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Interference analysis between WLAN and WBAN

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ABSTRACT

Over the past years, advances in electronics and wireless communications have enabled the rapid development of small size low-power wireless sensors. In a wireless scenario; two or more connected devices transmit data sharing in the available time and frequency resources. At the receiver side, due to the broadcast nature of the wireless channel, the intended signal and the interfering signals may be superimposed, which degrade the system performance.

In this work, we present a coexistence study for wireless body area networks (WBAN) and wireless local area networks (WLAN). The aim is to evaluate the feasibility of WBAN systems in realistic medical environments, assessing their robustness to interference. The performance of ZigBee for different system configurations and node topologies is shown, providing insights into the main factors that affect the system performance in a hospital room. In addition, recommendations for high performance operation are provided.

Finally we present a various parameters which are effecting the WBAN communication, and listed out the results by comparing with predefined values. Conclusions are given based on the analysis, and necessary precautions are mentioned.

Keywords—WBAN; WLAN; Low Range Wireless personal area network(LR-WPAN); Ad hoc On-demand Distance Vector(AODV); Constant Bit Rate(CBR)

I. INTRODUCTION

As we know from last few years, technology growth in wireless communications has highlighted the need of low-power wireless devices. The purpose of these wireless sensors is to collect, monitor and sending to desired location. Sensors are very low budget devices which need to send critical data which requires reliability. Because the wireless communication is broadcast in nature, many other devices which affect the actual data called interference.

Here interference due to various factors on the wireless sensors is being highlighted. As an example we are considering 802.11 (WLAN), effect on the 802.15.4(LR-WPAN/ZigBee) wireless sensor. In literature survey as of now, there is no proper coexistence study between WLAN and LR-WPAN.

Because these technologies uses unlicensed band of 2.4 GHz also called ISM band, this plays major role in business environment and research fields. So obviously there is lot many chances to interference among the communication protocols, which indeed affect the communication goals.

Here to analyze the interference between WLAN and LR-WPAN, we are considering the hospital environment .WLAN is a high power, high data rate devices and uses unlicensed frequency band causes interference to the low power and low data rate devices.

We are going to analyze by taking WBAN (Wireless Body Area Network) in medical environment in the presence of WLAN, means how it is affecting the low rate wireless personal area networks, what are the parameters which causes interference and how to reduce that interference. All these cases are done in practical environment by using tool called EXATA.

By using EXATA we can implement real time scenarios by taking this analysis into consideration we can go for hard ware implementation. so we can say that this tool is used for to do prior analysis before wasting money and time. In EXATA all wireless protocols are available, So that we can create all complex scenarios, and it is to check worst case and best cases in the scenarios.

Various parameters are how these are affecting the ZigBee communication was analyzed by different authors taking all the data into consideration we going to analyze the Health care application in different aspects.

II.INTRODUCTION TO WBAN AND WLAN

A. WBAN (802.15.4):

Body Area Networks (BANs) allow monitoring of the human body with detail that is opening new application opportunities in domains ranging from personalized health-care to sport and fitness monitoring. With the introduction of the IEEE 802.15.4 standard and its characteristics like low data rates, low power consumption, reduced complexity and device size, which makes that matches the specific requirement of a WBAN platform. Even, 802.15.4 technology has rapidly developing, lot of devices are made, but there is still a level of uncertainty whether it can meet the Quality of Services (QoS) requirements necessary for some WBAN applications under more challenging operating conditions.

B. WLAN (IEEE 802.11)

A **wireless local area network** (**WLAN**) is a network which links two or more devices using some wireless distribution method and usually providing a connection through an access point. This gives users the ability to move around within a local coverage area and still be connected to the network. Most modern WLANs are based on IEEE 802.11 standards.

Notably IEEE 802.11 (WLAN) and IEEE 802.15.1 (Bluetooth) are major factors which effects users of the unlicensed 2.4 GHz ISM band. Due to high data rate and comparably high transmit power WLANs pose a particular challenge. Apart from, interference mitigation mechanisms like DSSS and “listen-before- send" incorporated in both standards, result in notable deterioration of packet delivery performance.

