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5

Global Internet Protocol for Ubiquitous Healthcare Monitoring Applications

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1. Introduction

This chapter encompasses the realm of global healthcare applications monitoring approaches and network selection in IP-based ubiquitous sensor networks. In this chapter we describe the motivation, overview structure of the works, ubiquitous communication techniques and its performance.

The healthcare technology keeps healthcare executives and managers up-to-date about the latest computer-based solutions for improving medical care and making healthcare organizations more efficient. Information Technology (IT) has a unique, news-style approach to implementations at hospitals and other smart home across the country. These installations are profiled because they significantly improve clinical outcomes, reduce costs or raise the efficiency of a healthcare provider or doctor. Recent research has also focused on the development of ubiquitous sensor networks (USN) and pervasive monitoring systems for cardiac patients. IT is the combination of computer and communication technologies. It helps to produce, manipulate, store, communicate, and broadcast changed information. Due to rapid changes in communication technologies, we have new paradigm applications, wireless networks are morphing into IEEE802.15.4–the standard for lowpan (low power personal area networks), which are playing an essential role to realize the envisioned ubiquitous world. Lowpans need to be connecting with other lowpans and with other wired networks in order to maximize the utilization of information and other resources. However, IEEE802.15.4 maximum frame size is 127 octets but UDP and IPv6 have big packet size then no space for health applications data. The PANs consist of various Body Sensor Networks nodes as well as overcome of problems such as network overhead, node discovery and security. When that technology is integrated to IPv6, we have a vast amount of possibilities implementing applications because IP has been used for a long time and technologies related to it already exist because IP-connectivity is spreading to all kinds of applications [1-3].

1.1 Motivation

Since the last century, the number of people of age over 65 has been increasing gradually. For many governments today, this fact is rising as one of the key concerns. The population of this age group is expected to be doubled by the end of 2025. According to the current status, it is estimated that the population of this age group which was 357 million in 1990, will be increased to around 761 million by the year 2025. Since 1990s, the rate of growth in health spending has been two-times greater than the average across OECD (Organization for Economic Co-operation and Development) countries [1], [2]. From Jon Barron in to the Figure 1.1, there is worldwide percentage of elderly person who is 60 and over and all over the world has problem.

1998-2003 growth was 10.2 percent per year (OECD average 4.5 percent) driven mainly by rise in public spending from 37 % in 1990 to 49.4 % in 2003 (OECD average of 72 %) (6 % of GDP in 2003). Several new developments are contributing to the changing face of the South Korea healthcare industry such as aging population and changes in trade policies and regulatory environments [1].

Most of the pharmaceutical companies have increased significantly their R&D expenditure for novel drugs and medications and key driving forces [2]. In fact, R&D spending has drastically increased from 0.3 % of the GDP now to 3 percent. The healthcare field will change as whole since at least: a) role of occupational healthcare will grow, and b) care management chains will change to care management networks. New alternative funding mechanisms arises: self-paid insurances, healthcare paid by employers Demand and supply of privately owned healthcare services will grow, which provides flexible ppp (public-private-partnership) and good balance. Healthcare and wellness services expect activity from citizens, since ensuring the working healthcare system requires broad cooperation in the society [2-3].

