart of the system

3.2.2 Data Collection Units:

3.2.2.1 GPS receiver module:

GPS receiver module assigned by number (2) in the figure 3.3 above is used to receive the coordinates from satellites. It must be locked on to the signal of at least three satellites to calculate a two dimension position (latitude and longitude) and track movement. With four or more satellites in view, the receiver can determine the user's three dimension position (latitude, longitude and altitude), and from acquiring GPS data the speed can be calculated.

The tracking device will continuously request to the GPS satellite for its location information. At the same time GPS satellite will provide the location information for tracking device installed in vehicle, and then the in-vehicle device will send the location information back to the server through GPRS or Wi-Fi connection and continuously update the database.

3.2.3 Transmission unit:

Two methods are used for transmitting and receiving data collected by GPS receiver module, it’s through connected GSM/GPRS modem to the LinkIt-ONE development board or through Wi-Fi hotspot, which the location will not be accurate.

3.2.3.1GSM/GPRS module:

GPRS antenna assigned by number (3) in figure 3.3 above and SIM card installed inside LinkIt-ONE board as shown in figure 3.5, are used for transmit the data to the MCS web server and enable to visualized it as latitude and longitude on digital map.

Hardware setup:

Attach a GSM/GPRS antenna to the antenna connector and SIM card as shown below.

Figure 3.5: hardware setup of GPRS antenna and SIM card:

Standard size SIM card was inserted into the SIM socket on the rear of LinkIt-ONE board. Make sure that SIM is not PIN locked.

LinkIt-ONE SDK doesn't support PIN-locked SIMs. SIM900 is a Quad-band GSM/GPRS engine. It works on various frequencies i.e. EGSM 99MHz, DCS 1800MHz and PCS 1900MHz.

Software setup:

GSM library should be included in the Arduino code as shown below.

#include <LGSM.h>

3.2.3.2 Wi-Fi antenna:

LinkIt MT2502A Module is a low-cost and low-power consumption Wi-Fi Sip module. The module is targeted to mobile devices including smart phone, PDA, Wi-Fi phone, DSC, DVC which

need small Wi-Fi module. The highly integrated module allows the usage of web browsing, VoIP application.

The wireless Sip module support IEEE 802.11b/g/n standard and it can provide up to 72Mbps (GI=400ns) for IEEE 802.11n, 54Mbps for IEEE 802.11g, 11Mbps for 802.11b to connect your wireless LAN.

3.2.3.3 Connecting to the web using Wi-Fi:

This section describes how to configure your LinkIt-ONE development board and the code needed to connect to a Wi-Fi access points (AP) and retrieve the content of a web server.

Hardware setup:

To prepare your LinkIt-ONE development board, as shown in Figure 3.6, by attaching a Wi-Fi antenna to the antenna connector.

Figure 3.6: Wi-Fi antenna attached to the LinkIt-ONE

Software setup:

The code should be created to setup a Wi-Fi connection as well as retrieve web content.

Include the Wi-Fi library:

The Wi-Fi library should be included in the code, to do this with Sketch active in Arduino IDE, on the Sketch menu point to Import Library and click LWiFi. The Wi-Fi headers are now included in Arduino Sketch. In this guide LinkIt-ONE is used as the Wi-Fi client, so keep the first two headers and remove the others. And also Wi-Fi_ AP must be included in Arduino sketch and Wi-Fi_PASSWORD should be cancelled as shown below.

```
#include <LWiFi.h>
#include <LWiFiClient.h>
#define WIFI_AP "****"
//#define WIFI_PASSWORD "******"
```

3.2.4 Regulated Power supply:

The power source of in vehicle device is a polymer lithium-ion battery assigned by number (5) illustrated in the figure 3.3 connected to the LinkIt-ONE development board kit. The board can be plugging on by connecting battery and converting the switch into (BAT) position. The battery provided is a 3.7v, 1050 mAH li-ion which can be used to power ON the board and making it portable. It has a female connector at the other end which has to be plugged in to the male connecter at the bottom left corner of the board. The on board power LED should light up if you plug in the battery and slide the switch to battery mode.