In 802.15.4, a total of 16 channels can be selected, ranging from channel identifier 11 to 26, with a spacing of 5 MHz between center frequencies. Channel 11 is centered at 2405 MHz, and channel 26 is centered at 2480 MHz. On the other hand, the frequency channel plan for 802.11g starts at a centerfrequency of 2412 MHz and goes up to 2462 MHz, with5-MHz steps between selectable channel center frequencies, which correspond to

channel identifiers 1 to 13. In addition,channel 14 is available for transmission in Japan, centered at 2484 MHz. Figure 2 shows the frequency plan for 802.11gwith non-overlapping channels, which in the United States and Canada can only be obtained when using channels 1, 6 and11. The overlap with 802.15.4 channels is also depicted in the figure 1.

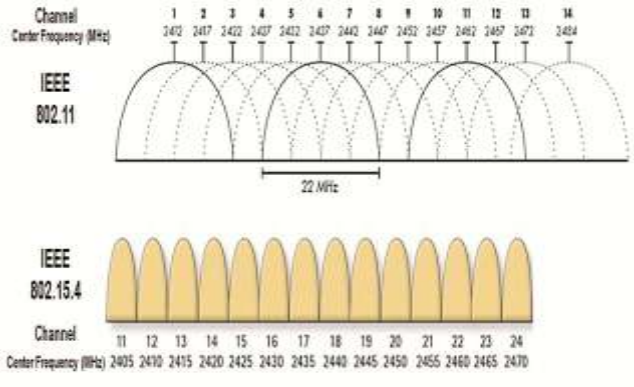

Fig1: 2.4 GHz Spectrum

So, here we have done the interference analysis by taking different parameters into consideration about which we will be discussing in the next section i.e., section-III.

III.INTERFERENCE ANALYSIS

Parameters that are taken into consideration in interference analysis are listed below:

1. Frequency offset effect on Interference
2. Beacon & SFO order impact on interference
3. Varying data rates in interfering node
4. Data rates varying at ZigBee communication
5. Multiple Interference
6. Varying distance between WBAN's
7. Varying Distance between WBAN and WLAN
8. Effect of Clear Channel Assessment (CCA) on Interference

Before going to the interference analysis, we will have a glance at EXATA, a networking tool which can be used for real time analysis for the various wired and wireless protocols, and the scenario used for simulation. Figure 2 shows a typical scenario used for simulation with the terrain size of 100 x 100.

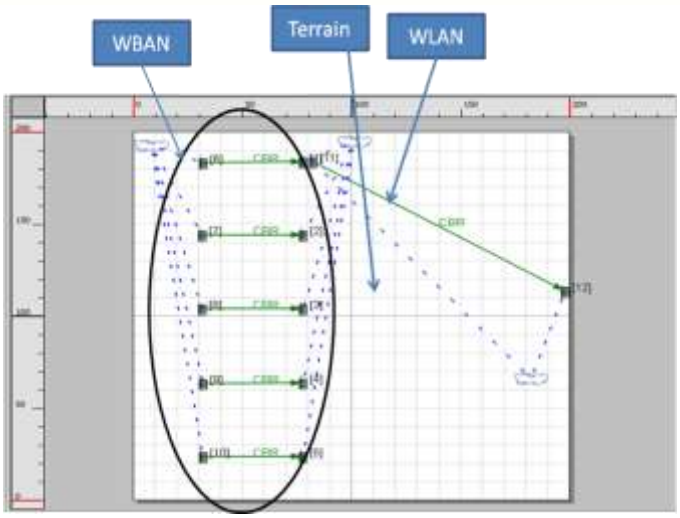

Fig 2: Typical Scenario in EXATA used for simulation

If we consider the general ward of the hospital environment, there are number of patients placed one by one by maintaining some distance between every two patient beds. In figure 2, it was shown that there were 5 patients (5 BANS). And the line connecting 11 &12 is WLAN causing interference to the required communication. Here WBAN (Body Area Network) means 802.15.4 protocol. So in practical there is a case that taking blood pressure, heartbeat, body temperature, where we have to use ZigBee protocol (802.15.4). In such situations there is a possibility that there is some other protocol using the same unlicensed frequency band may cause interference. The power levels and frequency of operation, data rates were accordingly set to each node. The necessary conditions which are need to be set before simulation in EXATA are given below:

C. Necessary Conditions to create ZigBee communication in EXATA:

1. For example take two nodes one as client another one as server by considering CBR.
2. Select the protocol as 802.15.4 in both physical and MAC layer for both the nodes.
3. Both the nodes must be full function devices in the MAC layer.
4. While taking data in CBR the item size not more than 74 bytes.
5. Take care of listenable channel mask and listening channel mask in the Physical channel. Listenable channel mask must be on wherever the listening channel mask is ON.
6. For creating interference scenario all the channels in the listenable mask must be ON.

