Bluetooth Based Wireless Sensor Networks

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Abstract— The history of sensor network technology originates in the first distributed sensing idea implementations. Wireless sensor network is one of the growing technology for sensing and performing the different tasks. Such networks are beneficial in many fields, such as emergencies, health monitoring, environmental control, military, industries and these networks prone to malicious users and physical attacks due to radio range of network, un-trusted transmission, and unattended nature and get access easily. Security is a fundamental requirement for these networks. In this paper the main principles, applications and issues of Bluetooth based wireless sensor networks, as well as an implementation of a simple Bluetooth based sensor network are described.

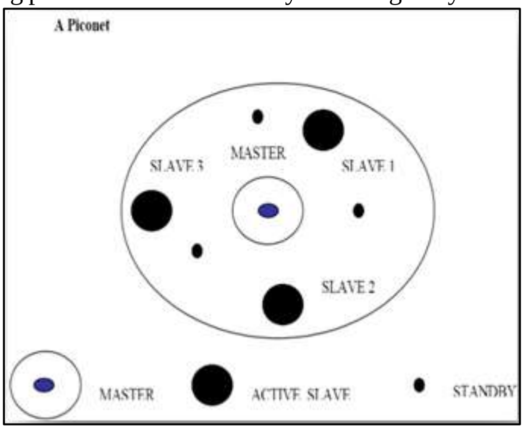
Keywords: Bluetooth Wireless Technology (BWT), Wireless Sensor Networks (WSN), Bluetooth

I. Introduction

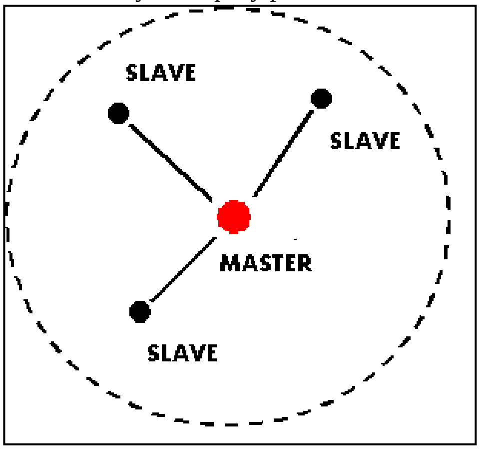
Bluetooth is wireless high speed data transfer technology over a short range (10-100m).Bluetooth Wireless Technology (BWT) was developed in 1994 at Ericsson in Sweden [1-2]. Originally it was build to eliminate the need for cable connections between PDAs and notebook PCs. Later the goals were to enable different devices through a commonly accepted standard for wireless connectivity Group called Bluetooth Special Interest Group (SIG) was formed in 1998 to develop the standard of IEEE 802.15 This specification standardized the Bluetooth technology worldwide. Depending on the type of connections established between various Bluetooth devices, 2 main topologies are as:

A. *Piconet topology:*

A piconet topology consists of 8 BWT enabled devices in which one device set up frequency hopping pattern and the other devices are synchronize their signals to the same pattern. Whereas the primary devices sets the frequency hopping pattern and the secondary devices gets synchronized.

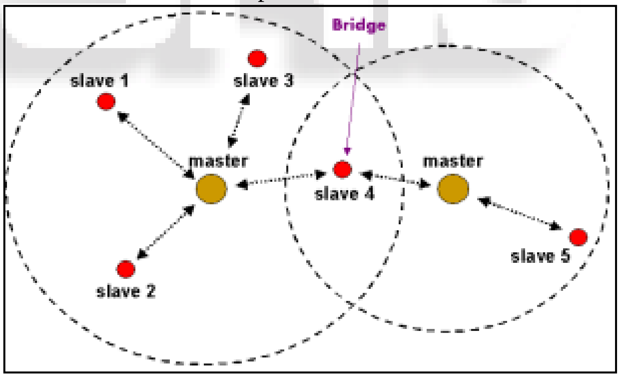


In Bluetooth, each piconet has 1 master for establishment of piconet and up to remaining 7 are slave devices. Masters Bluetooth address is used for defining the frequency hopping sequence. Slave devices use master clock to synchronize their clocks so as to hop simultaneously for establishing piconet and other Bluetooth devices with in the range are discovered by an inquiry procedure.



B. *Scatternet topology:*

Scatternet consists of several piconets connected by devices participating in multiple piconet. Here, devices can be slaves in all piconets or master in one piconet and slave in other piconets. There is a bridge connecting 2 piconets which is also a slave in individual piconets.



II. Smart Sensor Networks

It is to ensure interoperability among various Bluetooth manufactures' devices and to provide numerous applications. One such application is: WIRELESS SENSOR NETWORKS (WSN).The important features of (WSN) Collaboration of network nodes during execution and Data Centric nature. Many smart sensor nodes scattered in the field collect data and send it to users via 'gateway' using multi-hop routes.WSN consists of number of small devices equipped with a sensing unit, microprocessors, wireless communication interface and power source. Two main operations performed by WSN are:

Quering: Queries are used when user requires only the current value of the observation.

Tasking: More Complex operation used when a phenomenon has to be observed over a large period of time

A. *Functions of gateway:*

Communication with sensor networks: Shortage Wireless Communication; Discovery of smart sensor nodes. Gateway Logic: Controlling Gateway interface and data flow; providing uniform access to sensors Communication with users: Communication over Internet, WAN, Satellite, etc.

