Simulation of WPAN and S-MAC Protocols Based on Energy Consumption

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***Abstract*— Wireless Sensor Network (WSN) and Wireless Network (WN) are the two exciting topics because of its various uses and wide range of applications. The applications include health monitoring and environmental monitoring, industrial process monitoring, target detection, data acquisition and control systems, target tracking, energy efficient disaster management and military security systems and many more. Generally we call this as Internet of Things applications which deal with one or more devices with the support of Internet. In this paper, the comparison of the Wireless Personal Area Network (WPAN) and Sensor Medium Access Control (S-MAC) protocolshas been done by simulating them on the basis of the energy they consume. The energy consumed by the S-MAC is more than that of WPAN.Finally it is concluded that Wireless Network consumes less energy than the Wireless Sensor network.**

***Keywords*— Wireless Sensor Network, Energy Consumption, Medium Access Control, Wireless Personal Area Network, Internet of Things (IoT), Network Simulator.**

I. INTRODUCTION

TheWireless Sensor Network (WSN) which can also be called as wireless sensor and actuator network is comprised of autonomous devices that are distributed spatially [1]. A wireless network makes use of the sensors and they monitor the surrounding physical or environmental conditions like pressure, temperature, moisture, etc. The wireless connectivity to the wired world and distributed nodes is offered by a gateway which is included in the WSN system.According to the application requirements, the wireless protocol is chosen.

There are infrastructure systems that connect our world in a smart way, more than we ever thought possible like smart homes, smart water networks, intelligent transportation etc. The common visualisation of such systems is usually associated with one single concept thatis theInternet of Things (IoT). In the Internet of Things, various types of sensors are used and the complete physical infrastructure is closely united with information and communication technologies. By making use of thenetworked embedded devices the intelligent monitoring and management of the information and the related devices can be achieved.A wireless sensor network (WSN) is a network designed by a vastnumber of sensor nodes where every single node is built-inwith a sensor to sense physical occurrences such as light, heat, pressure, etc. WSNs are considered as a revolutionary information gathering method to form the information and communication system which will significantlyincrease the consistency and effectiveness of infrastructure systems. With the speedy technological expansion of sensors, WSNs has become the most suitable and key technology for IoT [2].

TheWireless Personal Area Network (WPAN) is personal, short distance area wireless networkthat will inter connect the different devices which arecentredaround aspecific person's workstation. WPANs are used inmobile computing and wireless networking devices such as personal computers, PDAs, peripherals, cell phones, pagers and consumer electronics. IoT applications will be indirectly making use of the WPANs for transmission of data between the devices in a short range of communication [3]. S-MACis a medium-access control (MAC) protocol which is intended for wireless sensor networks. The computing and sensing devices used by the wireless sensor networks are battery operated. Hence the energy consumed by the protocols is a matter of consideration. In this paperthe simulation of WPAN and S-MAC has done on the basis of the energy it is consumed during the IoT application work. Both the protocols are considered as wireless network protocols, which imply a great role in IoT field.

II. WORKING OF THE PROTOCOLS

The detailed description of the two protocols which we have used to simulate is given in this section. The architecture and a brief working are explained.

A. WPAN

A wireless personal area network (WPAN) is a personal, short distance area wireless network for interconnecting devices centred on an individual person's terminal. Wireless Personal Area Networks (WPANs), which function around a Personal Operating Space (POS), are anticipated to play a crucial part in the 4G communication systems by facilitating short range wireless ad hoc connectivity [4]. WPANs have some resemblances with fixed Wireless Sensor Networks (WSN). If we take IoT there are so many applications which are of short range [10 meters] and provide a great result. In that case WPAN helps a lot. If any sensor of IoT needs to collect the data from personal devices use battery-operated computing and sensing devices. In WPAN energy consumption is fundamentally subjective to the types of applications. The applications may be like connecting two cell phones or laptops or any two or more communication devices. Fig 1 shows the architecture of WPAN explained for Bluetooth module, which contains three basic layers such as Application, Profile and Stack. The outer devices will communicate in the Application layer, Profile layer contains WPAN core and platform for communication, Stack contains Personal Area Network Adaption Layer to maintain PAL Agent.

