High Speed Data Transmission in Medical Body Sensor Network by Reducing the Delay–A Survey

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Abstract— The technology of sensor, medical body sensor and intelligent information processing is widely used in Body Sensor Networks (BSNs), which are a branch of wireless sensor networks (WSNs). BSNs are playing an increasingly important role in the fields of medical treatment, social welfare and sports are changing the way humans use computers. In this research, proposed an energy-efficient Medium Access Control (MAC) protocol based on IEEE802.16 is specifically designed for Wireless Body Area Network (WBAN) to cognitively work in high interference environment. Proposed system uses the cross-layer optimization algorithm called such as Joint Cross-Layer Width Arbitrary Filter Length Algorithm (JCL) it significantly reduces the hand-off delay, energy-level. Simulation results show that, depending on the interference level, it is able to outperform the efficient medium access control protocol and existing IPv6 over Low power Wireless personal area network (6LoWPAN) in terms of energy utilization, packet delay, and network throughput.

Key words: Body Sensor Network, Wireless Body Area Network, Handoff Delay, 6LoWPAN, PMIPv6

I. Introduction

Various wireless sensor nodes can be attached to the human body or clothes and hence can form a wireless network named as the Wireless Body Area Networks (WBAN). These tiny sensors are used to measure particular parameters of the human body, such as the body heat, blood glucose, pulsate rate and heart-beat. These sensing values can be gathered and transmitted to the monitoring server for healthcare applications or surveillance systems. IPv6 is the newest IP version which has large address spaces and better auto configuration mechanisms and thus it can overcome the IP shortage problem; while Low-power Wireless Personal Area Networks (LoWPANs) can support the communications of the Internet of Things (IOTs) and thus it has attracted lots of attention recently.

A WBAN consists of in-body and on-body nodes that continuously monitor patient's vital information for diagnosis and prescription. Some on-body nodes are used for multimedia and gaming applications. A WBAN uses Wireless Medical Telemetry Services (WMTS), unlicensed Industrial, Scientific, and Medical (ISM), Ultra-wideband (UWB), and Medical Implant Communications Service (MICS) bands for data trans- mission. WMTS is a licensed band used for medical telemetry system. Federal Communication Commission (FCC) urges the use of WMTS for medical applications due to fewer interfering sources. However, only approved users such as physicians and trained technicians are eligible to use this band. Furthermore, the restricted WMTS (14 MHz) bandwidth cannot support video and voice transmissions. The another spectrum for medical applications is to use 2.5 GHz ISM band that includes guard bands to protect adjacent channel interference. A licensed MICS band (402-405 MHz) is dedicated to the implant communication.

IPv6 is the latest IP version which has large address spaces and better auto-configuration mechanisms and thus it can overcome the IP shortage problem. The IPv6 over low power wireless personal area network (6LoWPAN) has attracted lots of attention recently because it can be used for the communications of Internet of things. The concept of group-based network roaming in proxy mobile IPv6 (PMIPv6) domain is considered in the 6LoWPAN-based wireless body area networks. PMIPv6 is a normal to manage the network based mobility in all-IP wireless network.

Proxy Mobile IPv6 (PMIPv6): Proxy Mobile IPv6 domain refers to the network where the mobility management of a mobile node is handled using the Proxy Mobile IPv6 protocol as defined in this specification. The Proxy Mobile IPv6 area includes local mobility anchors and mobile access gateways between which security associations can be set up and authorization for sending Proxy Binding Updates on behalf of the mobile nodes can be ensure.

Local Mobility Anchor (LMA): Local Mobility Anchor is the home agent for the mobile node in a Proxy Mobile IPv6 domain. It is the topological anchor position for the mobile node's home network prefix(es) and is the entity that manages the mobile node's compulsory state. The local mobility anchor has the functional capabilities of a home agent as defined in Mobile IPv6 base specification with the additional capabilities required for supporting Proxy Mobile IPv6 protocol as defined in this specification.