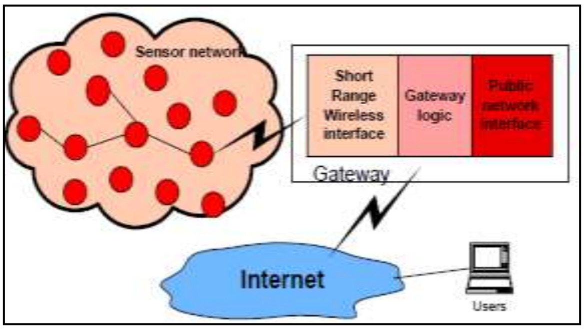


Fig. 4: A wireless Sensor network

III. APPLICATIONS

1) The features described above ensure a wide range of applications for sensor networks. Some of the possible scenarios are given below:
2) Health monitoring - Wireless sensor networks can be used in various ways to improve or enhance health care services. Monitoring of patients, health diagnostics, drug administration in hospitals, tele monitoring of human physiological data and tracking and monitoring doctors and patients inside a hospital are some of the possible scenarios.
3) Environmental monitoring - Fire detection, water pollution monitoring, tracking movements of birds, animals or insects, detection of chemical and biological agents are some of the examples of environmental applications of wireless sensor networks .
4) Industrial safety - Similar to personal health-care scenarios, wireless sensor networks can be used for "health-care" of buildings, bridges or highways . In such scenarios thousands of various sensors are deployed in and around monitored object and relevant information is gathered and analysed in order to assess condition of the object after a natural or man-made disaster
5) Military and security - The initial push towards wireless sensor network research came from military agencies. Military applications are various and vary from monitoring soldiers in the field, to tracking vehicles or enemy movement.
6) Sensors attached to soldiers, vehicles and equipment can gather information about their condition and location to help planning activities on the battlefield.
7) Other applications - Home automation, smart environments, environmental control in office spaces, detecting car thefts, vehicle monitoring and tracking, interactive toys are examples of other possible applications.

IV. RESEARCH ISSUES

There are mainly two research issues for Bluetooth based smart sensor network:-

– Hardware development issues,
– Software development issues.

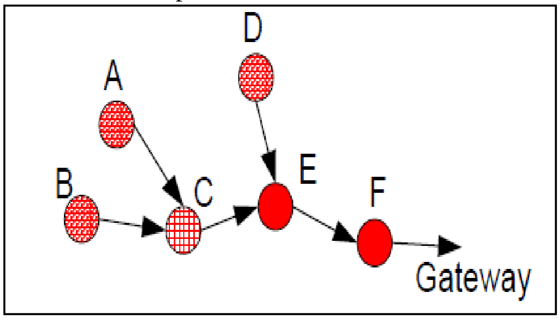


Fig. 5: Data aggregation Example

The main objective is to build a Hardware platform and generic Software Solutions to serve for research in WSN protocols. Components of Sensor Network: Smart Sensor Nodes and Gateway. Gateway and Smart nodes are members of piconets and so, not more than 7 nodes can exist in the network. For implementation of Sensor as Bluetooth Node, following components are important:

– Bluetooth Device
– Sensors, Microcontroller

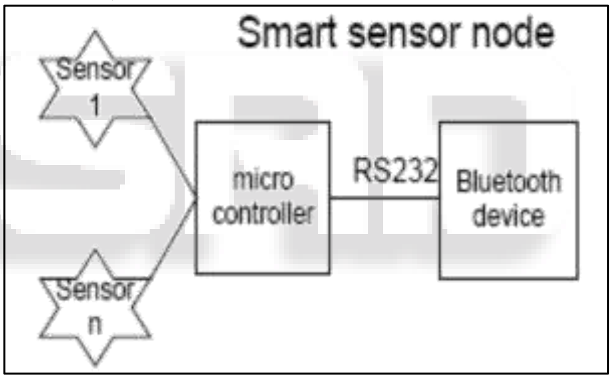


Fig. 6:

Complete software functionality is developed in java, It can be implemented by the use of either bluetooth PCMCIA CARD or using infrared connection. Java community undertook the first effort towards bluetooth stack API application Ex-JSR-82 JABWT

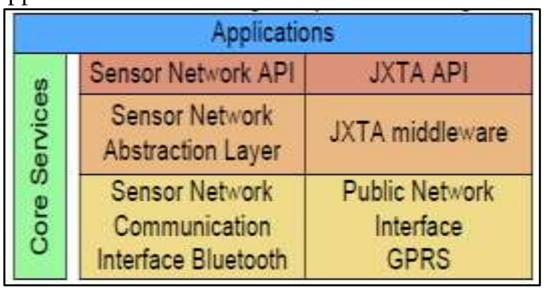


Fig. 7: The Architecture of the implemented gateway

A. *Discovery of smart sensor nodes:*

After installation, the primary step during execution is to discover the smart sensor nodes in the area. which is to prepare a list of sensor's characteristics and network topology. Next in execution process, provision is to have addition of new or removal of existing sensors.

B. Communication with smart sensor nodes:

Initialization of gateway and Bluetooth Inquiry Procedure. Discovery of Bluetooth device and Checking of major and minor devices. Setting of parameters and assigning type of devices and sensors. Description by Service-Class Field. Discarding of non-smart nodes. Else, service database of the discovered smart node is searched for sensor services. If no current sensor profile, then database is searched for serial port connection parameters. Lastly, Bluetooth link is established and data exchange with smart node starts. Recent studies are presented [3-9].

V. Conclusion

Wireless sensor networks are an interesting research area with many possible applications. They are based on collaborative effort of many small devices capable of communicating and processing data. There are still many open issues ranging from the choice of physical and MAC layer to design of routing and application level protocols.

Bluetooth is a possible choice for data communication in sensor networks. Good throughput, low-power, low-cost, standardized specification and hardware availability are Bluetooth advantages, while slow connection establishment and lack of scatternet support are some of the deficiencies. An initial implementation of a Bluetooth based sensor network platform is presented. Implemented functionality and various problems experienced during the implementation are described. Implemented platform presents a good environment for further research and development of sensor network protocols and algorithms.

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