Power Saver: Increasing Mobile Device Battery Life Durability Using WiMAX Technology

N.A.M. Liyanage, V.W.R.M.W.B. Ranaraja, N.S. Vithanage, P.S.M. Alavatta, S.M.R.B. Samarakoon, P. Navaratnam and Dhishan Dhammearatchi

Sri Lanka Institute of Information Technology Computing (Pvt) Ltd

Abstract- As per today, the mobile phone has become the major equipment which is being used by people for multiple purposes. Due to the advancements of technology, the capabilities of the mobile phone have been increased. One of the major uses of mobile phones is accessing the Internet. One of the biggest issues in mobile devices is consuming higher battery life especially when the phone is connected to internet. As more and more technology like Third Generation (3G)/Long Term Evaluation (LTE) have come with more improved data transmitting speed and none of the technologies focuses on the power consumption of the Mobile stations (MS). Unlike 3G /LTE the Worldwide Interoperability of Microwave Access technology (WiMAX) provides some additional features like sleep and idle modes which will allow the base stations (BS) to suspend the connection often when needed. WiMAX is a wireless data transmission technology same as Wi-Fi but affects to a closer range. Additionally, these standards (sleep and idle) define mechanism which will enable the control of MS stations transmitting power to BS. In this research paper the research team first gives an overview of the key aspects of WiMAX, and its Media Access Control (MAC) layer and finally describes a mechanism to implement the sleep mode protocol which will highly decrease the power consumption of the MS.

Index Terms- WiMAX, MS, BS, 3G, LTE

I. INTRODUCTION

Nowadays, mobile phones have become the most important device for humans. People used to carry mobile devices with them where ever they travel to make their life easier. Mobile devices now been developed not only for voice communication it is far more developed for data communication. Due to the advance development of mobile devices with including data communication people used to do their work on mobile devices such as sending emails, browsing the web, downloading's, online payments etc. Concerning this upcoming generations mostly used to use with wireless devices more than wired devices because it is easy to use and it saves more time since it can be used anywhere without doubt.

However, the major problem arises with mobile devices is the battery life. The size of the mobile devices is small unlike the included battery is also low energy weighted. Therefore, to perform more tasks, mobile devices need durable battery life. Major problem that makes the mobile battery reduce faster is, it runs 3G/LTE, and for 3G/LTE data connectivity, the consumption of the battery is very high since its fast access and intelligence and which means, that a high- end battery is needed in a mobile phone, or the battery will not last long. Though reducing the power possible to alter the functionality of MAC layer to get support for power consumption reduction purposes.

The proposed solution presents a mechanism to reduce the battery consumption of MS which will be implemented using only the sleep mode protocol which was defined by IEEE 802.16e-2005 [10].

II. BACKGROUND AND RELATED WORKS

Communication devices and especially portable communication devices such as cellular handsets or devices are known. Battery life for these devices is an important attribute since that is a major contributor to user satisfaction and convenience. Shorter battery life means that a battery will need to be recharged more often and that the likelihood of service failure due to insufficient battery charge will increase for a given user. Larger batteries could be used, but that would have a detrimental impact on device size, Weight, and cost. Typically, battery life is determined by power consumption of the device when it is in a standby condition. Wide area system architects are familiar with this issue and normally design access protocols and the like so that devices associated with the network can spend much of their time in a sleep mode whereby power consumption is minimized by powering down much of the circuitry of the device.

Most of the mobile devices get low with the battery life when the phone is connected to the internet when using mobile data. There for mobile data bandwidth is very low. Since the bandwidth of the mobile devices are low the consumption of the battery life is high. Therefore, as a solution for that the research group proposed the WiMAX protocol to overcome the problem with the mobile device battery.