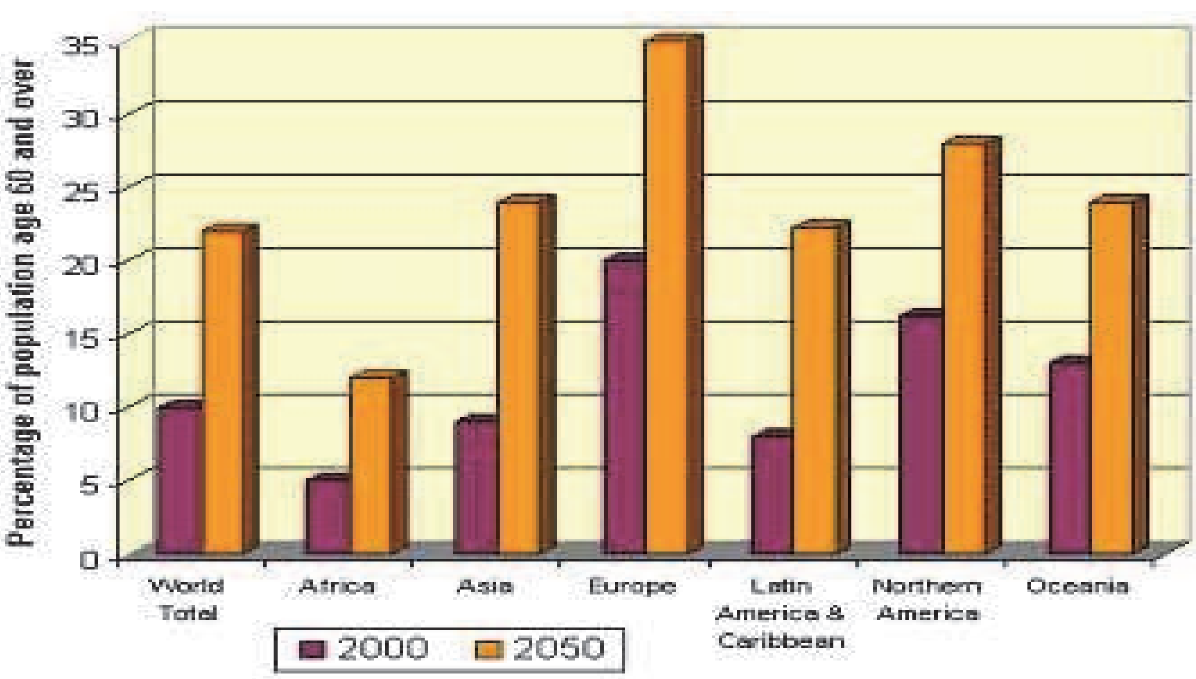

Fig. 1. Percentage of world population age 60 and over.

The healthcare technology keeps healthcare executives and managers up-to-date about the latest computer-based solutions for improving medical care and making healthcare organizations more efficient. Information Technology (IT) has a unique, news-style approach to implementations at hospitals and other smart home across the country. These installations are profiled because they significantly improve clinical outcomes, reduce costs or raise the efficiency of a healthcare provider or doctor. Recent research has also focused on the development of ubiquitous sensor networks (USN) and pervasive monitoring systems for cardiac patients. A new technology, RFID enabled patient identification and real-time information management in synchronization with a central data base over a wireless connection (according to Alvin) systems are working in global monitoring [4].

There are several international projects use biomedical sensor networks for Body Area Networks. Biomedical sensors, which collect the body signal, need to attach to the patient body. There are many researches such as the Mobile Health System, Code blue etc for example. If user transmits ECG analysis monitoring data on server computer via sensor this can cause the big traffic problem for sensor nodes in a USNs. The USNs has intermittent connectivity and limited resources constraints such as bandwidth and delay. During mobility, it creates big problem, which is due to data centric. In order to overcome this problem, an IP-based ubiquitous sensor network is implemented to improve bandwidth and small delay for multiple layers holding systems [5].

1.2 Chapter organization

This chapter provides novel techniques for globally health monitor system and presented fundamental information related to IEEE802.15.4 standard and discusses the importance of Lowpan networks in the future pervasive paragon to integrate small embedded device with IP-based networks. The chapter has presented two approaches for global healthcare monitoring applications which are SHA (Smart Hospital Area) networks and SA (Smart Home) networks. The chapter presents benefits of the proposed global healthcare monitoring applications their test results. There, we have presents routing and sensor performance results of various IP-USN and finally conclude the information of future aspects.

