Transmission of IPv6 Packets over Wireless Body Area Networks (WBANs)

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Muhammad Sajjad Akbar

Bournemouth University, England

R. Bin Rais Ajman University,

AR. Sangi Individual Contributor

M. Zhang Huawei Technologies

C. Perkins Futurewei

IETF 99, Prague

Current status

- Informational
- Potential precursor to standard track effort
- Suggestions and feedback are requested

Motivations

- It is estimated that high growth in population will overload the health care systems, moreover it is expected that in requirement of remote healthcare monitoring services will reach to 761millions in 2025 [1].
- The current expenditure with respect to gross domestic product (GDP) for different countries is increasing every year.
- The countries like Australia, Japan, Switzerland, France, United Kingdom, Germany and United states are spending 9.3%, 11.2%, 11.5%, 11%, 9.8%, 11.1% and 16.9% respectively of their GDP.
- Recent practices show that cost to approach 20% of the GDP in 2022, which is alarming for USA and for many other countries as well. These statistical evidences demand a new shift in existing health care systems for affordable and approachable health care solutions [2].

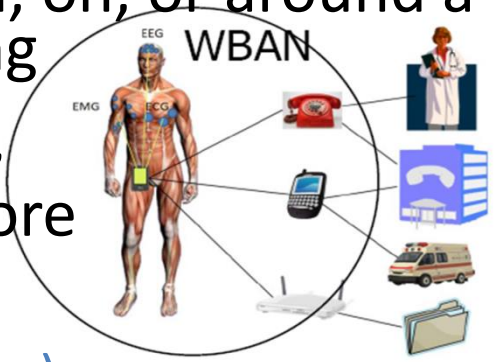
1. Movassaghi, S., et al., Wireless body area networks: A survey. IEEE Communications Surveys & Tutorials, 2014. 16(3): p. 1658-1686.
2. Shu, M., et al., A MAC protocol for medical monitoring applications of wireless body area networks. Sensors, 2015. 15(6): p. 12906-12931.

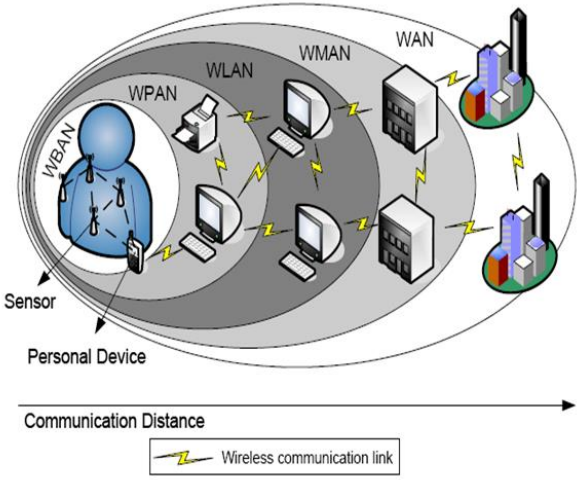
Wireless Body Area Networks

- Wireless Body Area Networks (WBANs) intend to facilitate use cases related to medical field
- IEEE 802.15.6 standardized in 2012; defines PHY and MAC layer and is designed to deal with better penetration through the human tissue without creating any damage to human tissues with the approved MICS (Medical Implant Communication Service) band by USA Federal Communications Commission (FCC)
- Specific Absorption Rate (SAR)
  - Radiation can damage tissue

Why is WBAN technology needed?

- WBAN is a RF based wireless networking technology that interconnects tiny nodes with sensors in, on, or around a human body, real time health monitoring
- A WBAN usually consists of inexpensive, lightweight platforms hosting one or more physiological sensors.
  - Motion Sensors, ECG (Electrocardiograms)
  - Pulse Oximetry Sensors
  - Breathing Sensors, Blood pressure
  - EMG (Electromyograms)
  - EEG (Electro-encephalograms)
  - Blood Glucose Sensors





- Data can be on-demand, emergency, or normal
- Use cases: Patient monitoring, Elderly care centres, Fitness monitoring etc

IEEE 802.15.6 Wireless Body Area Networks

- Scope: Standard for short range(2-5m), wireless communication in the vicinity of, or inside, a human body (not actually limited to humans)
  - Uses existing ISM bands and/or bands approved by national medical and/or regulatory authorities
  - Supports QoS, extremely low power, & data rates up to 10 Mbps
  - Complies with strict non-interference guidelines
  - Takes into account the effects on portable antennas due to the presence of a person (varying with male, female, body mass, etc.)
  - Meets Specific Absorbed Radiation limits

Why need to be standardized?