This research systematically examines the effect of idle mode on power saving in mobile WiMAX network. The research group propose mobile subscriber stations, mobile worldwide interoperability for microwave access. Idle mode allows the mobile station (MS) to conserve power and resources by restricting its activity to scanning at discrete intervals and thus eliminates the active requirement for handover operation and other normal operations. On the base station (BS) and network side, idle mode provides a simple and timely method for alerting the MS for pending downlink (DL) traffic directed to the MS and thus eliminates air interface and network handover traffic from essentially inactive MS s. Its performance of idle mode in terms of power saving in MSs for long battery life. Its performance is

saving power in both sleep mode and idle mode. This research dose not discuss about some applications using more power to run that application and how to save the power in using that application [1]. The research considers the state-of-the-art power management methods in next-generation wireless networks with a focus on next-generation WiMAX networks and 3GPP LTE. Two advanced power conservation mechanisms, sleep and idle modes, which are enhanced versions of the legacy system's sleep and idle modes. The research group proposed and adopted in similarly, 3GPP LTE adopts a discontinuous reception mechanism for power conservation in RRC_CONNECTED and RRC_IDLE states. Power management techniques in WiMAX and 3GPP LTE provide less control signaling and operational overhead while providing more efficient power saving, and use simpler operation procedures than the existing power management techniques [2].

Effect of idle mode on power saving in mobile WiMAX Network. This will effects enabling of idle mode increases battery lifetime and thus the power performance. Energy consumed by the idle enabled in MS. WiMAX technology has power saving features that allow portable subscriber stations to operate for longer durations without having recharge. Signaling methods that allow the MS to retreat into a sleep mode or idle mode when inactive [3]. Performance Evaluation of Wi-Fi comparison with WiMAX Networks. This technology not support the mobility of a network. Establishes as the wireless network, and also called Mobile Network. Providing a wireless alternative to cable and DSL for "last mile" broadband access. Furthermore, the connection speed increased and band width is high mobile devices use very less power consumption. Providing a source of Internet connectivity as part of a business continuity plan. And Provide internet access and multimedia services at very high speed to the end user. Since mobile devices use less power to continue the task. WiMAX network execute a connection oriented MAC layer [4]. Simulation of WiMAX Physical Layer: IEEE 802.16e stranded. This research paper focus was the development of a LoS-based point-to-multipoint wireless broadband system for operation in the 10–66GHz millimeter wave band. WiMAX systems for achieving high speed mobile wireless access services and outlined the technologies supporting these systems. When channel conditions are poor, energy efficient schemes such as BPSK or QPSK were used and as the channel quality improves, 16-QAM or 64- QAM was used. Simulation phase was done as a first step in implementing WiMAX networks using field programmable gate array (FPGA) systems [5]. Extending battery life in communication devices having a plurality of receivers. In this research paper primary receiver in one network and secondary receiver in another network, send the data packet use in less battery power [6]. Energy consumption in mobile phones a battery life of a mobile phone is increasingly drained huge amount of energy by one of the reason that the phones are popularized with the usage of network applications. Here the research paper considers on 3G and 2.5G enabled phones to make a study on how the energy is consumed. It reveals that the energy is used not just by the data size of the applications but the traffic pattern it takes also be the cause. Hence a Design Tail Ender protocol is introduced to resolve the energy draining by shaping the data traffic and contributed up to 40% of energy reduction in common applications like email, web search in these 3G enabled phones. The applications are observed as they can tolerate delays like email and prefect as used in web search. Prefetching and delay tolerance can help to shape the traffic by reducing the transferring time. Decreasing of inter transfer time reduce energy. Sending more data requires less energy. The research paper evaluates the energy consumption during Web Search Emulation on phones when using a Tail Ender Protocol and without it as a default one. It is observed that Tail Ender retrieves more data, consumes less energy and enjoys lower latency than the default one. It is observed from the evaluation of email that the Tail Ender nearly halves the energy consumption for a 15minute delay tolerance. (Over GSM, improvement is 25%) [7]. Energy Consumption in Mobile Phones. The research paper gives a measurement study and implications for network applications. Research team find the energy consumption is related to the workload and not the total transfer size, e.g., a few hundred bytes transferred on 3G can consume more energy than transferring a megabyte in one shot. A simple model of energy consumption of network activity for each of the three technologies. Research team develop Tail Ender to identify opportunities for reducing the energy consumption of network activity induced by common mobile applications. Measurement study of the energy consumption of the 3g, GSM, and Wi-Fi. Based on these measurements, research team develop a solution for energy usage by network activity for each technology. Tail Ender, a protocol for energy usage for mobile applications. Tail Ender schedules transfers to minimize the cumulative energy consumed while meeting user specified deadlines. Tail Ender saves more data and response times while consuming less energy. Three applications email, newsfeeds, and web search based on real logs show reduction of energy consumption of Tail Ender. The protocol that minimizes energy usage, for applications that can benefit from prefetching, Tail Ender aggressively prefaces data, including useless data, and yet reduces the overall energy consumed [8].