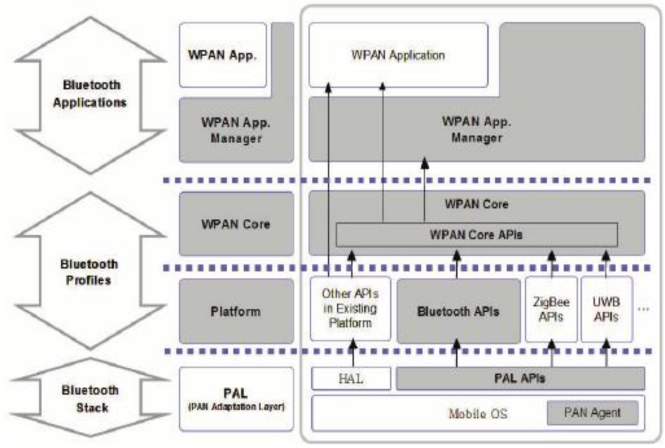

Fig. 1 WPANArchitecture

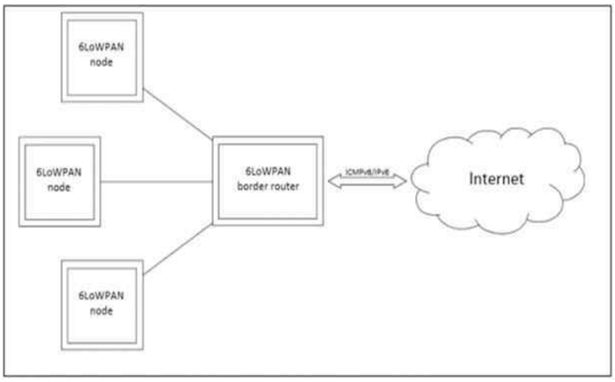

Fig. 2 Nodes and Border Router in a WPAN

Energy consumed by this network is less compared to S-MAC. It also has a few characteristics such as low power consumption, low cost, small personal network, communication between devices within a personal space etc. Fig 2 shows that nodes of WPAN connecting to the border router and that will be communicating with the devices using Internet. Hence all the nodes in WPAN will not be connectedto the internet so that power consumed by the nodes is less and the energy efficiency will be increased.

B. S-MAC

A sensor-medium-access control (S-MAC) protocol is designed for wireless sensor networks. Compared to any wireless sensor network this protocol consumes a reduced amount of energy. S-MAC employs three distinctiveprocedures to shrink energy consumption and maintain self-configuration. Nodes will form virtual clusters with shared sleep schedule in S-MAC, so all the clusters wake up and start sending the data at the same time. Wireless sensor network'srange, multi-hop communication instead of long-range communication conserves few amount of energy [5]. MAC is very small in size such that it can be placed into 4–8 KB of data space. The size of the S-MAC is determined by all the additional elements which are added. The channel is separated into an active or wake up and sleep period. Potential energy saving is determined by the ratio between the active and passive periods when the active period is going on. A different and advanced feature of S-MAC is message passing. The message passing feature helps in having a common overhead through which a long message is sent in burst by dividing it into small messages. This helps in energy saving by using common overhead [6]. To reduce energy consumption by listening to an idle channel, nodes will periodically go to sleep state. By this we can tell that energy will be saved compared to other WSN protocol. Fig 3 shows the general look up of S-MAC protocol.

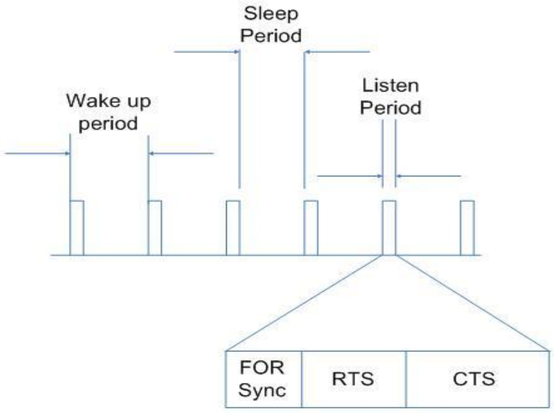

Fig. 3 S-MAC Protocol Scheme.