- Proprietary solutions are available
- Standards based solutions help create interoperable solutions, a larger market and lower cost alternatives, all of which leads to greater adoption
- So why not leverage existing standards?
- Current solutions are optimized for other types of applications besides medical; Bluetooth is optimized for supporting voice links, Zigbee is optimized for industrial sensor applications, and Wi-Fi is optimized for data networks
- The IEEE 802.15.6 started specifically for wireless networks on or in the body with low power

Comparison with existing standards

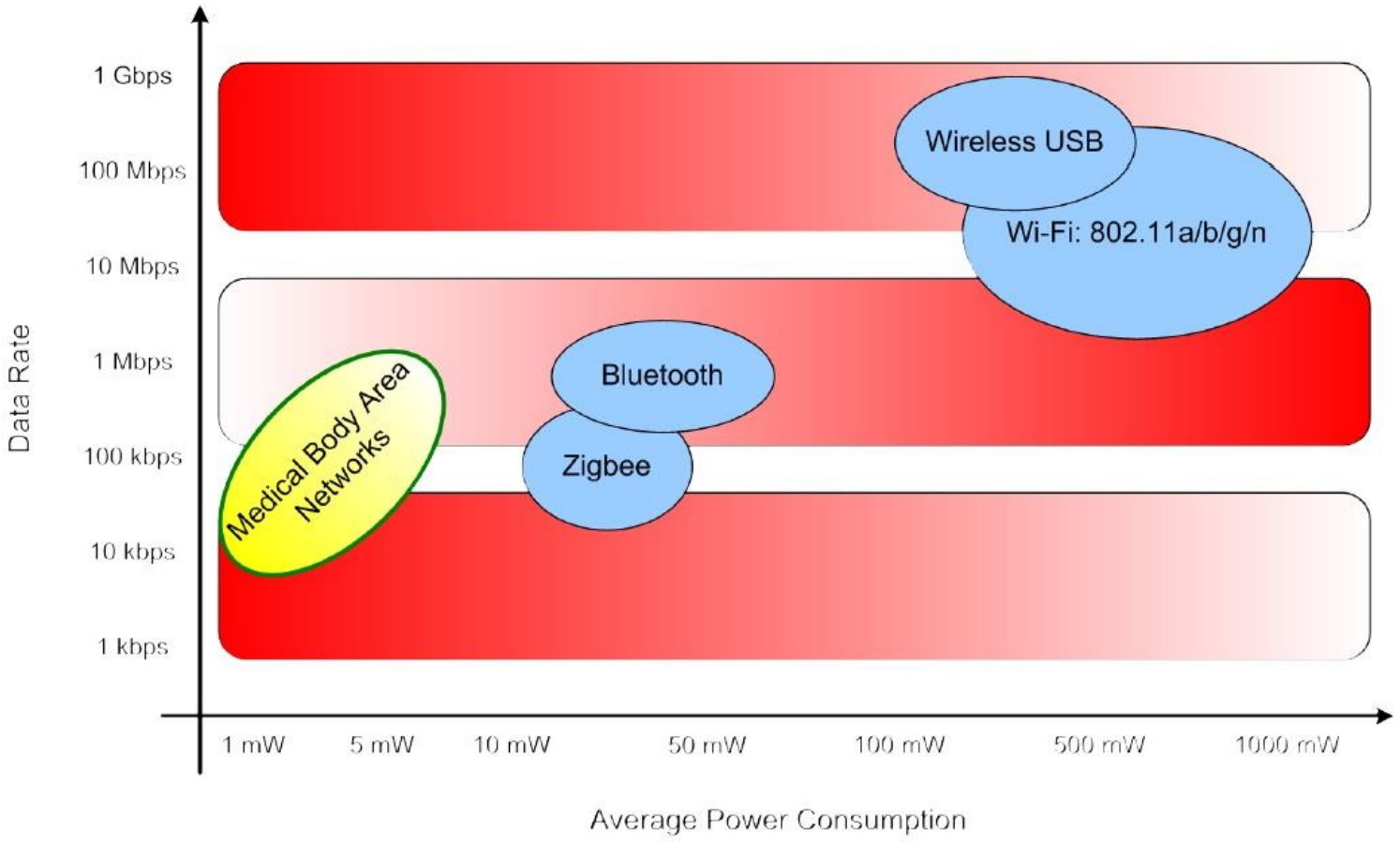
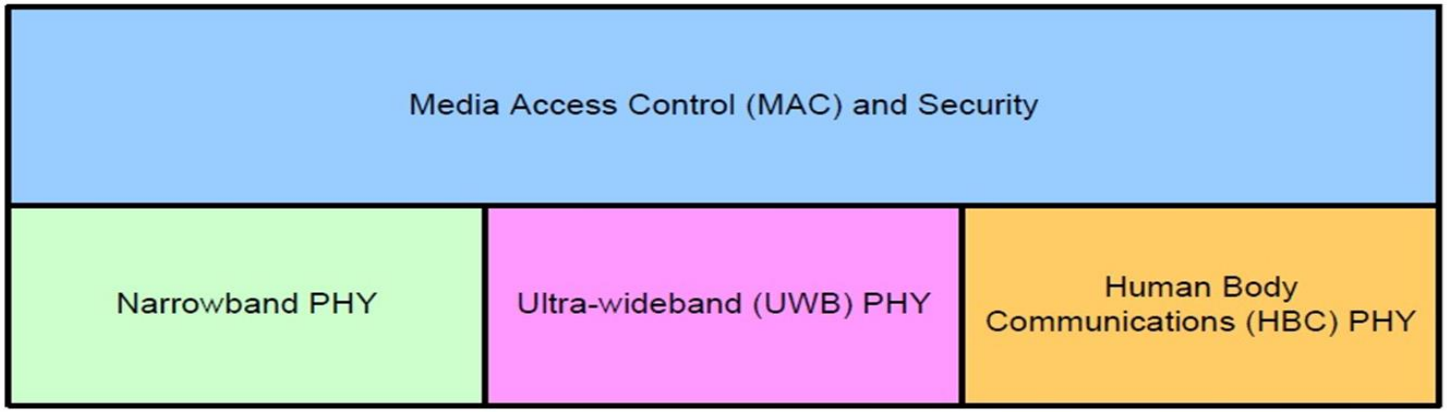