Reducing the power consumption of wireless mobile devices with multiple radio interfaces (Cool Spot). Cool Spots enable a wireless mobile device to automatically switch between Wi-Fi and Bluetooth to increase battery lifetime. The main part of this work is creating the policies that enable a system to switch between these technologies, each with radio characteristics and different ranges, in order to save power. The system and policies do not require any changes to the mobile applications themselves, and changes required to existing infrastructure are minimal. The model provides a way for mobile devices to automatically reduce their power consumption during wireless data transferring. Without any application modification, the system utilizes multiple wireless channels to realize a greater than 50% energy savings when compared against standard Wi-Fi only power saving. Several policies form the basis for switching between the wireless interfaces. A more adaptive algorithm (cap-dynamic), based on active channel measurements, is very effective at recognizing the appropriate instant to switch interfaces [9].

In this research, the research group give an overview of the key aspects of WiMAX and how to reduce the power in mobile devices using WIMAX technology. Sleep mode operation for IEEE 802.16e based WiMAX in less power consumption, it can

be observed that the energy drop age in wireless metropolitan area network communication by the frequent sleep to awake transitions. By proposing dynamic algorithm, it is tuned the ratio of the sleep windows and receive windows based on real time load. A Markov chain model is helped to analyses the energy efficiency and mean access delay. The energy- saving mechanisms of the sleep mode operation in WiMAX helped to achieve energy efficiency over traditional energy saving. NS2 simulation results show that energy efficiency is better in the proposed dynamic algorithm than that in standard, overcame the problem of energy efficiency decrease by short time sleep. Here the paper tells that the data speed from a network to base station is lower when compared with base station to mobile station. Since to maintain the limited energy resources in MS, BS uses the time multiplex to forward data by time sharing and energy consumption is progressed as MS receives downlink data in fixed time. Leisure waiting time is getting reduced when MS keeps sleep. A MS can able receive real time services frequently since the terminal equipment of WiMAX network supports for various real time services. When these services are received in high speed, MS would transfer to sleep modes often where the energy is lost cannot be ignored in mode conversion. MS works in higher load, the limited energy resources will be consumed during frequent mode conversion by sleep mechanism and the data speed of energy saving mechanism won't be effective. Bigger the load is the longer the MS energy consumption time will be, and the energy efficiency will approximate to 1Here the effective area of load to be determined. Research paper mainly focus on concrete parameters settings of real-time service in initial sleep window, packets arrival time in sleep and delay analysis of new packets arrived in different receiving time when MS is awake, because the standard does not give a specific method of sleep parameters setting. The study of real-time service is very deficient. The key of dynamic algorithm explains whether some energy can be saved when in sleep mode, if can, MS activates sleep mechanism, or else, goes into idle mode, or we say MS goes into idle test condition immediately after receiving data, but this state duration and sleep window size are dynamically adjusted, if the duration is zero, then this state is only an absorption condition, if it is not zero, the sleep time should be set zero because MS under such load cannot save more energy when in sleep mode. The performance of the proposed algorithm will be more suitable if the load is smaller. This is because when packet arrival rate is lesser, dynamic algorithm can fit a smaller receiving time and a bigger sleep window. Moreover at this time the standard leisure time is larger, so is the energy consumption, however, the proposed algorithm, although the sleep time is bigger, the energy consumption in sleep is less, the total energy efficiency is improved [10]. An analysis of power consumption in a smartphone in power consumption on mobile phones are powered from batteries which are limited in size and therefore capacity. Proper energy management requires a good understanding of where and how the energy is used. The researchers develop a power model of the free runner device and analyze the energy usage and battery lifetime under a number of usage patterns. According to the also analyze the energy impact of dynamic voltage and frequency scaling of the device's application processor. A core requirement of effective and efficient management of energy is a good understanding of where and how the energy is used: how much of the system's energy is consumed by which parts of the system and under what circumstances. This is the core idea of this research paper and we are trying to come to a solution through this [11].

