

Design of Multiplexed Multi-mode Communication System for Real-time Critical Alerts

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ABSTRACT: Communication is the term which resolves many overlay distances to seconds, with the rapid advancement in technology, which introduces multiple modes of means to communicate, brings the miles away distance where messages can be reached in less than a second duration. In the current fourth industrial revolution, there are many means of communication using wireless technologies such as BLE, WiFi, and GSM. These wireless technologies had proven individually their respective merits and demerits. Considering these technologies individually numerous applications and products are developed and deployed in day to day life. This research paper focuses on a point to integrate all these wireless technologies as single element which can be deployed in applications, where real-time critical alerts are necessary and most essential. The Design involves Raspberry Pi 3 as platform to achieve “Multiplexed multi-mode communication system for real time critical alerts”, which was tested and operated successfully.

KEYWORDS - Raspberry Pi, GSM, Bluetooth, Wi-Fi, Python script, Real-time, Critical Alerting system.

I. INTRODUCTION

We are in the fourth industrial revolution with Internet of Things (IoT) being the current trend of automation and data exchange, primarily depends on manufacturing technologies [3]. It includes interface scenario sensors, cyber-physical systems, IoT and cloud computing. Within the modular structure, IoT framework is embedded with cyber-physical systems monitor physical processes creating a virtual copy of the physical world and make decentralized decisions. Over the Internet of Things, cyber-physical systems communicate and cooperate with each other and with humans in real time [3].

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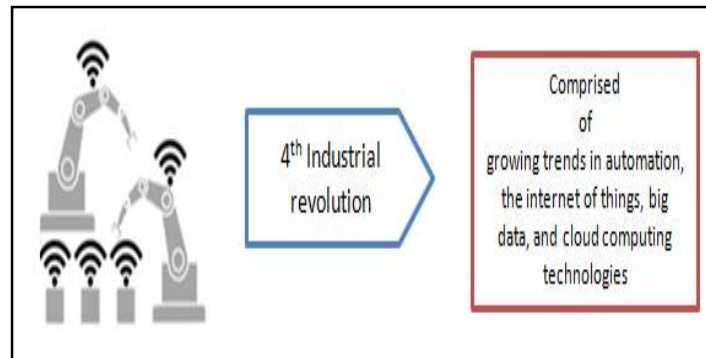


Figure 1: fourth industrial revolution

Real-time communication is the key factor for utilization of this fourth generation industrial revolution applications. To support this need, embedded device platforms have evolved rapidly with means of communication options [6]. It is the fact to realize communication, preference is towards wireless mode and many means of wireless mode of communications are established and successfully utilized. Wireless technologies are expected to be bit expensive when compared with wired solution. This paper presents the “concepts of achieving and establishing multiplexed wireless communication platform which enable data to exchange in multi-mode system without compromising on real-time services”.

II. CONCEPT

The concept of multiplexed multi-mode communication system is, to establish and achieve data to exchange in multi-mode system without compromising on real-time services. In this concept, three wireless means of communication is utilized which are described below.

1. GSM - Global System for Mobile communication) is a digital mobile telephony system that is widely used across the world. GSM uses a variation of time division multiple access (TDMA) and is the most widely used of the three digital wireless telephony technologies (TDMA, GSM, and CDMA) [1].
2. Bluetooth is a Low Energy (Bluetooth LE, BLE, marketed as Bluetooth Smart) wireless personal area network technology designed and marketed by the Bluetooth Special Interest Group aimed at novel applications in the healthcare, fitness, beacons, security, and home entertainment industries [1].
3. Wi-Fi - Wi-Fi is a technology for wireless local area networking with devices based on the IEEE 802.11 standards. Wi-Fi compatible devices can connect to the Internet via a WLAN and a wireless access point [1].