Mobile Access Gateway (MAG): Mobile Access Gateway is a function on an access router that manages the mobility related signalling for a mobile node that is attached to its entrance link. It is responsible for tracking the mobile node's movements to and from the access link and for signalling the mobile node's local mobility anchor.

Sensor Node (MN): The term sensor node is used to refer to an IP host or router whose mobility is managed by the network. The sensor node may be an IPv4-only node, IPv6-only node, or a double-stack node and is not required to participate in any IP mobility related signaling for achieving mobility for an IP address that is obtained in that Proxy Mobile IPv6 domain.

LMA Address (LMAA): The global address that is configured on the interface of the local mobility anchor and is the transport endpoint of the bidirectional tunnel established between the local mobility anchor and the mobile access gateway. It is the address to which the mobile access gateway sends the Proxy Binding Update messages. When supporting IPv6 traversal, i.e., when the network between the local mobility anchor and the mobile access gateway is an IPv6 network, this address will be an IPv6 address and will be referred to as IPv6-LMAA.

Proxy Care-of Address (Proxy-CoA): Proxy-CoA is the global address configured on the egress interface of the mobile access gateway and is the transport endpoint of the tunnel between the local mobility anchor and the mobile access gateway. The LMA views this address as the care-of address of the mobile node and registers it in the Binding Cache entry for that sensor node. [1] When the transport network between the mobile access gateway and the local mobility anchor is an IPv4 network and if the care-of address that is registered at the local mobility anchor is an IPv4 address.

Sensor Node's Home Network Prefix (SN-HNP): The SN-HNP is a prefix assigned to the link between the sensor node and the mobile access gateway. Additional one prefix can be assigned to the link between the sensor node and the mobile access gateway, in which case, every one of the assigned prefixes are managed as a set associated with a mobility session. The sensor node configures its interface with one or more addresses from its home network prefix(es). If the sensor node connects to the Proxy Mobile IPv6 domain through multiple interfaces, concurrently, each of the attached interfaces will be assigned a unique set of home network prefixes, and every prefixes assigned to a given interface of a sensor node will be managed less than one mobility session.

Mobile Node’s Home Address (MN-HoA): MN-HoA is an address from a mobile node's home network prefix. The mobile node will be able to use MN-HoA address as long as it is attached to the access network that is in the scope of that Proxy Mobile IPv6 domain. If the mobile node uses extra one address from its home network prefix(es), every one of these addresses is referred to as mobile node's home address. Nothing like in Mobile IPv6 where the home agent is aware of the home address of the movable node, in Proxy Mobile IPv6, the mobility entities are only aware of the mobile node's home network prefix(es) and are not always aware of the exact addresses that the mobile node configured on its interface from its home network prefix(es). Except, in some configurations and based on the enabled address configuration modes on the access link, the mobility entities in the network be able to certain about the exact addresses configured by the mobile node.

Mobile Node's Home Link: This is the link on which the mobile node obtained its layer-3 address configuration for the attached interface after it moved into that Proxy Mobile IPv6 domain. This is the link that theoretically follows the mobile node. The network will guarantee the mobile node always sees this link with respect to the layer-3 network configuration, on every access link that it attaches to in that Proxy Mobile IPv6 domain.

Group of Mobile Node: A mobile node that connects to the same Proxy Mobile IPv6 domain through more than one interface and uses these interfaces simultaneously is referred to as a Group mobile node.

Mobile Node Identifier (MN-Identifier): The identity of a mobile node in the Proxy Mobile IPv6 domain. This is the secure identifier of a mobile node that the mobility entities in a Proxy Mobile IPv6 domain can always acquire and use for predictably identifying a mobile node. This is normally an identifier such as a Network Access Identifier (NAI) or other identifier such as a Media Access Control (MAC) address.