III. OUR APPROCH

A. How WiMAX protocol works in MAC layer of the device?

WiMAX is the proposed research technology which is been used to consume the battery life of the MS. Consumption of the battery life happens through the MAC layer. MAC layer is been divided as lower MAC (LMAC) and upper MAC (UMAC). LMAC layer implements the hardware aspect while UMAC layer implements the software aspect. Power consumption take place in the UMAC layer since it's the place where traffic and data management reassembled. Consumption of the battery in MAC layer works through the software (UMAC layer) which implements a function to power save the operation in processor of the MS. The UMAC layer works for the above mentioned aspect when the MS doesn't provide any instruction or while it does not send or receive any data. Moreover, to consume the battery of the MS physical layer of the LMAC works independently with the UMAC layer. Figure 01 bellow shows Mac layer hardware diagram.

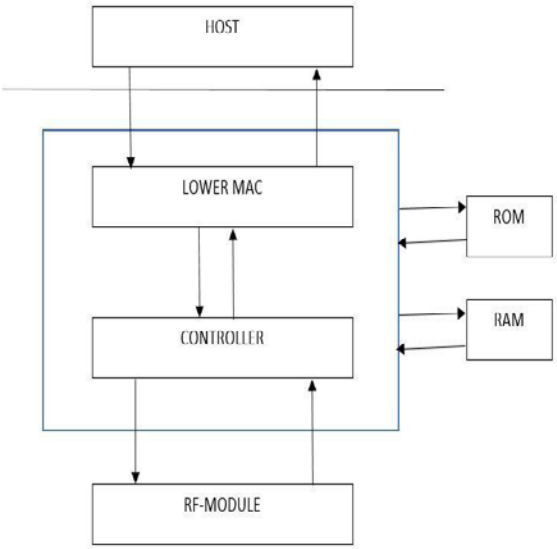

Figure 01: MAC layer hardware Diagram

B. Proposed Solution

As the WiMAX protocol is a new technology, it is essential to support future enhancements of the protocol in a flexible manner. The WiMAX protocol defines two modes known as idle mode and sleep mode which suspends the transmitting and receiving operations. The proposed research paper based on only sleep mode.

In sleep mode, unlike the idle mode, the MS transmits and receives data over connections between the BS and MS. The periods of no transmission and reception of each connection are not necessarily synchronized. The period when all connections

are in this called “unavailable” and the MS can terminate the operation of the wireless interface. In the unavailable period, the BS can decrease its processing power consumption by suspending the wireless interface block.

Concerning the WiMAX system, the BS handles and control the transmission energy of the MS in the same way as in the Code Division Multiple Access (CDMA) system. In CDMA system, the BS adjusts the transmission of MSs to equalize the powers received at the BS. In WiMAX system, the MS transmission power is controlled in order to avoid exceeding the BS’s total receiving power from the antenna.

The proposed WiMAX technology supports adaptive modulation and coding, which varies the modulation, such as quadrature phase shift keying (QPSK) or quadrature amplitude modulation (QAM), or error correction coding rate according to the wireless channel quality. Transmit a signal to the MS, the BS determines the modulation and coding scheme (MCS) by observing the signal-to-interface-and-noise-ratio (SINR) of the received signal. MCS information is transmitted for each MS. If SINR is good, the MS can high-speed modulation and a small amount of error correction code, so a high transmission rate can be achieved. Method to improve the SINR is for the MS to transmit at high power. However, increasing the transmission power increases the battery power consumption, so the battery life time becomes shorter.

The research group developed an algorithm that is implemented in the BS prolong battery life. The algorithm is shown in figure 02(Not a Busy Mode) and figure 03(Busy Mode)

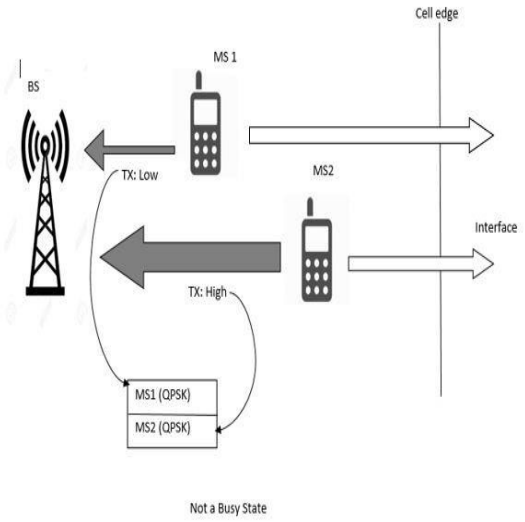

Figure 02: TPC Algorithm Overview (Not a Busy Mode)