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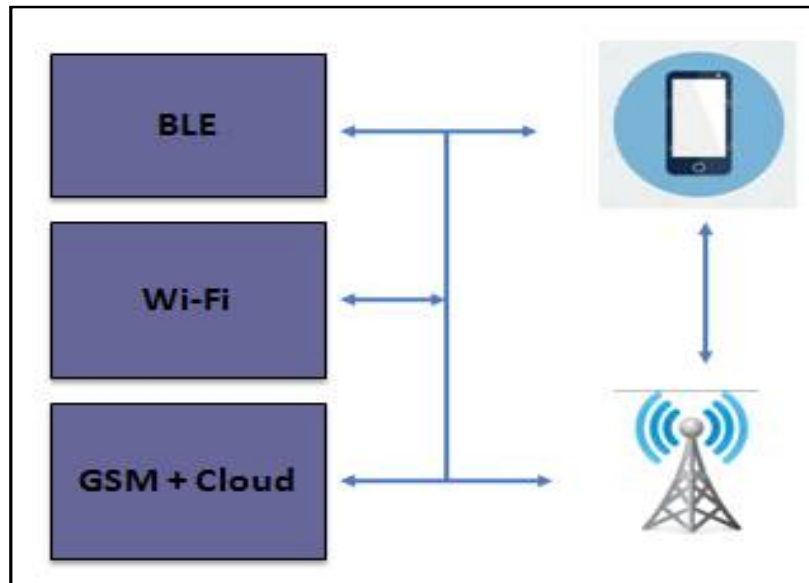


Figure 2: multiplexed multi-mode communication system

The objective of this concept was, constructed over single embedded platform with GSM, BLE and Wi-Fi communication modules. On the event occurrence the firmware associated in the platform initiates the communication process as per set preference. The preference is to first send SMS to the registered mobile, communicate the messages connecting to the paired mobiles through Bluetooth and Wi-Fi mediums. The primary objective is to communicate the important and emergency alerts in multiple means based on the available options and avoid void conditions [4].

Mobile usage in today's world is rapidly marching towards to meet the head count of country population. The capabilities of mobiles phones differ and usage of all the features in mobiles are dependent which in times limit the communication [5]. For an instance, Wi-Fi option utilization is completely depends on the availability of external devices like hotspots, modems or dongles. In this case even though the Wi-Fi features available the utilization is limited and dependent. In order to handle these scenarios, this concept will enable and ensure the communication to reach the desired destination.

Understanding the technologies GSM, BLE and Wi-Fi as means of communication following are the scenarios which indicate limitations and dependencies.

- GSM was available for complete mobile communication setup with Base stations, Network Switching Subsystem (NSS) and Operation & Support Subsystem (OSS). Even though with the current establishment very rarely we are finding unavailability of signal strength, but there are still possibilities of situation where mobile becomes void to send/ receive messages. Through GSM limited information can be conveyed through SMS but most reliable with minimal dependencies.
- BLE required counterpart device paring and these devices to be located in nearby distance. BLE means of communication is cost effective and no limitation in message size. The limitations with BLE are prior pairing and distance of communication which reduces the reliability

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- Wi-Fi required additional devices to attain connectivity for establishing communication but comprises of scope to reach extreme ends to the world. No limitation in data size and representation of data is open for creativity with applications which can be designed to view in web pages and mobile utilities.

Considering all the pros and cons of GSM, BLE and Wi-Fi, this research work enables to achieve and establish multiplexed wireless communication platform which enable data to exchange in multi-mode configuration [2].

III. METHODOLOGY

Hardware Design

Below figure: 3 depicts the hardware design for this communication system. Using Raspberry Pi 3 along with GSM module in the design, it provides an advantage in utilizing on-chip BLE and Wi-Fi features for the implementation of this system. These modules are interfaced properly to communicate with each other, for this, pre-defined set of protocols are used in developed software. With this design, remote communication was possible.