D. Necessary Conditions to create WLAN communication in EXATA:

1. By default the nodes in the EXATA are set to 802.11 at Physical and MAC layer, so leave it as it is and change the routing protocol to AODV.
2. Maximum item size in CBR application of 802.11 Protocol is 10000 bytes.
3. Same as ZigBee take care of listenable channel mask and listening channel mask.
4. There must be separate channels for each protocol.

E. General Consitions which are taken for simulation

AODV routing protocol is used for all the scenarios.

Each CBR application in the scenario must have separate start time, in practical cases all nodes do not start at the same time.

Maintain the terrain size as per the protocol using, otherwise it will affect the communication between the nodes the protocol.

After setting all the parameters as mentioned in the necessary conditions, we had simulated the scenario for different parameters that are affecting the interference between WLAN and WBAN network. These simulation results and their parameters are discussed in the results section.

IV.RESULTS

In this section, we are presenting various parameters which cause interference and suggested the optimal values.

F. Frequency offset effet on ZigBee communication:

Specifications:

Number of channels : 6(5 ZigBee channels,1 WLAN channel)

Routing protocols : AODV

Data rate sent by ZigBee : 1.045 Kbps.

Data rate sent by WLAN : 41.131 Kbps.

Application using : CBR.

Comparing Frequency offset for 10KHz and 1 MHz:

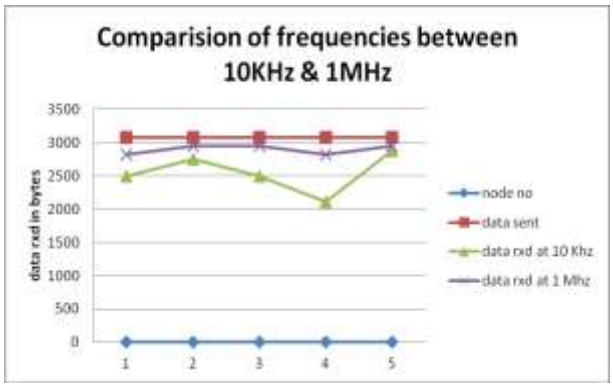

Fig. 3(a): Frequency offset effect on interference for 10 KHz & 1 MHz

Comparing Frequency offset for 1 MHz and 2 MHz:

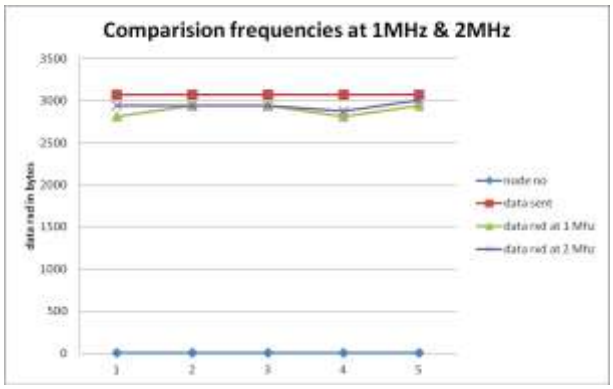

Fig. 3(b): Frequency offset effect on interference for 1 MHz & 2 MHz

From Figure 3**,** we can say that the interference effect at Lower Frequency offset is more than higher frequency offset. Because the data received at higher frequency offset is higher than the data received at Lower frequency offset.

G. Beacon and SFO order impact on interference:

Specifications:

Number of channels : 6(5 ZigBee channels,1 WLAN channel)

Routing protocols : AODV

Data rate sent by ZigBee : 5.141 Kbps.

Data rate sent by WLAN : 41.131 Kbps.

Application using : CBR.

The number of data packets that can be transmitted in each Super frame and also the length of the inactive period in each Super frame can be determined by using Super frame order value and beacon order value on IEEE 802.15.4 protocol. Multi hop networks use this technique. Optimum number of Beacon Order and Super frame Order is found to be 3, and the best value is found to be 15 from the analysis.