Mobile Node Link-layer Identifier (MN-LL-Identifier): An identifier that identifies the attached interface of a mobile node. The LL identifier, in some cases, is generated by the mobile node and convey to the mobile access gateway. This identifier of the attached crossing point must be constant, as seen by some of the mobile access gateways in a given Proxy Mobile IPv6 domain. In some extra cases, there might not be any link-layer identifier associated with the mobile node's interface. An identifier value of zero is not measured a suitable identifier and cannot be used as an interface identifier.

Policy Profile: Policy Profile is an abstract term for referring to a set of configuration parameters that are configured for a given mobile node. The mobility entities in the PMIPv6 domain require access to these parameters for providing the mobility management to a specified mobile node. The specific details on how the network entities obtain this policy profile is outside the scope of this document.[2]

Proxy Binding Update (PBU): A request message sent by a mobile access gateway to a mobile node's local mobility anchor for establishing a binding between the mobile node's home network prefix(es) assigned to a given interface of a mobile node and its current care-of address (Proxy-CoA).

Proxy Binding Acknowledgement (PBA): A reply message sent by a local mobility anchor in response to a Proxy Binding Update message that it received from a mobile access gateway.

Per-MN-Prefix and Shared-Prefix Models: The term Per-MN-Prefix model is used to refer to an addressing model where there is a unique network prefix or prefixes assigned for each node. The Shared-Prefix model is used to refer to an addressing model where the prefix(es) are shared by more than one node. This specification supports the only Per-MN-Prefix model and do not support the Shared-Prefix model.

Mobility Session: It is the context of Proxy Mobile IPv6 specification, the term mobility session refers to the creation or existence of state associated with the mobile node's mobility binding on the local mobility anchor and on the serving mobile access gateway.

II. RELATED WORK

L2 and L3 Handoffs: The reduction of the handoff delay is a critical issue for the mobility protocol. The L2 delay contains the channel scanning, authentication, and association delays; while the L3 delay contains the movement detection, Coal (Care of Address) configuration, DAD (Duplicate Address Detection), and registration delays. Many researches try to improve the L2 handoff by reducing the channel scanning delay because channel scanning is the most time consuming part of the L2 handoff. The neighbor graph is used in both Enhanced hand- off latency reduction mechanism in layer 2 and layer 3 of mobile IPv6 (MIPv6) network and a fast handoff mechanism for IEEE 802.16 and IAPP networks, so as to imprison the probing scope to the potential handoff targets and thus reduces the channel scanning delay. Pre-registration is used in [2] so as to further reduce the handoff delay. In [3], caching is used so that the STA can associate with the caching AP fast. If the two caching AP cannot be associated successfully, the selective scanning is performed. A Deuce-Based Fast Handoff Scheme (named as Deuce Scan) is proposed in [4]. Deduce scheme uses a spatiotemporal graph to provide spatiotemporal information for accurately and correctly making the handoff decision. A rescan approach is also adopted in the Deduce Scan scheme so as to further reduce the L2 handoff latency.

When an SN is waiting for the DHCP server to assign a new IP address, a temporary IP address is assigned for the SN to resume the communication immediately after the handoff. The pre-handoff route discovery (PRD) concept for AODV is proposed in a fast handoff mechanism for IEEE 802.16 and IAPP networks. PRD enables MNs to set up routes in the handoff-target network before handoff. The FMIPv6 Mobility support in IP uses L2 triggers for anticipation and initiation of L3 handoff. The duplication of the new Coal is validated before the MS's movement and thus the FMIPv6 can reduce the movement detection and Coal delays. The L3 delay (around 2300ms) is much longer than the L2 delay (around 50 ~ 250ms) and hence there is more potential to greatly reduce the handoff delay by reducing the L3 delay. The proposed group handoff protocol can not only reduce the signalling cost (L2 handoff) but also reduces the registration cost (L3 handoff).