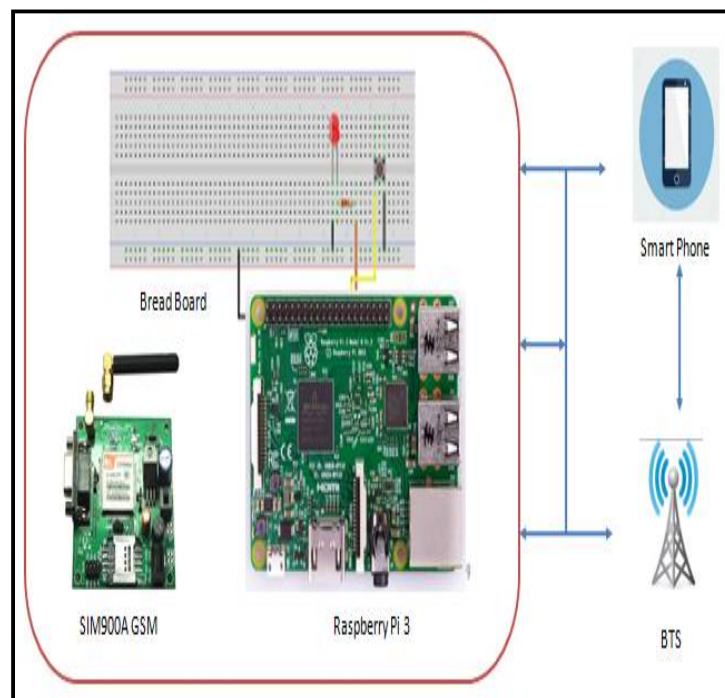


Figure 3: hardware design of multiplexed multi-mode communication system

Table-1 details the major hardware components that are deployed in this design of multiplexed multi-mode communication System.

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Table-1
Major hardware design components

Item	Description
Raspberry Pi 3	<ul style="list-style-type: none"> • 1.2GHz 64-bit quad-core ARMv8 CPU • 802.11n Wireless LAN • Bluetooth 4.0, Bluetooth Low Energy (BLE) • 4 USB ports, 40 GPIO pins • Full HDMI port, Ethernet port • Combined 3.5mm audio jack and composite video • Camera interface (CSI) • Display interface (DSI) • Micro SD card slot (now push-pull rather than push-push) • Video Core IV 3D graphics core
SIM 900A	SIM 900A GSM modem/module with SMA antenna high quality
Switch	Push button switch to toggle GPIO state between ON and OFF
LED	To indicate the Switch status
Power Supply	Power Adaptor 5V, 2 Amp
Mobile Phone	GSM smart phone with Android OS, Bluetooth and Wi-Fi

Raspberry Pi 3 plays the master role in the design. Multiplexed multi-mode concept is implemented considering on-chip BLE and Wi-Fi feature in Raspberry Pi 3 and additionally SIM900A modules is interfaced externally for GSM communication [5, 7]. Presence of Switch depicts the trigger event to initiate multiplexed multi mode communication. This switch can be replaced with any application as emergency event trigger to achieve real-time critical communication in all the means [8].

Software Design

The Software design of multiplexed multi- mode concept is, sequential and systematic. Software was developed in python scripting language. Figure 4 depicts the work flow of software upon the power ON. The interface modules GSM which is external to Raspberry Pi and in built BLE and Wi-Fi interfaces are initialized. Followed by initialization the software waits for trigger event to initiate the multiplexed multi-mode communication.

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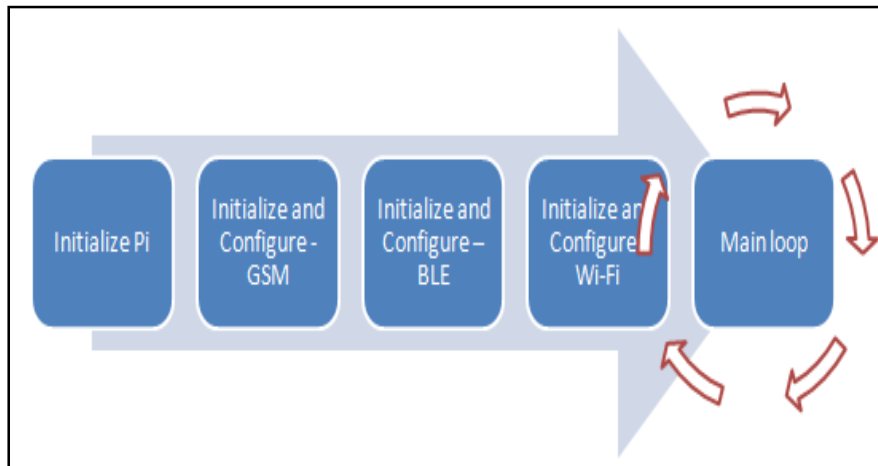