2. Global internet protocol

The IETF (Internet Engineering Task Force) working group has been presented various drafts to development 6lowpan (IPv6 over Low-Power Wireless Personal Area Networks) it refers IPv6 integrated to Lowpan device. The Fig.1 has depicted the IEEE 802.15.4 standard defined RFD (reduced-function devices) and FFD (full-function devices) type of nodes. We have considered RFD as BMS (Biomedical Sensors) node and FFD as (6lowpan) node. The combination of BMS and 6lowpan makes IP-USNs (IP-Based Ubiquitous Sensor Networks). Whereas BMS nodes are utilized for sensing and transmit MAC layer beacons to 6lowpan in a star topology. The BMS node only interacts with 6lowpan node even though 6lowpan node is able to connect other 6lowpan nodes due to its full functional capability there has IPv6 compression, neighbor discover, mesh routing and BMS packet binding techniques. Lowpan is a network which offers wireless connectivity in applications that have limited computational capacity, power and relaxed throughput. Some typical characteristics of 6LowPAN are: small packet size, support for 16 bit or IEEE 64-bit extended media access control addresses, low bandwidth, two kinds of topologies (mesh and star), low power, low cost and so on. [8] Routing in different kinds of topologies should be implemented in such a way that computation and memory requirements are minimal [7-9].

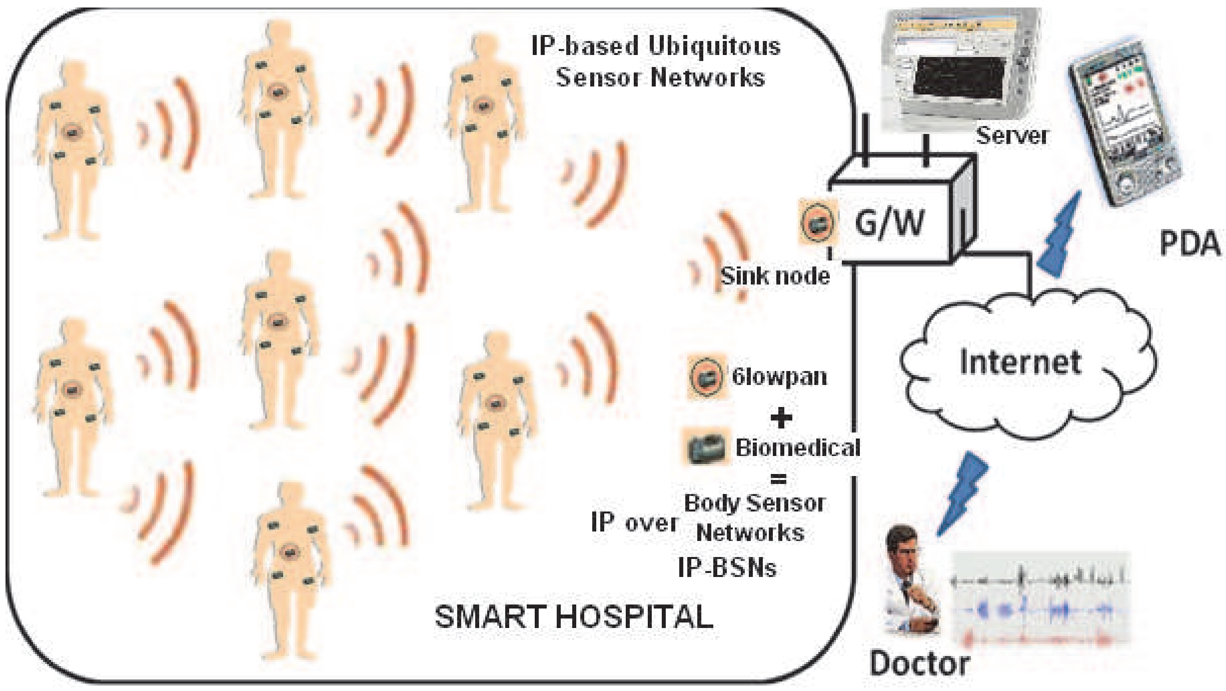

Fig. 2. Ubiquitous Healthcare Monitoring Applications.