In WBANs, the sensors always move together and take handoff at the same time. For example, a patient may walk around in the hospital for inspections or surgeries. Hence, how to achieve the seamless handoff scheme with less delay time is an important issue. The existing group-based protocol [6], [7] relies on the first newly attaching node to carry the rest of nodes' binding information to reach the goal of reducing the signalling cost and handoff delay. However, the sensors equipped on the human body always attach to the newly access link at the same time. Hence, it is better to use one control message (RS and RA) to carry the whole body sensors' information for reducing the signalling cost. Grouping the body sensors to enhance handoff procedure is also a feasible solution. To achieve the goals of reducing the delay time and signalling cost during the handoff procedure, the new enhanced group mobility scheme and a new format of RS and RA message is proposed in this paper to solve those problems

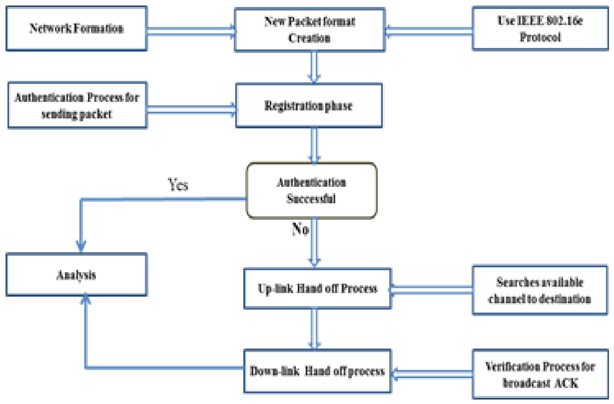

Fig. 1: Architecture Design

This architectural diagram can be used to represent the architectural view of our system. New Packet Format Creation: The new enhanced mobility protocol mainly simplifies the procedure of home registration and handoff. To achieve this goal, a new packet format is proposed to increase the speed of data transmission, and to reduce the signal cost and handoff delay. This new packet format creation is used for IEEE 802.16 protocol. The IEEE 802.16 standard essentially standardizes two aspects of the air interface the physical layer (PHY) and the media access control (MAC) layer. This section provides an overview of the technology employed in these two layers in the mobile IEEE 802.16 specification.

Physical layer (PHY): The IEEE 802.16e uses scalable OFDMA to take data, supporting channel bandwidths of between 1.25 MHz and 20.0 MHz, with up to 2046 subcarriers. It supports adaptive modulation and coding, so this conditions of good signal, a highly efficient 64.0 QAM coding scheme is used, where as when the signal is inferior, a more robust BPSK coding mechanism is used. In middle conditions, 16.0 QAM and QPSK can also be employed. Extra PHY features include support for multiple-input multiple-output (MIMO) antennas in order to provide good non-line-of-sight propagation (NLOS) characteristics (or higher bandwidth) and hybrid automatic repeat request (HARQ) for good error correction performance. Although the standards allow operation in any band from 2.0 to 66.0 GHz, mobile operation is best in the lower bands which are also the most packed, and therefore most exclusive.

Media access control (MAC) layer: The MAC describes a number of Convergence Sub layers which describe how wire line technologies such as Ethernet, Asynchronous Transfer Mode (ATM) and Internet Protocol (IP) are encapsulated on the air boundary, and how data is classified. It also describes how protected communications are delivered, by using protected key exchange during authentication, and encryption use Advanced Encryption Standard or Data Encryption Standard during data transfer. Additional features of the MAC layer include power saving mechanisms (using sleep mode and idle mode) and handover mechanisms. A key feature of 802.16 is that it is a connection-oriented technology. The MAG cannot transmit data until it has been allocated a channel by the base station (BS). This allows 802.16e to provide strong support for quality of service (QoS). The QoS in 802.16e is supported by allocating each connection between the MAG and the BS to a specific QoS class.

Registration Phase: The registration phase aims to reduce the amount of control messages. One of the body sensors needs to act as a coordinator, which can interact with other sensors in 6LoWPAN environment. All the sensors use DHCP-based address configuration. The procedure of the group-based registration is given as follows: When a group of body sensors enter a PMIPv6 domain and attaches to an access link, the body sensor sends an RSEG message by multi-hop transmissions to the MAG. Upon the MAG received the RSEG message, the MAG uses all the LL_ID I one by one for authentication by sending the AAA query. After a successful authentication, the AAA server sends a reply which includes the LMA's address and the MN's parole.