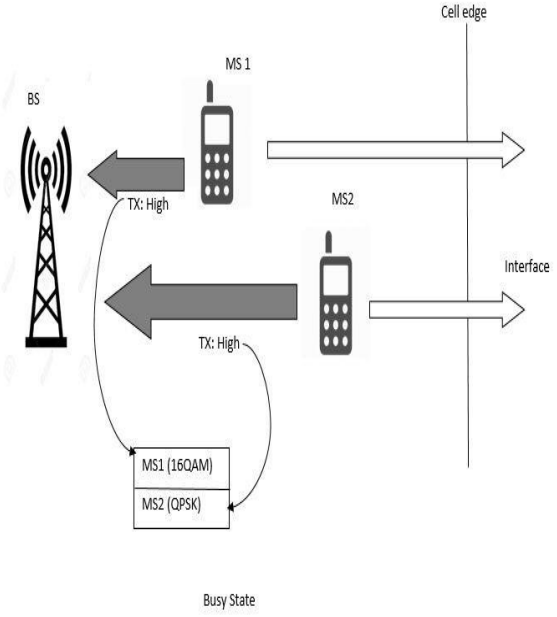

Figure 01: TPC Algorithm Overview (Busy Mode) As a solution, an algorithm can be introduced to extend

the battery durability. The concept is that the lowest- rate MCS is used as much as possible because the required transmission power is the lowest. Furthermore, the BS designates the lowest-rate MCS such as QPSK half for each MS when all the data required to be transmitted using that MCS. A transmission power for each MS is appointed as the minimum level that guarantees transmission capacity for that MCS, the BS selects a MS that does not overlap with most of the MSc under other BSs and appoints a higher-rate MCS for that MS by boosting the MS transmission power to a level that guarantees transmission using the new MCS. Using the higher rate MCS reduces the air resources required for the MS. The BS can allocate the released resources to other MSs. To identify the MS that intercedes the least with MSs under other BSs, the transmission power of the MS suffering the least interference from MSs under other BSs is the minimum because the required SINR is the same. This is because the effect of interference is symmetrical. The MS that transmits at the lowest power is selected as the MS to send at the higher rate MCS at the higher transmission power.

IV. CONCLUTION

Power saving is becoming critical in next-generation wireless systems such as mobile devices, connectivity and advanced air interfaces are essential to the need for more compute power. Next-generation wireless networks to provide advanced power saving mechanisms. Available gaps and missing gaps turn the basic mechanism provides efficient and simple way to conserve electricity. Third generation (3G) technology as much as / long term evaluation (LTE) technology introduced in this article, and more improvements and technologies to transmit data with the speed of any mobile station (MS) of power focusing on consumption. Mobile wireless access networks, battery life and handoff mobile applications are essential criteria. So mobile WiMAX power saving mode (sleep and idle mode) to extend the battery life of mobile devices supports. IEEE 802.16e standard power idle mode specified in this paper has analyzed the efficiency savings. From the results, the passive mode enabling increased battery life and power performance is thus clear. The

study shows that enable energy consumed by idle MS is disabled and therefore much less passive mode provides high-power savings is compared to. WiMAX performance than with a wireless Wi-Fi network is a good way. WiMAX networks have problems away from Wi-Fi networks. Wi-Fi network access is restricted problem area. But there is no restriction to work WiMAX. Both networks are reliable networks. WiMAX and Wi-Fi networks with the technology than the safe, reliable service. It supports battery-powered mobile devices, mobile WiMAX subscriber stations to recharge the portable power-saving features that no longer allowed to operate for durations. Saving electricity in a controlled manner to close parts of MS power when it is not actively transmitting or receiving data is achieved by turning off the power parts.

V. FUTURE WORKS

The most important part of a mobile devices is battery life. WiMAX reduce more power consumption of a mobile device when transferring data with 3G, GSM and Wi-Fi. As give up 3G, GSM and Wi-Fi, also WiMAX can be give up because of the new wireless technologies coming up. There is more advanced data transferring methods are coming up nowadays like LiFi. With the new data transferring methods new power saving methods are coming up data saving protocols, automatically switching between transferring technologies etc. In the future technologies like LiFi can be used in the same way we used WiMax, to reduce the power consumption of a mobile device.