Also can use 5V via USB connection as power source of Linkit-ONE by converting the switch into USB position when there's no battery inserted to the board as shown in figure3.7 below.`

Figure 3.7: LinkitONE with USB power source:

LinkIt-ONE can be powered through USB cable by converting the switch illustrated in the figure 3.7 into USB position.

Figure 3.8: LinkitONE with battery source

LinkIt-ONE can be powered through lithium-ion battery by converting the switch illustrated in the figure 3.8 into BAT position.

3.2.5 Relay Driver:

The relay assigned by number (6) illustrated in the figure 3.3 is connected to the pin (13) of LinkIt-ONE pins. This pin receives logic 1 or logic 0 from LED_CONTROL button (illustrated in the next section) to make the relay ON or OFF, that is used to control the vehicle by turning ON or OFF the main power line.

Owner can turn OFF the vehicle when it is navigating under two conditions, the customer out of range for long time, and when the vehicle was not returned to the owner at agreed period of time.

The figure below illustrates the relay controller circuit and how it works.

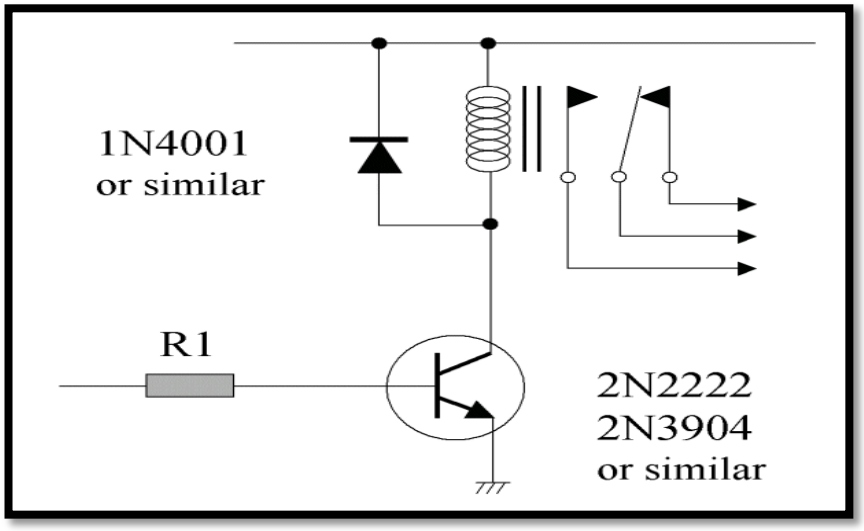

Figure 3.9: relay contactor

Relays are components which allow a low-power circuit to switch a relatively high current ON and OFF, or to control signals that must be electrically isolated from the controlling circuit itself. Newcomers to electronics sometimes want to use a relay for this type of application, but are unsure about the details of doing so. Here's a quick rundown to make

a relay operate, you have to pass a suitable holding current (DC) through its energizing coil. And generally relay coils are designed to operate from a particular supply voltage often 12V or 5V, in the case of many of the small relays used for electronics work. In each case the coil has a resistance which will draw the right pull-in and holding currents when it's connected to that supply voltage. So the basic idea is to choose a relay with a coil designed to operate from the supply voltage you're using for your control circuit (And with contacts capable of switching the currents you want to control), and then provide a suitable relay driver circuit so that your low-power circuitry can control the current through the relay's coil. Typically this will be somewhere between 25mAand 70mA.Often your relay driver can be very simple, using little more than an NPN or PNP transistor to control the coil current. All your low-power circuitry has to do is provide enough base current to turn the transistor ON and OFF, as you can see from figure 3.9, NPN transistor Q1 (say a 2N2222 or 2N3904) is being used to control a relay with a 12V coil, operating from a +12V supply. Series base resistor R1 is used to set the base current for Q1, so that the transistor is driven into saturation (fully turned on) when the relay is to be energized. That way, the transistor will have minimal voltage drop, and hence dissipate very little power ó as well as delivering most of the 12V to the relay coil. How do you work out the value of R1? It's not hard. Let's say RLY1 needs 50mA of coil current to pull in and hold reliably, and has a resistance of 240Ωso it draws this current from 12V.