This option is at MAC layer of ZigBee protocol. The maximum value of Beacon& SFO order is 15. By default it is set to 3.As we increase this value the interference reduces up to the value 7. But after 7 to 13 it increase and at the Beacon& SFO value 15, the scenario gives the best results.

Comparing results at 3,5, 15 values:

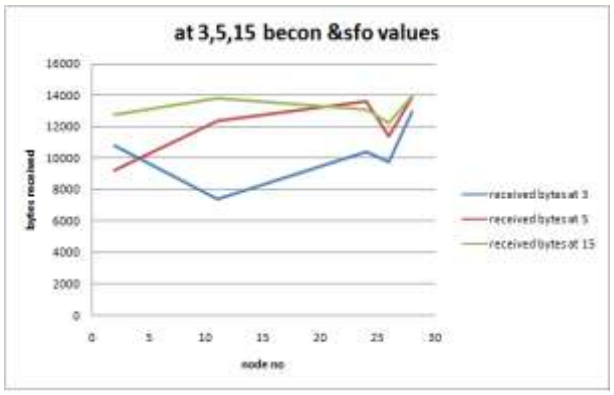

Fig.4: Beacon and SFO order impact on interference at 3, 5, 15

From figure 4 it is observed that at Beacon& SFO value 15 (Green line) data receiving is high on average at each node.

H. Varying data rates at interfering nodes:

At interfering nodes CBR application, by changing Item size and interval we can change the data rate. As data rate increasing at WLAN communication means data transfer rate increases, it interferes the ZigBee communication more.

Specifications:

Number of channels : 6(5 ZigBee channels,1 WLAN channel)

Routing protocols : AODV

Data rate sent by ZigBee : 5.141 Kbps.

Application using : CBR .

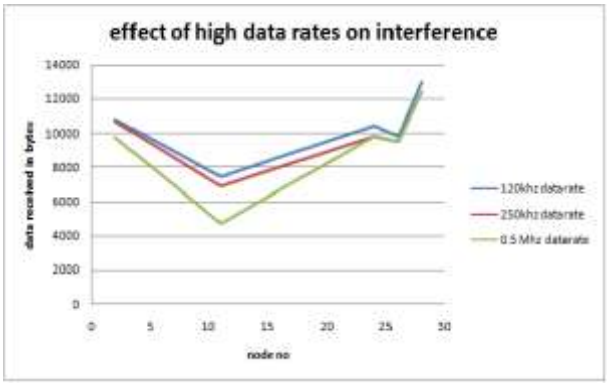

Fig.5: Varying data rates at interfering node

As shown in Figure 5, at higher data rate (green line) data received is less compared to low data rate (blue line).

I. Data rates varying at ZigBee communication:

At ZigBee CBR applications, by changing item size and interval we can change the data rates of ZigBee. As data rates increases interference increases, and interference decreases as data rates decreases.

Specifications:

Number of channels : 6(5 ZigBee channels,1 WLAN channel)

Routing protocols : AODV

Data rate sent by WLAN : 41.131 Kbps.

Application using : CBR.

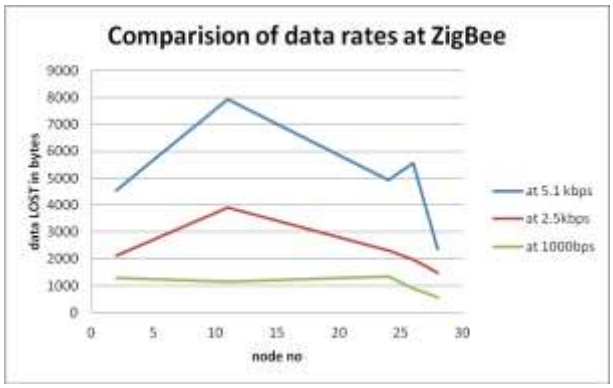

Fig.6: Data rates varying at ZigBee communication

As shown in Figure 6 for 5.1 kbps data LOST in bytes increase means interference is more, and for less data rate 1kbps(green line) data LOST is less compared to blue line shown in figure 6**.**

J. Multiple Interference:

When interference nodes increase near to the ZigBee communication it effects more and more. There is a case that in hospital environment people may use mobile phones which affects readings taken from human body.

Specifications:

Number of channels : 2(1 ZigBee channels,1 WLAN channel)

Routing protocols : AODV

Data rate sent by ZigBee : 5.141 Kbps.