After the MAG gets the LMA's address, MAG then sends a PBUEG message, which contains all the identifiers, to the LMA. Once the LMA receives the PBUEG message, LMA performs access authentication to verify whether PBUEG message is genuine or not. After the MAG received the PBAEG message, the MAG stores the BN and requests the addresses from the DHCP server on behalf of the body sensors. The DHCP server then configures the respective Home of address (HoA) from those prefixes and sends it to the MAG. Upon received those messages, the MAG stores the IP address and sent an RAEG message back. Assume that sensor node 1 is the coordinator of the group of body sensors.

Up-link Hand-off Phase: The body sensor performs an active scan that searches a list of the available channels by periodically sending a beacon request to the nearby FFDs. The nearby FFD, that receives he beacon request from the body sensor, advertises a beacon message including their MAG-IDs. Upon receiving the beacon messages, the body sensor decides whether itself is still in the same MAG or has moved to another MAG by comparing the current MAG-ID with the previous MAG-ID contained in the beacon message. If the comparative results of all the MAG-IDs in the received beacon messages are the same, the movement represents intra-PAN mobility, and the body sensor has moved within the same PAN area. On the other hand, if the body sensor moves from the previous MAG (p-MAG) to the next MAG (n-MAG), the body sensor is able to detect its movement since the current MAG_ID is different from the previous MAG_ID, as contained in the received beacon messages. The body sensor can then be associated with the new MAG. The proposed protocol is able to reduce (n − 1) RS messages because it replaces per identifier per RS message with a set of all identifiers. Furthermore, by using the assigned BN, it can also save (n − 1) handoff messages such as deregistration PBU and PBA. The proposed new group- based handoff scheme is described as follows.

The previous link on MAG (p-MAG) detects the detachment event from the body sensor, the MAG will signal the LMA by sending the deregistration PBU. Instead of all nodes sending the deregistration PBU respectively here the MAG sends only one LL_ID from the body sensor. Upon the LMA receives this message, LMA can obtain the rest sensors' information due to previously assigned BN, which is stored in the binding cache. After the LMA has confirmed all the information of sensors, the LMA will remove the binding and routing states if the LMA does not receive any PBU message within the given amount of time. Then, the LMA replies a PBA message and informs the MAG not to send other unnecessary deregistration PBU message. This way, the proposed scheme can reduce (n −1) times of sending deregistration PBU to advertise the LMA. The n-MAG obtains the assigned group value of the body sensor, once the body sensor has attached to the new MAG (n-MAG), the coordinator of the body sensor sends the RSEG message on behalf of all sensors to the n-MAG by unicast.

The n-MAG received the RSEG message, MAG stores the BN, all the MN_ID i and LL_IDi in the binding cache. Then the n-MAG uses all the LL_ID i one by one for authentication by sending the AAA query. After a successful authentication, the AAA server sends a reply which includes the LMA's address and the MN's profiles.

This step aims to enhance the handoff performance by using the assigned group value in the LMA. Therefore, After the n-MAG obtaining the LMAs address, n-MAG sends a PBUEG message. Compare to the original PMIPv6 protocol, the PBUEG message can reduce (n−1) times of binding message. The reason is that the LMA can obtain the other sensors binding information by using the previously assigned BN.

Down-Link Handoff Phase: Assume that the sensor node 1 is the coordinator of the body sensor group. In the first step, the MAG sends only LL_ID 1. Upon the LMA receives this message, LMA knows the rest sensors' information due to the assigned B1 value, which is stored in the binding cache. Once the group of body sensors attaches to the new MAG, the body sensor in B1 sends the RSEG message and the value 0x01 of B1 to the n-MAG. Once the LMA received the PBUEG message, the LMA still needs to perform authentication to verify whether the PBUEG message is genuine or not. After the n-MAG received the PBAEG message, the n-MAG stores the information of HNPs and then sends the DHCP requests. Thus, the DHCP server identifies the client from the client-DUID and identifies that link from the link-address. After that, the DHCP server allocates the same addresses of all the body sensors' prefixes respectively to the n-MAG one by one. Upon received IP configuration messages, the n-MAG store the IP address and sends an RAEG message to the coordinator of the body sensor. After the coordinator receives the RAEG message, the coordinator broadcasts the ACK to the rest of the body sensors.