The design of routing protocols also highly relies on availability of other information, such as physical location, global ID, etc. A good number of location-aided routing protocols have been proposed, which hold the assumption that each sensor node has the accurate location information. GPS is a simple and direct solution to localization, but it is too costly for sensor networks due to the additional power consumption and high deployment expense. Thus, effective and inexpensive localization techniques have become very important, which is another topic of interest of our research. Global ID is desirable in senor networks so that each sensor can be distinguished from each other. The sensor node has address space for global ID, which will cause to establish communication with IPv6 networks. For operations of some routing protocols, we do need to distinguish sensor nodes to some extent, but a locally unique ID may be enough. Thus, this poses a challenging research opportunity. The health monitoring applications architecture for 6lowpan needs to be scalable and flexible which can handle large number of nodes. At the same time, this architecture must support localization communication in order to increase network capacity. The general USN applications have been designed and realized to provide physical environment monitoring. But, IP-based USN technology has provided mobility and global connectivity. The cognizant of internet on USNs has connects assets in the physical networks to the IP networks. Internet-based USNs architecture has proposed and developed in this chapter. IP-USN tends to be implemented as a separate network for dedicated services in the PANs. An effective smart hospital/ home networks have data aggregation mechanism with limited resources even though connection to infrastructure networks is hardly considered. Current, USNs are far from actualizing a global connectivity. Its considering IEEE802.15.4 for communicate between one USN to another USN but it cannot connect globally and mobility state. The main objective of the chapter has developed architecture to IP over USNs which is integrated with IPv6-based wired networks for global communication between Doctor and patients. In this chapter has considered various applications such as design a new technique of routing protocol, application based MAC frame format, mobility techniques, energy consumption and data delivery ratio and association with one PANs to others [9-14].

2.1 Biomedical sensors and IP-sensor

The IETF working groups has been presented two RFCs 4919 and 4944. Here they presents several characteristics such as low power, low cost, low bandwidth, short range, PAN maintenance, transmission and reception on the physical radio channel, channel access and reliable data transmission port (MAC).

The main role of IP-USNs node is pervasive nature, it allow connectivity with existing IP-based networks. For that there are many challenges for biomedical application based node discovery, network selection method and their packet size. The maximum transmission unit of IPv6 is 1280 octets and IEEE 802.15.4 frame has 127 octets at physical layer. The lowpan network consists of two devices FFD (Full function Devices) and RFD (Reduce Function Devices). The FFD (which is 6lowpan) node supports which is complete implementation of protocol stack and it can operate with Gateway. The RFD (which is normal Biomedical Sensor) node is a simple device with minimum implementation of protocol stack and minimum memory capacity. The Biomedical Sensor (BMS) nodes should communicate only 6lowpan node at a given instance of time. The 6lowpan node should communicate with other 6lowpan node and Biomedical nodes.

IP-USNs node brings up various biomedical sensor devices. The sensor devices are occurrence simultaneously on IP-USNs with complex interactions. In my approach, IP-USNs node has resource allocation and energy conservation techniques which can identify the unique biomedical data. The algorithms have implemented on devices which optimize their performance [9].