The figure shows the three states of S-MAC protocol. Wake up, Sleep and Listen mode. During some random time the node will come to listen state and send the RTS signals to look whether all the neighbouring nodes are active. If all the nodes are working, then accordingly that node will go to sleep state, if not that node will become active. Like this every single node will be working.

The sensor nodes will be communicating with each other. They will be communicating with other nodes when they are in listen state and send some control packets such as SYNC, RTS (Request to Send), CTS (Clear to Send) and ACK (Acknowledgement). By the exchange of the packet SYNC, all neighbouring nodes can be synchronized all together and exchanging the RTS/CTS helps the two nodes to communicate with one another [8].

III. SIMULATION AND RESULTS

A. Simulation Model

Network Simulator (NS2) [7] is used to simulate the proposed protocol. NS2 runs on Linux and it is an open-source simulation tool. It is a discreet event simulator directed at networking research. The NS2offersconsiderableprovision for simulation of routing, multicast protocols and IP protocols, like UDP, TCP, RTP and SRM over wired and wireless (local and satellite) networks[7].There is aemergentappreciation within different internet groups of the significance of simulation tools whichprovide assistancein designing as well as testing the new internet protocols. The newly introduced services and protocols will face challenges while testing. For illustration, quality of service and multicast delivery necessitateenormous and complex atmospheres. The benefits of simulation are acknowledged by the protocol designers when computing resources do not exist or are too costly to replicate a real lab setup. With the aid of simulation tools like NS2, researchers can do large-scale experiments that are organized and reproducible. This was precisely what we needed to shape our case scenarios; the search started mainly for an open-source tool since most of the work aims at the deployment of open-source software based on Linux.

NS-2 has numerousbenefits whichmake it a useful tool, likethe capability of graphically detailing network traffic and support for multiple protocols. Furthermore, NS2 provisionsquite a lot of algorithms in routing and queuing. Routing algorithms includes LAN routing and broadcasting. Queuing algorithms comprise of fair queuing, deficit round-robin and FIFO. NS2 is accessible on numerous platforms such as FreeBSD, Linux, SunOS and Solaris. NS2 also builds and runs under Windows. Simple scenarios have to run on everysensible machine; though, very bulkyset-ups benefit from bulkyvolumes of memory [7].

B. Parameters

Here WPAN and S-MAC is simulated using NS-2 simulator considering energy consumption. Initially for 5 nodes then for 10 nodes, 15 nodes, 20 nodes and 25 nodes the energy consumed by the protocol is calculated.

Consumed energy is calculated using the formula:

ConsumedEnergy[i] = FinalEnergy[i] –InitialEnergy

Total energy is calculated using the formula:

TotalEnergy += ConsumedEnergy[i]

And average energy consumed by the each node is calculated using the formula:

AverageEnergy = TotalEnergy / n, where n is the total number of nodes in the network.