Figure 4: Software work flow of multiplexed multi-mode communication system

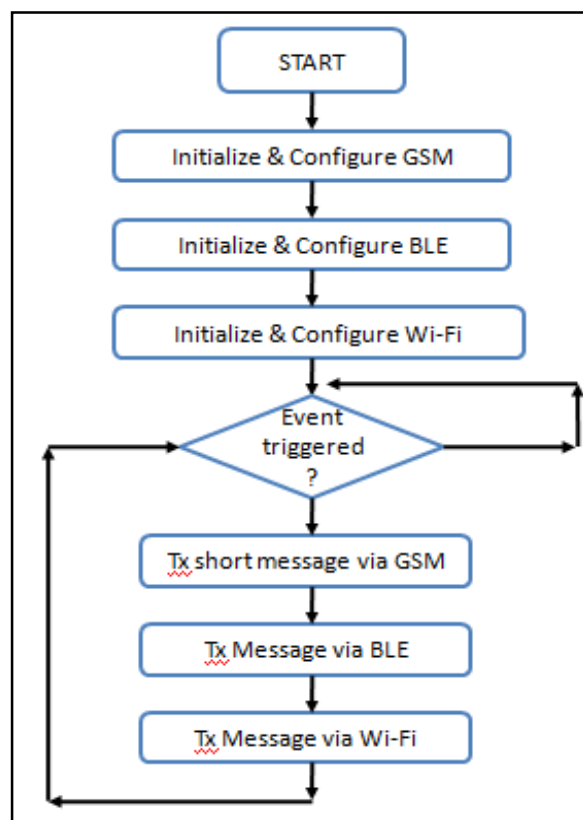


Figure 5: high level software algorithm of multiplexed multi-mode communication system

Figure 5 provides the high level software algorithm deployed for multiplexed multi-mode communication. Followed by initialization and configuration of GSM, BLE and Wi-Fi the algorithm awaits for trigger event to initiate

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the communication. Upon occurrence of trigger event, defined messages are transmitted, in the current design, switch press is considered as trigger event which can be associated with any real-time application.



Figure 6: mobile applications to receive alert messages

Simple mobile applications are developed to receive the alert messages through means of BLE and Wi-Fi. These applications are developed to prove the concept and exceptions for robust interface to be implemented.

IV. RESULTS

Figure6 shows the complete setup of the multiplexed multi-mode communication System in which Raspberry Pi 3 plays the master role in the design. Multiplexed multi-mode concept is implemented by considering on-chip BLE and Wi-Fi feature in Raspberry Pi3 and additionally SIM900A GSM modules is interfaced externally to the mobile for communication.

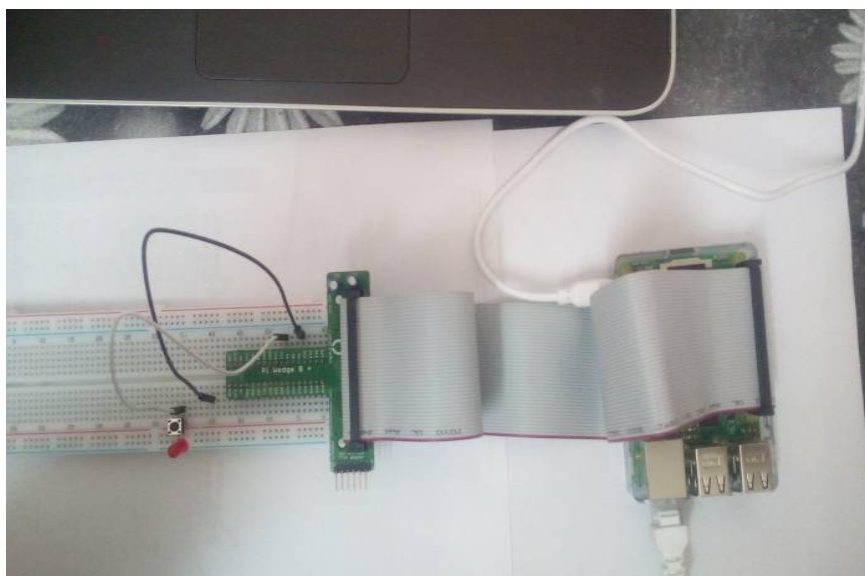


Figure 6: multiplexed multi-mode communication System

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The concept of achieving and establishing multiplexed wireless communication platform which enable data to exchange in multi-mode system without compromising on real time service is implemented. Initially trial had issue with synchronization between BLE and Wi-Fi data reception later with introduction of minor delay in transmission the issue was resolved. The performance of the designed system was tested and the results were tabulated, the designed system performance was satisfactory.

V. CONCLUSION

Multiplexed multi-mode concept is implemented, the performance of the designed system was tested and the results were tabulated, the designed system performance was satisfactory. Further, this concept will be extended with application oriented where data to exchange in multi-mode system without compromising on real-time service was required.

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