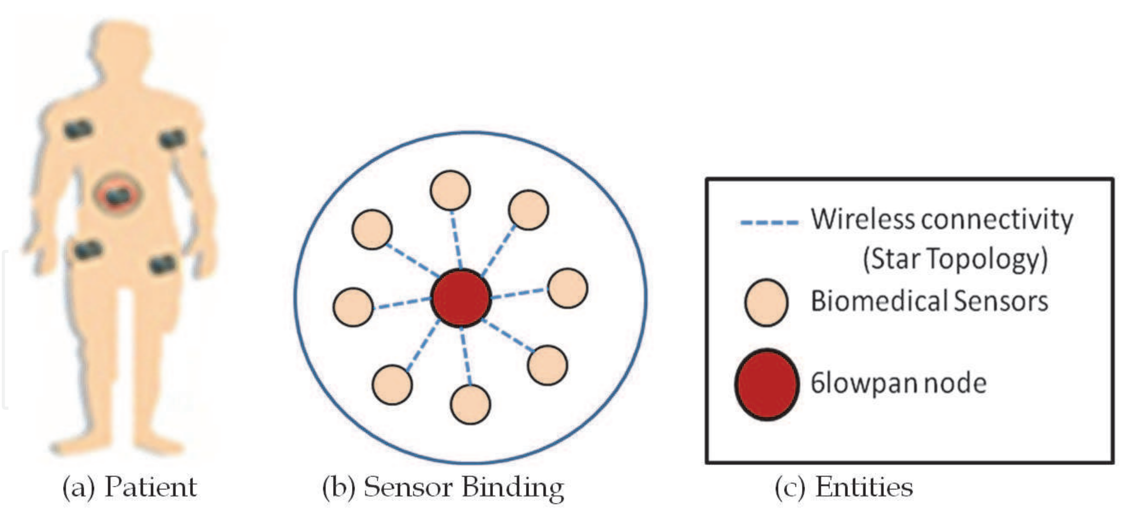

Fig. 3. Biomedical Sensors association with IP-USN.

The Fig.3 has described IP-USNs node which is captured with various biomedical sensors. There are specific gateways associated with IP-USN devices, though routing technique. All IP-USNs nodes have worked its PAN for network utilization with greedy approach of choosing the closest nodes but it has to face lots of challenges.

Case 1. Mobility protocol is balancing between biomedical sensor and IP-USN node in Body Aare Networks.

Case 2. Safely transmit biomedical data from IP-USN node to gateway during patient movement.
Case 3. To optimizes energy latency mobility protocol for different applications with QoS.
Each biomedical sensor node enables to execute a certain tasks which has capability, sense and transmits to IP-USN node. All sensor nodes dense deployments on BAN which should be transmit data in a specific time periods to the IP-USNs. The IP-USNs sensor node transmits all data to the gateway. A gateway initiates the resource solicitation on behalf of an application for a specific gateway via routing. The routing protocol use address centric of the biomedical data packet which used subsequence frame techniques.
The following approaches can help to overcome from above (cases) problems.
Scheme1. The IP-USNs have to choose active IP-USNs node in a mesh network to successfully transmit its data to the gateway, which is based on current novel mobility protocol and remaining battery energy.
Scheme2. The gateway can measure by localization and transmit distance information (by modified gateway packet) of mobile IP-USNs, which is helping choose right path a mobile node.
Scheme3. The gateway broadcast RREQ message to IP-USNs, which is using one or two hop. When IP-USNs node is transmitting data packet then hop (mediator) nodes should be ignored sensing activities and use routing to transmit successfully data to the gateway. This techniques use highly network utilization.

3. Global healthcare monitoring system

The chapter has investigated two scenario for global healthcare monitoring system, SHA (Smart Hospital Area) and SH (Smart Home) The IP-USNs placed on the patient BAN that should be connected to the gateway, which is placed on gateway in a PANs (Personal Area Networks). Each IP-USNs node has its own id and IP-address, Id use the identification of Gateway and IP-address for global connectivity via internet. However, Service Provider directly ping his patient and get globally current status of the patient using internet service provider equipments such as Cell phone, PDA, Note book etc. The system has been evaluated by technical verification, clinical test, user survey and current status of patient. The global monitoring system have a big potential to ease the deployment of new services by getting rid of cumbersome wires and simplify healthcare in hospitals and for home care.
In healthcare environments, delayed or lost information may be a matter of life or death. Thus, we have to use more reliable network topologies. We have used start networks for patient BANs and mesh for IP-USNs networks in PANs. It made of highly constrained nodes (limited power, limited memory, limited CPU) interconnected by a variety of lousy networks. As any IP-USNs has necessarily comprise of biomedical sensors and actuators.
For instance, in a healthcare monitoring system, sensor nodes might detect biomedical data and then send commands to activate the sprinkler system. An IP-USNs network can be seen as small star or mesh networks each consisting of a single node connected to zero or more IP-USNs nodes for healthcare applications.
The following section has been described in details our scenarios and its problems.

3.1 Smart Hospital

The SHA (Smart Hospital Area) has been described the design space of USNs in the context of the 6lowpan working group. The design space is already limited by the unique characteristics of a Lowpan (low-power, short range, low-bit rate) [3].