Data rate sent by WLAN : 5.141 Kbps.

Application using : CBR.

As shown Figure 7 number of interfering nodes increases data received will get reduced. Here blue line shown data sent in bytes and red line indicates degrading in the communication.

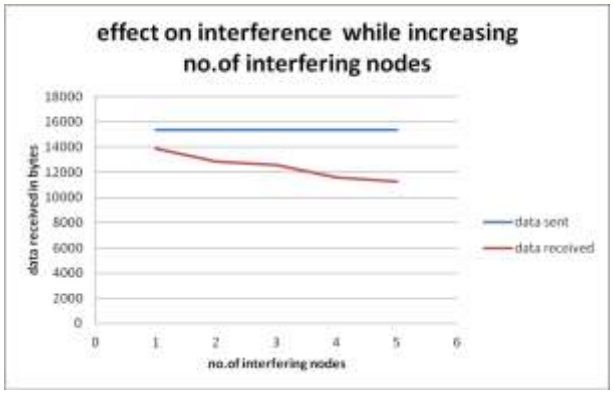

Fig.7: Data Multiple interference

K. Varying distance between WBAN's:

Distance between two WBANs (Wireless Body Area Network) also effects the communication of individuals.

Specifications:

Number of channels : 2 (2 ZigBee channels)

Routing protocols : AODV

Data rate sent by ZigBee : 5.141 Kbps.

Application using : CBR .

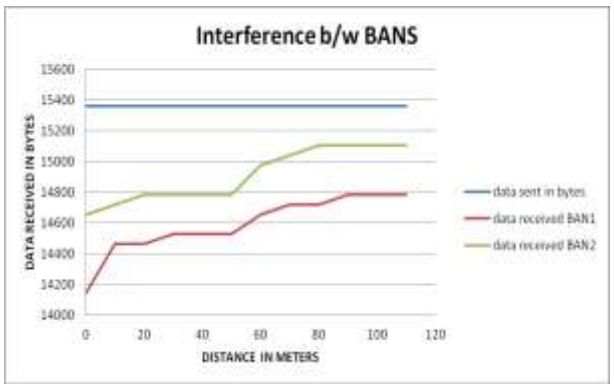

Fig.8: Varying Distance between WBAN's

Figure 8 shows as distance between BANs increase data received in bytes increase.

For ZigBee the range is around 100 meters theoretically. So up to 100 meters the ZigBee node radiates around it. But by making channel difference we can reduce this interference because in practical cases distance between patients is less than 2 meters.

L. Varying distance between WBAN and WLAN:

Distance between WBAN and WLAN also effects the communication between ZigBee nodes.

If the interference node near to the WBAN it effects readings taking from the human health. In practical cases if doctor uses cell phone while taking readings causes interference.

Specifications:

Number of channels : 6(5 ZigBee channels,1 WLAN channel)

Routing protocols : AODV

Data rate sent by ZigBee : 1.045 Kbps.

Data rate sent by WLAN : 4.274 Kbps.

Application using : CBR.

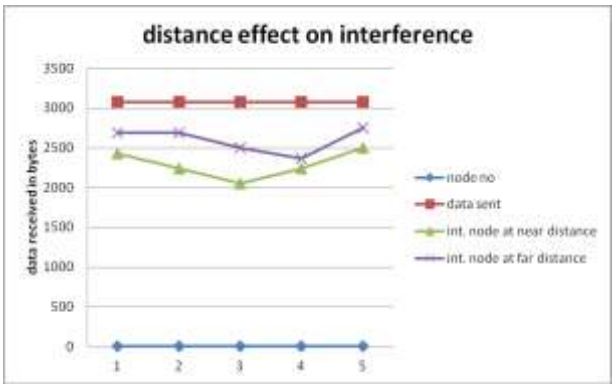

Fig.9: Varying distance between WBAN and WLAN.

As shown in Figure 9, WLAN having high power high speed are effected more and data received is very less(red line).where as for low power and low speed data received is very high compared to earlier one(green line).

M. Effect of Clear Channel Assessment(CCA) on interference:

In physical layer of 802.15.4 protocol there is a option called CCA mode. If we change that we can get the required clear channel assessment method.