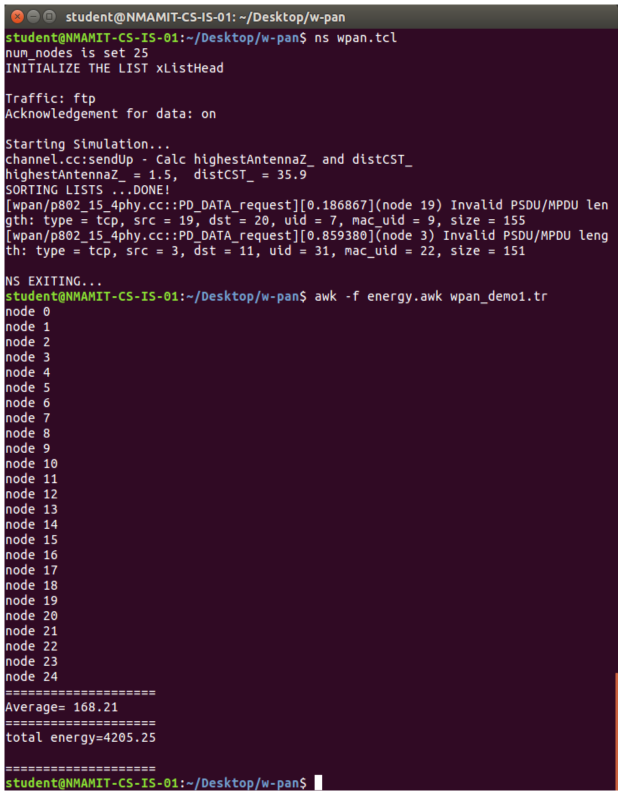

Fig. 4 WPAN energy consumed for 25 nodes.

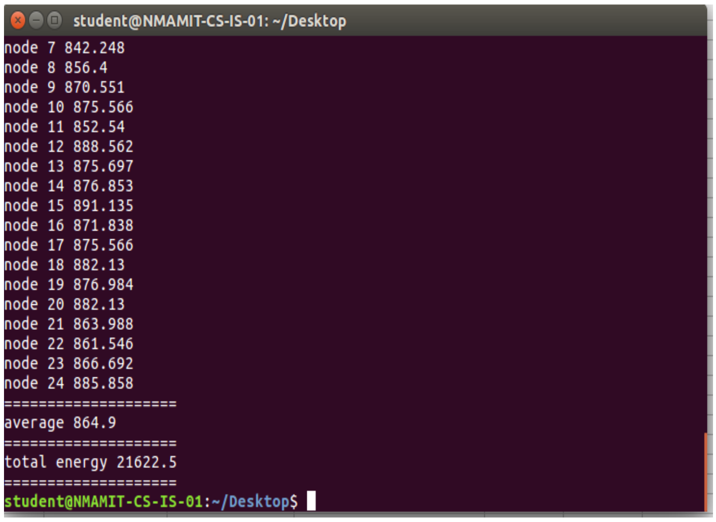

Fig. 5 S-MAC energy consumed for 25 nodes.

Fig. 4 and Fig. 5 are the screenshots of WPAN and S-MAC protocol's energy consumed for 25 nodes each, simulated using NS2 simulator. The consumed energy, total energy and the average energy has been calculated. From the simulation for 25 nodes, the average energy of the node in WPAN is 168.21 joules and for S-MAC it is 864.9 joules. Thereby we conclude that the S-MAC protocol consumes more energy than the WPAN.

C. Results

Total energy consumed by WPAN and S-MAC is shownin Fig. 6. In X-axis number of nodes is taken and in Y-axis energy consumed by respective nodes is shown.

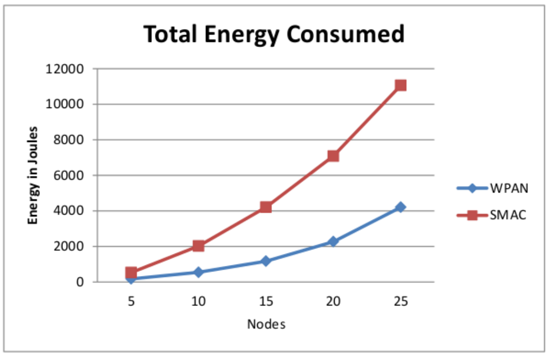

Fig. 6 Total energy consumed by WPAN and S-MAC

It clearly shows that the total energy consumed by the WPAN for 25 nodes is around 4205 joules whereas the total energy consumed by the S-MAC is more than 11200 joules.

IV. CONCLUSIONS

When both WPAN and S-MAC compared with one another on the basis of energy consumed we will get to know, WPAN consumes less energy than S-MAC (is shown in Fig.6) because S-MAC is the sensor medium access control protocol which is of wireless sensor network deals with the sensors of IoT applications where as WPAN is the wireless network which is used to connect the devices of IoT applications. It is clearly understood that WPAN takes less energy compared to the SMAC in this simulation. So the total energy consumed by the wireless sensor network is more than energy consumed by the wireless network.

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