UNIT III WIRELESS HEALTH SYSTEMS 9

Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges- System security and reliability, BAN Architecture – Introduction, Wireless communication Techniques.

3.1 Need for wireless monitoring

Wireless monitoring through wearable devices could be useful for hospitalized patients, particularly those who are unstable or at higher risk for serious complications such as critically ill patients. This review aims at summarizing current evidence regarding the use of wireless monitoring in the ICU setting.

Wireless sensor network (WSN) technologies have the potential to change our lifestyle with different applications in fields such as healthcare, entertainment, travel, retail, industry, dependent care and emergency management, in addition to many other areas. The combination of wireless sensors and sensor networks with computing and artificial intelligence research have built a cross-disciplinary concept of ambient intelligence in order to overcome the challenges we face in everyday life.

3.2 Definition of Body area network

Body Area Network (BAN) technology uses small, low power wireless devices that can be carried or embedded inside or on the body. Applications include but are not limited to:

- Health and wellness monitoring
- Sports training (e.g., to measure performance)
- Personalized medicine (e.g., heart monitors)
- Personal safety (e.g., fall detection)

A number of wireless BAN communication technologies have been implemented based on the existing radio technologies. However, if BAN technology is to achieve its full potential, it needs a more specific and dedicated technology, which is optimized for BAN. For example, solutions for monitoring people during exercise one or two hours a day, or a few days a week, may not be suitable for 24/7 monitoring as a part of the Internet of Things (IoT) concept.

3.3 BAN and Healthcare

Body Area Network (BAN) is a technology that allows communication between ultra-small and ultra low-power intelligent sensors/devices that are located on the body surface or implanted inside the body. In addition, the wearable/implantable nodes can communicate to a controller device that is located in the vicinity of the body. These radio-enabled sensors can be used to continuously gather a variety of important health and/or physiological data. Radio-enabled implantable medical devices offer a revolutionary set of applications among which we can point to smart pills for precision drug delivery, intelligent endoscope capsules, glucose monitors and eye pressure sensing systems. Similarly, wearable sensors allow for various medical/physiological monitoring (e.g. electrocardiogram, temperature, respiration, heart rate, and blood pressure), disability assistance, human performance management, etc.

Wearable devices that work outside the confines of the hospital without expert medical assistance must fulfill a number of characteristics:

- Usability: The device has to be worn on a continuous basis and must therefore be small and lightweight. The challenge is to compress the device size down.
- Power consumption: The device should have low power consumption, reducing the need for frequent re-charging and disruptions in monitoring.
- Design: The device must be elegant without the need to attach long wires and electrodes from the device to the patient and from the device to the mobile gateway that transmits data (to the remote medical care unit).
- Cost: If a patient is required to purchase the unit, it should cost sub US$200 to be affordable or for the hospital to give it away free as part of medical care.

Devices that fulfill these conditions can expect to become popular. Manufacturers will find that users are able to easily integrate such devices into their daily lives for maximum benefit.

The typical set of parameters that the device must monitor include heart activity, fetal heart rate, skin resistance, skin temperature, refractive index of blood etc. Based on what the device is required to measure and monitor, its components would include:

- Bio sensors: Application specific bio sensors that emit signals indicating measured parameters
- Analog-to-digital converters: Application specific analog front end to digitize the sensor signals. The device may also be equipped with signal conditioning circuitry.

- General purpose micro controller: To process signals for the device to function. Signals could indicate battery levels, failure, etc. or signals received from accelerometer, displays and switches, memory and connectivity solutions.
- Wireless interface: In most instances, the device will connect to a mobile gateway over a Body Area Network (BAN) or the newer Bluetooth LE (low energy) suitable for continuous transfer of medical data.
- Memory: In modern wearable devices, the data is sent in real-time to a mobile gateway (smart phone or a tablet) and then to the patient's remote health care provider. These devices can also store data in off line mode, synchronizing the data when the device goes online.
- Power management: The device design must ensure that energy consumption is minimized for longer uninterrupted device deployment and stand by time.

3.4 Technical Challenges

Effectiveness of the WBAN is important from both patients and healthcare perspective. As the time passes, challenges to the emerging technologies increases along with the advancements. There is variety of challenges faced by WBAN as explain below. These challenges are classified in six major classes such as energy, mobility, security and communications (i.e., networking, QoS and cooperation).

A. Energy Requirements: Since, most of the devices in WBAN are using the wireless medium, therefore they are portable. Such devices are small in size and carry power source too. Hence, the power is always limited. Wireless natures made them roam free, meaning the devices are free to move. The power to the device of the network is provided with the help of batteries. Things are not simplified by allowing the power from battery but is encompasses some more challenges of power management of the battery supplies especially in case of implants. Since the sensors that are implanted in the body are so small that the battery cannot sustain more than a month. Removing the implants and re-installation require even more management of the complications generated. Different parameters that alter the power consumption include communication bandwidth and processing power. There is

need to have better scheduling algorithm along with better power management schemes.

B. **WBAN Security**: In any network, communication data is of worth importance. In case of WBAN, it becomes more critical as it has been connected to the Physical system. These communication channels are very much visible to the attacker and if not securely implemented it could any of the attack including eavesdropping on traffic between the nodes, message injection, message replay, spoofing and off course compromise the integrity of physical devices. Upon successful attack, such actions not only invade privacy but may lead to catastrophic situation.

C. **Mobility Support:** WBAN provides two major advantages, i.e., portable monitoring and location independence. Regardless of the application, these are the key factors due to which WBAN is potential candidate in many venues. But these two advantages put some special limitations i.e., mobility. Mobility can pose serious problem in some application like E-Health care even posture do effect the communication. The mobility is defined between the user and the WBAN as a seamless link. One of the major issues is to reach to sink, which may be single or multi hop. Message is flooded to all nodes to reach sink node and the path with minimum delay is selected. Reliable multipath routing is another solution proposed. A path list is maintained depending upon different factors of the routing and the link is established accordingly.

D. **Quality of Service:** Quality of Service (QoS) is the requirements fulfilled by system as requested by the users. For more life critical system, timeliness may be the parameter for the quality. System, that cannot fulfill the said requirement, falls short of providing the QoS. Same is true for other factors like bandwidth, latency, jitter, robustness, trustworthiness, adaptability. Similarly, seamless roaming and end to end wireless connection between the body nodes and the sink nodes is another QoS factor.

E. **Cooperation between Nodes:** When the intermediate nodes help source destination pair in communication, the cooperation occurs. The intermediate nodes may refer as helper or relay as shown in Fig. Cooperation offers a good solution for

many of the limitations in WBAN such as distance, mobility, coverage and channel impairments.