Analysis Phase: In this phase various aspects of data transmission in the body sensors are analyzed .In Registration Phase, Group transmission if there is any node is failed during authentication in the sense then they are analyzed whether it is a malicious node or not in the coverage area. ACK during data transmission also analysed in this system. Performance metrics are also analyzed such as speed, accuracy, Hand-off delay and cost.

An Enhanced Groyp Mobility Protocal for 6LowPAN-Based Wioreless Body Area Networks introduced a concept of group-based network roaming in proxy mobile IPv6 (PMIPv6) domain is considered in the 6LoWPAN-based wireless body area networks. Proxy mobile IPv6 is a standard to manage the network-based mobility in all-IP wireless network. But, it does not perform well in group-based body area networks. To further reduce the delay and signaling cost, an new enhanced group mobility scheme is proposed in this paper to reduce the number of control messages, including router solicitation (RS) and router advertisement (RA) messages as opposed to the group-based PMIPv6 protocol.(1)

"A survey on body area network, networking and mobile computing"[8] gives an overview of body area networks, and a conversation of BAN communications types and their related issues. We offer a detailed investigation of sensor devices, physical layer, data link layer, MAC layer and radio technology aspects of BAN research. Advances in wireless communication technologies, such as wearable and implantable sensors, along with modern developments in the embedded computing area are enabling the design, expansion, and implementation of body area networks. This class of networks is road surface the way for the deployment of innovative healthcare monitoring applications. The research in the area of body area networks has focused on issues related to wireless sensor designs, sensor efficiency, low-power sensor circuitry, signal processing, and communications protocols.

Ipv6 Over Low Power Wpan is IP-based mobility protocols. Mobile IP, HAWAII, Cellular IP, HMIP, Tele MIP, Dynamic Mobility Agent, and workstation Independent MIP that will play an important role in the forthcoming convergence of IP and legacy wireless networks[9]. A relative analysis with respect to system parameters such as location update, handoff delay and signaling fixed cost exposes their ability in managing micro/macro/global-level mobility. We use this observation to relate their features against a number of key design issues identified for seamless IP-based mobility as envisioned for future 4G networks.

The MAP will limit the amount of Mobile IPV6 signaling outside the local domain[10]. Two modes are proposed in the memo, based on the usage of RCoA. A MN only needs to perform one local BU to a MAP when changing attached point within the MAP domain. When using an RCoA, a MAP acts as a local Home Agent (HA) for the MN. MAP concept is simply an extension to the MIPv6 protocol. Furthermore, a MN can at any time stop using the MAP. This provides great elasticity.

Hierarchical Mobile IPv6 Mobility Management protocol that enables Mobile Networks to attach to different points in the Internet. The NEMO Basic Support ensures session continuity for all the nodes in the Mobile Network, the Mobile Router changes its point of attachment to the Internet. It also provides connectivity and reaches ability for all nodes in the Mobile Network as it moves. The solution supports equally mobile nodes and hosts do not support mobility in the Sensor Network.

III. CONCLUSION

In this paper, new format of MAC Layer based on IEEE 802.16 based is proposed to combine the necessary information of the sensors into one message and thus reduces the number of control messages. Power consumption plays major role in sensor networks since it significantly reduces the Energy consumption. Proposed fast data transmission scheme with JCL- AF further reduces the handoff delay time between the LMA and the MAG. The signaling cost can also be reduced due to the group management. Simulation results shown that it outperforms accuracy, high speed and low power.

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