Figure 1. Data and Power Profile (source Texas Instruments

Frequency Bands

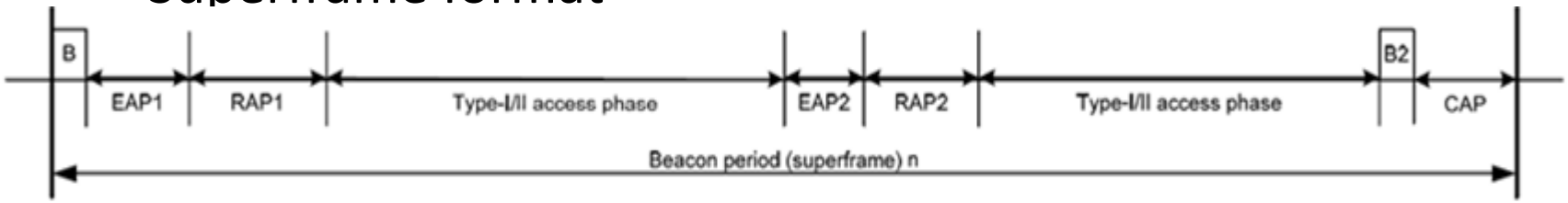
Communication	Frequency	Bandwidth
HBC	16 MHz	4 MHz
HBC	27 MHz	4 MHz
NB	402-405 MHz	300 KHz
NB	420-450 MHz	300 KHz
NB	863-870 MHz	400 KHz
NB	902-928 MHz	500 KHz
NB	956-956 MHz	400 KHz
NB	2360-2400 MHz	1 MHz
NB	2400-2438.5 MHz	1 MHz
UWB	13.2-4.7 GHz	499 MHz
UWB	6.2-10.3 GHz	499 MHz

- Bandwidth
  - Throughput increases linearly with bandwidth
- Transmit power
  - Increased transmit power implies more SNR at the receiver



Channel model and Superframe

- The channel model will include body effects
  - Specific Absorption Rate (SAR), health effects
  - Body shadowing causes severe attenuation at some frequencies
  - Superframe format



The EAP is Emergency Access Period
-> In this period only devices with emergency traffic can contend

The RAP (Random Access Period) can be used by any device both emergency and non-emergency

Benefits by using IPv6 solution

- The number of devices in WBANs makes network auto-configuration and statelessness highly desirable.
  - IPv6 has auto-configuration solutions
- Total population of WBAN of devices suggests the need for a large address space
- The limited packet size of WBANs suggests incorporation of IEEE 802.15.6 address as part of the IPv6 address
- Simple interconnectivity to other IP networks including the Internet

Issues

- Limited Packet Size Applications within WBANs are expected to originate small packets maximum 256 octet whereas IPv6 MTU requirement is much larger

Industrial development

- Questions