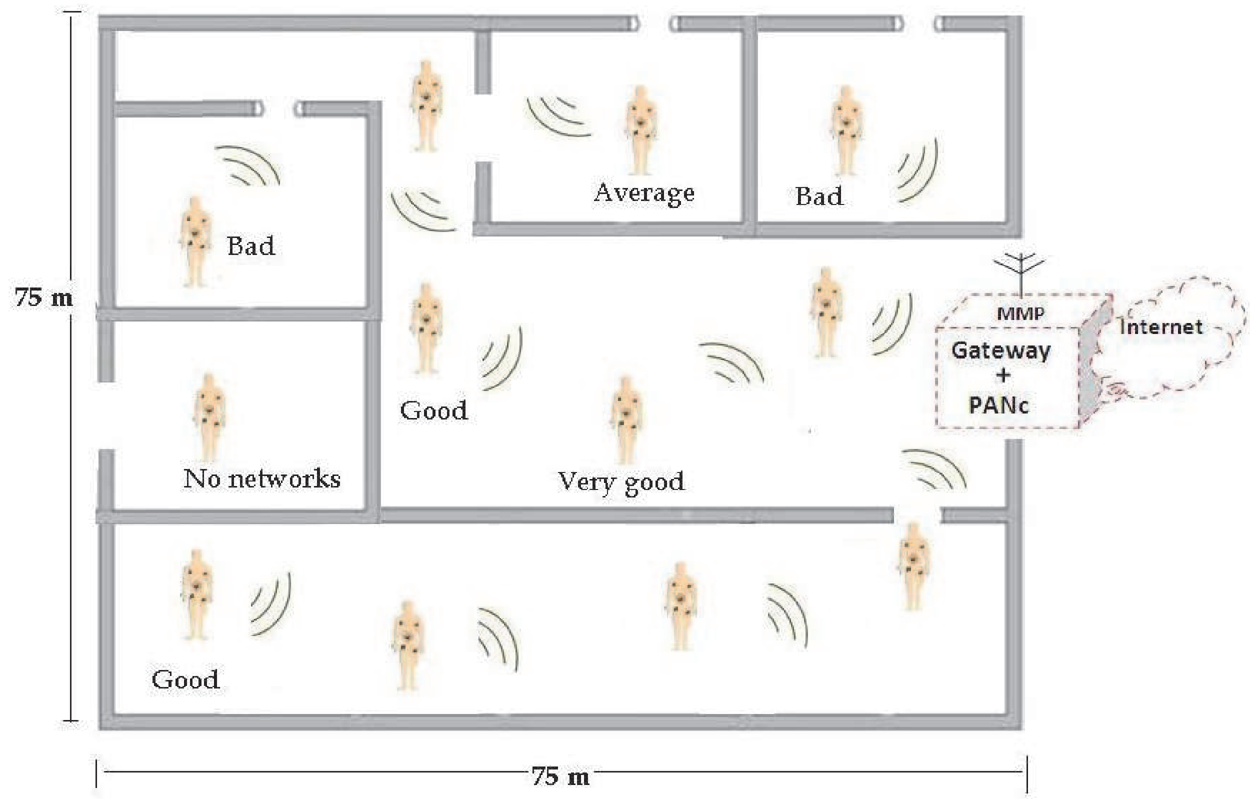

Fig. 4. System Architecture of Hospital Area Networks.

The IP-USNs nodes have to pre-planned deploy in an organized (manually or automatically) manner in SHA. The deployment has an impact on high node density for location to allocate addresses in the networks. The no. of IP-USNs nodes could be less in a PAN- coordinator (6 nodes) to provide the intended network capability and it can moves in the range of PAN coordinator (gateway). The power source of nodes need to be hybrid, whether the nodes are battery-powered or mains-powered, influences the network design. The system has considered that IP-USNs nodes always connected to the Gateway (internet based gateway).