Specifications:

Number of channels : 6(5 ZigBee channels,1 WLAN

channel)

Routing protocols : AODV

Data rate sent by ZigBee : 1.045 Kbps.

Data rate sent by WLAN : 20.625 Kbps.

Application using : CBR.

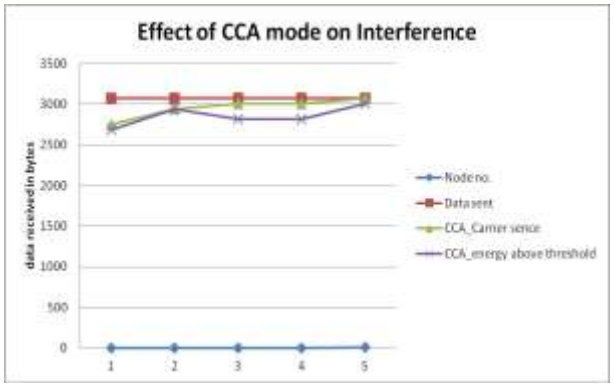

Fig.10: Effect of Clear Channel Assessment (CCA) on Interference

Here we can find difference between 'carrier sense' and 'energy above threshold' as shown in Figure 10, So we can conclude that for carrier sense method ZigBee will give better performance.

V.CONCLUSION

In general interference between IEEE 802.15.4 and WLAN is there but with acceptable performance, provided distance between the nodes, selection of frequency channels, Power levels, Data rates are selected in proper manner. But It is clear that effect of WLAN on WBAN is not be neglected.

In our application if the area is limited, by increasing difference between centre frequencies of the channels, we can reduce the distance between WBANs, So that we can accommodate more number of WBANS. The transmitter power, and majorly speed of data transmission using by WLAN nodes have given considerable effect on ZigBee communication. So lesser the speed of transmission cause less interference

Placing other wireless devices using unlicensed frequency far away from the ZigBee communication is recommended. Beacon and Super Frame Order is a kind of algorithm it can find the optimum data packets to be sent in each Super frame, so using maximum value is recommended.

There are 3 kinds of clear channel assessment (CCA), Carrier sense, Carrier sense with energy above threshold, Energy above threshold out of these 3, Carrier sense is recommended. As per the frequency spacing between the channels, we should take care of the distance between the successive WBANs. For 10 KHz frequency difference between the channels 100 meters distance is required between every 2 WBANS, but it is practically not possible so more than 1MHz is recommended.

REFERENCES

[1] Co-existence of IEEE 802.15.4 at 2.4 GHz Application Note JN-AN-1079 Revision 1.0 18-Feb-2008.

[2] Ruben de Francisco, Li Huang, and Guido Dolmans,Coexistence of WBAN and WLAN in Medical Environments.

[3] R. Rodriguez. Free scale Semiconductor Application Note.

[4] Gilles Thonet , Patrick Allard-Jacquin, Pierre Colle, ZigBee – WiFi Coexistence, White Paper and Test Report.

[5] Jie Dong , David Smith, Coexistence and Interference Mitigation for Wireless Body Area Networks: Improvements using On-Body Opportunistic Relaying.

[6] Jung Nam Bae, Young Hoon Choi, Jin Young Kim, Jang Woo Kwon, and Dong In Kim., Efficient Interference Cancellation Scheme for Wireless Body Area Network.

[7] Jan-Hinrich Hauer, Vlado Handziski, and Adam Wolisz Experimental Study of the Impact of WLAN Interference on IEEE 802.15.4 Body Area Networks*.

[8] B Polepalli, W Xie, D Thangaraja, M Goyal, H Hosseini, Y Bashir Johnson, Milwaukee, Impact of IEEE 802.11n Operation on IEEE 802.15.4 Operation.

[9] Route des Lucioles, Sophia Antipolis Cedex Machine-to-Machine Communications (M2M); Use Cases of M2M applications for eHealth, Reference.

[10] Dusit Niyato, Ekram Hossain, Sergio Camorlinga Remote Patient Monitoring Service using Heterogeneous Wireless Access Networks: Architecture and Optimization .

[11] Garth V. Crobsy, Tirthankar Ghosh, Renita Murmi, Craig A. Chin, Wireless Body Area Networks for Healthcare.

[12] Exata-4.1-Programmer'sGuide, Exata -4.1-User'sGuide, Exata -4.1-Documentation-Portfolio Exata Libraries.