3.3 Web server:

Server acts as a central connector for transmitting unit and monitoring unit. As both transmitting side and monitoring side communicate with each other through Server only which is provided by Mediatek Cloud Sandbox (MCS). It used to store all of history data to be visualized at any time the user required.

3.4 Monitoring unit:

Monitoring unit is an Android Application provided by Mediatek Cloud Sandbox which is provides interfacing between the user to communicate with the system, which enables to collect and visualize the actual position and speed recorded on In-vehicle device of proposed vehicle or each vehicle on the fleet and control it by turning ON/OFF the power line of the vehicle. The purpose of monitoring application is to provide users with easy, user friendly and comfortable tracking platform.

Monitoring device continuously access the database from the web server. From that database the location information can be plotted on Google map. This application works when the internet connection is available.

3.4.1 Templates for tracking and control:

3.4.1.1 Visualization:

GPS**:** Used to display the location of vehicle on digital map.

LATITUDE and LONGITUDE**:** Used to visualize latitude and longitude as a floating number.

SPEED**:** Displays vehicle's speed in mile/hour.

3.4.1.2 Control:

LED_CONTROL**:** For sending control signal to in-vehicle device, to turning ON/OFF relay.

LED_DISPLAY**:** Is the display type data channel, it's indicated an ON or OFF state according to the control button.

3.5 Software Program:

3.5.1 Programming of LinkIt-ONE chip:

LinkIt-ONE uses the same C language used by Arduino which making it easier to build and prototype projects, and uses the same software that is IDE with an additional plug in for IDE called Linkit-ONE software development kit (SDK) which makes this board compatible with IDE. Without the SDK, it would not work with the board selected as Arduino UNO.

The LinkIt-ONE chip can be easily programmed by uploading the code from PC by using USB cable to the flash memory of the chip. The small switch (2) beside the battery connector should be set to UART while another switch (3) near the SPI connector is set to SPI as shown in figure 3.10 below.

Figure 3.10: LinkIt-ONE switches.

3.5.2 Running Linkit-ONE code:

The linkIt-ONE can be programmed by using Arduino software. Select "LinkIt-ONE from the Tools > Board menu (according to the microcontroller on the board), then in tools > port debug COM should be selected for uploading code. Debug port used for uploading code, and modem port used for printing message, such as Serial.println( ).

LinkIt-ONE SDK compiles the sketch into a LinkIt-ONE executable (VXP file) as shown in Figure 3.10. The IDE plug-in then loads the VXP file into the file system of LinkIt-ONE development board. When the LinkIt-ONE development board boots up, it automatically executes the loaded VXP file. The VXP executable is then loaded by the run-time environment.

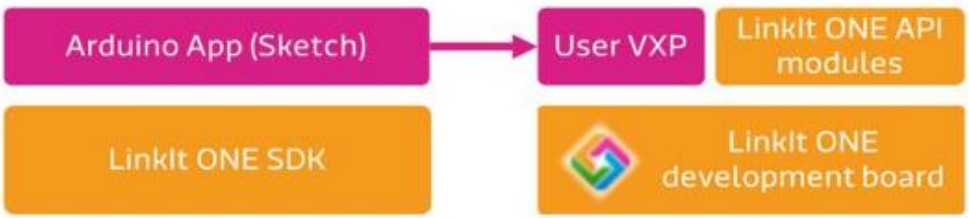

Figure 3.11: development and list process source [19].

The MT2502A (Aster) on the Arduino LinkIt-ONE comes pre burned with a boot loader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol.

You can also bypass the boot loader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header.