REFERENCES

[1] Thontadharya H.J., Shwetha D., Subramanya Bhat M., and Devaraju J.T (2012) “Effect of Idle Mode on Power Saving in Mobile WiMAX Network” Available at: https://www.researchgate.net/publication/229077499.pdf [Accessed 2016.08.20]

[2] Ronny Yongho Kim and Shantidev Mohanty (2010) ‘’Advanced Power Management Techniques in Next-Generation Wireless Networks’’ Available:https://www.iith.ac.in/~tbr/teaching/docs/powerMgmt- LTE-WiMAX.pdf [Accessed 2016.08.15]

[3] H. J. Thontadharya , D. Shwetha, M. Subramanya Bhat and J. T. Devaraju “Effect of Idle Mode on Power Saving in Mobile WiMAX Network ” Available: http://link.springer.com/chapter/10.1007%2F978-81-322-0740-5_60 [Accessed 2016.08.15]

[4] M. Sreerama Murty , D. Veeraiah, A . Srinivas Rao (2012) “Performance Evaluation of Wi-Fi comparison with WiMAX Networks” Vol.3, No.1, January 2012” Available: https://arxiv.org/ftp/arxiv/papers/1202/1202.2634.pdf [Accessed 2016.08.20]

[5] 2010 M.A. Mohamed, F.W. Zaki , R.H. Mosbeh (2010) “Simulation of WiMAX Physical Layer: IEEE 802.16e ” VOL.10 No.11, November 2010 Available: http://paper.ijcsns.org/07_book/201011/20101109.pdf [Accessed 2016.08.20]

[6] Daher J, James David Hughes and Ronald R- Rockwelli “Extending Battery Life in Communication Devices having a Plurality of Receivers” Available: https://www.google.ch/patents/US7496060 [Accessed 2016.08.15]

[7] N.Balasubramanian, A.Balasubramanian, A.Venkataramani “Energy Consumption in Mobile Phones: A Measurement Study and Implications for Network Applications” Available: http://dl.acm.org/citation.cfm?id=1644927 [Accessed 2016.08.20]

[8] N.Balasubramanian, A.Balasubramanian and A.Venkataramani (2009) “Energy Consumption in Mobile Phones: A Measurement Study and Implications for Network Applications” Available:http://dl.acm.org/citation.cfm?id=1644927 [Accessed 2016.08.20]

[9] T.Pering, Y.Agarwal, R.Gupta, R.Want (2006) “CoolSpots: Reducing the Power Consumption of Wireless Mobile Devices with Multiple Radio Interfaces” Available: http://dl.acm.org/citation.cfm?id=1134704 [Accessed 2016.08.20]

[10] Xue, J., Wang, W., Zhang and T. et al. (2013) “Sleep mode operation for IEEE 802.16e UGS based WiMAX” Available:http://link.springer.com/article/10.1007/s11235-013-9685-2 [Accessed 2016.08.23]

[11] Aaron Carroll and Gernot Heiser “An Analysis of Power Consumption in a Smartphone” Available:https://www.google.lk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwitztm27YzPAhUFlZQKHZJWA9IQFggcMAA&url=http%3A%2F%2Fciteseerx.ist.psu .edu%2Fviewdoc%2Fdownload%3Fdoi%3D10.1.1.395.5855%26rep%3Drep1%26type%3Dpdf&usg AFQjCNHcS_nSOW2gu74ZGr!YtdqmeHLMCg&sig2 dkeKkVLR8SxphfntgOP-Jw [Accessed 2016.08.24]

AUTHORS

First Author – N.A.M. Liyanage, Sri Lanka Institute of Information Technology Computing (Pvt) Ltd
Second Author – V.W.R.M.W.B. Ranaraja, Sri Lanka Institute of Information Technology Computing (Pvt) Ltd
Third Author – N.S. Vithanage , Sri Lanka Institute of Information Technology Computing (Pvt) Ltd
Fourth Author –P.S.M. Alavatta, Sri Lanka Institute of Information Technology Computing (Pvt) Ltd
Fifth Author – S.M.R.B. Samarakoon, Sri Lanka Institute of Information Technology Computing (Pvt) Ltd
Sixth Author – P. Navaratnam a, Sri Lanka Institute of Information Technology Computing (Pvt) Ltd
Seventh Author – Dhishan Dhammearatchi, Sri Lanka Institute of Information Technology Computing (Pvt) Ltd