In this system need to be provide data privacy and security. Role based access control is required to be support by proper authentication mechanism and need to be encryption mechanism. The data collection techniques are used point to point, multipoint to point and point to multipoint for traffic. It has plug-and-play configuration during mobility and real-time data acquisition such as in Fig.4, patient IPv6ID-A moves his current position to other into (SHA) PAN-1 then node IPv6ID-A send mobility status to the Gateway and should update its new neighbor's information in its routing table and gateway also update its current position in to the SHA. The point to point connectivity provides efficient data management, reliability and robustness of the networks.

The patient's BANs can be simply configured as a star topology IP-USNs (several biomedical sensors such as ECG, Blood Pressure, Temperature, SpO2 etc. and 6lowpan sensor) for data aggregation and dynamic network during movement of patients. The patient's IP-USNs node uses globally unique IPv6 address for the identification of patients. Thus, the SHA itself does not require globally unique IPv6 address but could be run with

link-local IPv6 address. The security used between IP-USNs node and Gateway for reliable and secure data communication.
In this system, patients freely can move inside the SHA and corroborate closely with doctor to sharing biomedical data. In Fig.4 has shown SHA networks there are 5nodes of IP-USNs. Each IP-USNs node has several (Biomedical Sensor) BMS and One 6lowpan node that should be monitored by gateway. IP-USNs retrieves patient's biomedical data and transmit to the PAN–coordinator (gateway).

3.2 Smart Home

The SH (Smart Home) are similar SHA (Smart Hospital Area) which has been described in upper block. This system has fixed gateway in the center of the room and wearable IP-USNs device placed on the patient's BANs. MMP has planted in to middle of the room, this well calculate exact location of the patient during its mobility state. The SH system, use point to point routing and there are no hop node, IP-USNs node directly send data to the gateway. However, the gateway always connected to the internet, and the service provider any time monitors his patient.

3.3 Major challenges

There are several challenges the use of global connectivity. We have given the solution of mobility, biomedical data binding, and IP-USNs node association with gateway as well as we investigate two techniques in SHA.

3.3.1 Handoff techniques

The gateway broadcast a query packet to all IP-USNs nodes (includes approximate receiving signal strength for 1st level) at once and then waits for reply until timer expires. Timer set on the IP-USNs according velocity of signal strength and distance between IP-USNs and gateway. Each level has to define hop distance between IP-USNs and gateway. The gateway broadcast query packet in to mesh topology. IP-USNs received packet within an area then compare the signal strength according to RSS value that node join or establish connection to gateway. Then, IP-USNs send a Query_response (IP-addr.) packet to Gateway that they are joining the coordinator. IP-USNs adjust their transmission power to the coordinator for further communication process.

3.3.2 Patient move one PAN-other-PAN networks

We have presented a technique to detection of a neighboring PAN, identification of the MMP (Micro Mobility protocol). It is a common channel based gating protocol, algorithms to diffuse common interest across collocated PANs, and methods to define and regulate gating scope. The SHA has same region but sharing information of common interest amongst PANs and accessing internet from other PANs. The proposed algorithm has to systematically allow neighboring PANs to communicate with each other by diffusing into each other. The diffusion takes place through gating operation performed by nodes. This resides at the MMP of the two non-interfering PANs. The MMP identification are used common channel based gating mechanism. The mechanism has to diffuse common interest (query/response) across collocated PANs, and regulate gating scope. The PAN association procedure has specified logical channel assignment procedure in IEEE802.15.4 networks that prevents interference amongst overlapping PANs. Relates channel assignment as the bottleneck for diffusion across PANs.