The MT2502A (Aster) firmware source code is available. LinkIt - ONE SDK is released as a plug-in for Arduino IDE. The APIs in the SDK provide access to all the connectivity functions provided by LinkIt-ONE development platform in addition to core Arduino functions, such as the ability to control digital pins and parse analog sensor inputs. This enables to build prototypes and demonstrations of connected wearable and IoT devices quickly and easily. As shown in Figure 3.12 using the LinkIt- ONE SDK created an Arduino Sketch to make use of the LinkIt-ONE APIs. These APIs execute over the run-time environment to enable for access the features of the LinkIt-ONE development board [19].

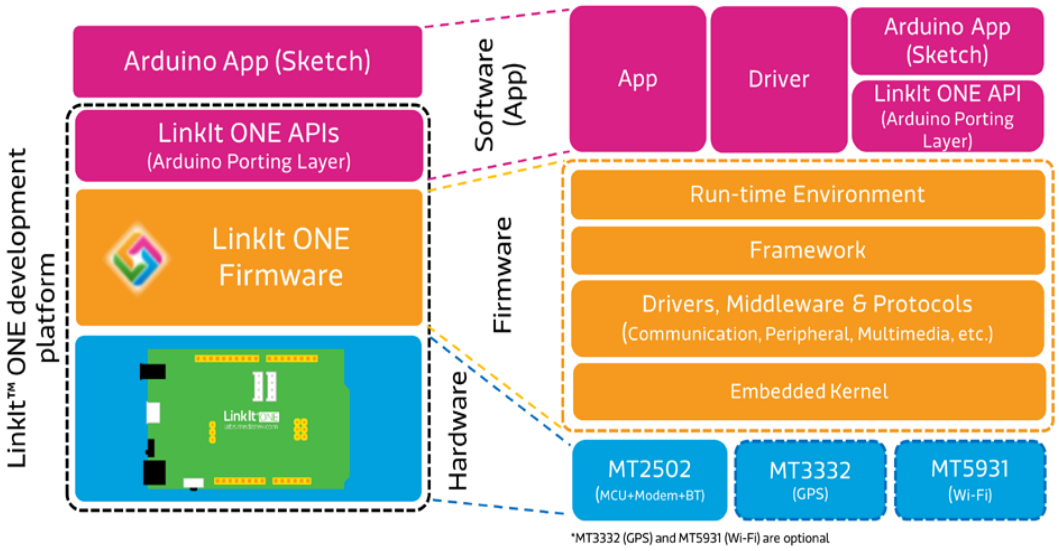

Figure 3.12: Architecture of the LinkIt ONE development platform source[19].

3.5.3 Configuration Switches:

Figure 3.1: configuration switch of LinkIt-ONE.

Switch No.	Functionality	Position-1 Functionality	Position-2 Functionality
1	**Program Mode**	**MS** : In this position, when connected to PC, LinkIt-ONE board will be shown as 10MB USB drive. The program will not execute in this mode. Any file that is copied to this drive can be read via the code.	**UART**: This position is used to set the board to program mode. Firmware can be uploaded in this mode.
2	**Power**	**BAT**: Board powered by Li-ion Battery. To charge battery, set the switch to this position and connect the board to PC.	**USB**: Board powered by USB port. Set switch to this position when there is no battery connected to program board.
3	**SD/SPI**	**SPI**: This position allows access of external SPI pins (D10 - D13).	**SD**: This position allows the code to access SD card. This mode also disables access of SPI pins (D10-D13).

3.6 Advantages and Applications of the system:

Advantages:

- Gives exact location with the help of Google maps.
- Easy to track.
- Within an organization everyone can be given the application to track their transportation.
- It provides more security than other system.
- From the remote place we can access the system.

Applications:

- Car rental companies.
- Anti-theft system for vehicles.
- Managing of public transports likes buses and trains.
- Tracking of valuable assets.
- Fleet Management of cars.
- As vehicle management software for transport companies and many more similar applications thus, this system can prove to be very helpful in future.