1. //Parameters indicates that the channels are to be scanned and scan time per channel. Active or Passive
2. Network layer issues NLME-NETWORK-DISCOVERY. request [Active Mode] (ScanChannels, ScanDuration)
3. Network layer issues NLME-NETWORK-DISCOVERY.request [Passive Mode]
4. //On the receipt of MLME-SCAN.confirm and NLME-NETWORK-DISCOVERY.confirm
5. Network layer issues MLME-SCAN.request
6. NLME selects a tuple (PANId, LogicalChannel)
7. Such as
8. (PANId, LogicalChannel) New ≠ (PANId, LogicalChannel) Existing⇔ A. V B.
9. Where
10. (PANId)New ≠ (PANId)Existing
11. [(PANId) New = (PANId)Existing ^ (LogicalChannel)New ≠ (LogicalChannel) Existing]

Table 1. Channel Allocation Algorithm

4. Benefit of global healthcare system

The integration of IP over BSNs in healthcare will improve quality and efficiency of the treatment in various ways. We assume that IP over BSNs integrated system will be used in general hospital area and home area during patients moves inside these facilities. There are various potential applications for patient monitoring. The various benefits will overcome using Internet based small embedded devices.

4.1 Treatment quality improvement

The patient's conditions are carefully monitored, while doctor and patient visit inside an operating room or a hospital but not while they are in outside hospital, for instance home or abroad visit. The same can be true when they are outside hospital. However, it is possible that patients' condition gets worse while they are in unmonitored field, and it's vital. With the availability of IP over BSNs integrated systems, it is possible to monitor patients' conditions in such scenarios and to notify doctors when patient's conditions degenerate suddenly. To make this kind of integrated global connectivity can allocate current position of the patients, and their health conditions monitored by doctor using internet based equipments. Various types of BSNs, depends on the patient, we need to provide a flexible technologies to deal biomedical data in a plug-and-play mode. Global health monitoring systems have monitored patient's biomedical data and position identification inside a smart hospital/ home. In other words, the systems need to maintained a global connectivity to discover the available BSNs and examined biomedical data while the doctor not in to the hospital.

4.2 Medication error reduction

The present an important problem in healthcare is to reduce biomedical errors include nurse's treatment mistakes, their check and order mistakes and so on. If any case, the technical system identifies the patient condition and verifies treatment orders then some of biomedical error will be solve. An important dispute in global health care monitoring system to reduced the biomedical errors. But if the global monitoring system supports doctors during patient monitoring applications, some of the biomedical errors will be kept. These kinds of error require real-time transactions for quality improvement applications. Therefore, IP integration with BSNs makes real time patient identification during dynamically movement and vital biomedical data information.

4.3 Accurate medical record

In hospital, nurses are keeping accurate biomedical records of the patient is a foundation of medical treatment. If biomedical records are not kept accurately, it wills accidents but patient die. In addition, BSNs devices can store accurate records condition of patient in to the server. The IP integrated BSNs system will enable the identification of biomedical data to them. In the case, patient condition history data is inquired to doctor from global systems then also he can monitor for server data base.

4.4 Accurate location tracking

The present monitoring system has their basic limitations is that they offer coarse and often unreliable location information. On the other hand, location tracking technologies such as GPS can accurately locate a patient but not identify it. The global monitoring system using more IP-based BSNs in smart hospital/home are will enable more accurate and reliable patient's location tracking. There are several ways to integrate these pieces of information.

4.5 Cost reduction

The management of both cost reduction and quality of treatment is an important challenge. In a potential area is to reduce biomedical administration. IP over BSNs is used to identify the biomedical data and make global connectivity. The patient monitoring and change of biomedical data is an important, semantics.

4.6 Security reduction

Security is always a big issue in Information Technology field and there are several cases as attackers have been crash system. Thus, we have also considers security protocols to prevent global IP based healthcare system. We have used Time stamp and nonce into fragmentation packets to prevent healthcare data.

5. Conclusion

This chapter has presented the combination of IT over embedded devises for global healthcare monitoring applications. The chapter had presented two schemes, which are SHA (Smart Hospital Area) networks and SH (Smart Home) networks, parallel it is presenting internet connectivity over biomedical devices to collect globally biomedical date and the benefits of global communication system for healthcare monitoring applications. It is a unique news-style approach to implementation at hospitals and other smart home across the country. These installations are profiled because they significantly improve clinical outcomes, reduce costs or raise the efficiency of a healthcare provider or doctor. Recent research has also focused on the development of ubiquitous sensor networks (USN) and pervasive monitoring systems for cardiac patients.

6. Acknowledgment

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