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Implementation of LEACH protocol in Wireless Sensor Node Using PSoC

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Abstract: A large number of small tiny device called sensor nodes are use to develop wireless sensor network that can be effectively used as a tool for monitor physical or environmental conditions, such as temperature, sound, vibration, pressure and motion at different locations. There are two major issues, one is energy-efficient routing protocol and other is overall lifetime of the sensor network. This project focuses on reducing the power consumption and increase overall life of a wireless sensor networks. Therefore, first energy efficient routing protocol named LEACH (Low-Energy Adaptive Clustering Hierarchy) has been used. For developing any wireless sensor node which also consists of radio and processor so we are using CyFi low power RF module and PSoC respectively. In this paper we are taking the features of CyFi radio and LEACH protocols, and by using NS2 simulator we tried to come up with the experimental result that shows this LEACH protocol analyse in terms of network lifetime and power consumption minimization.

Keywords: LEACH, PSoC, Radio, WSN.

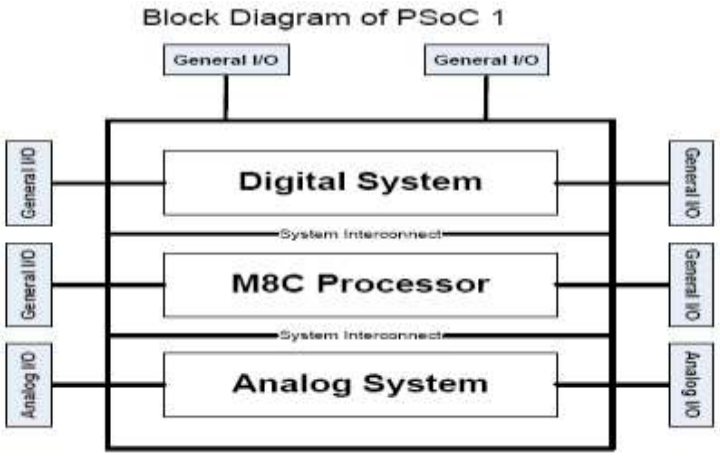
I. INTRODUCTION

In the past few years, the field of wireless sensor networks has become a key area of research. Sensor networks find applications in several military as well as civilian domains. The field of wireless sensor network is receiving a lot of attention, and is evolving very fast. Therefore our aim to is to make these nodes as energy-efficient as possible and rely on their large numbers to obtain high quality results. Sensor networks have attracted wide attention over the years due to their utility in monitoring a wide variety of physical phenomena, often remotely. A wireless sensor network consists of spatially distributed sensor nodes to monitor physical or environmental condition such as temperature, humidity etc. The nodes communicate among themselves using a specified wireless routing protocol. Therefore we have taken a developed the economical wireless sensor node which contain the advantages of the CYRF7936 CyFi™ transceiver is a radio IC designed for low power embedded wireless applications. It can be used only with Cypress's PSoC, programmable system-on-chip. Combined with the PSoC and a CyFi network protocol stack, CYRF7936 can be used to implement a complete CyFi wireless system. Network protocols must be used to achieve fault tolerance in the presence of individual node failure while minimizing energy consumption. Eventually, the data being sensed by the nodes in the network must be transmitted to a control center or base station, where the end-user can access the data. There are many possible models for these sensor networks. Thus, communication between the sensor nodes and the base station is expensive, and there are no "high energy" nodes through which communication can proceed. So nodes communicate among themselves using a specified protocol. In this paper we are trying to examine the suitability of PSoC as a sensor node to set up a wireless sensor network. After a brief introduction of PSoC architecture ,it is shown how CYFISPI user module (a part of PSoC Designer software) along with CYFI transceiver (CYRF7936) RF module can be configured to act as sensor node to both transmit and receive the data. A few such nodes have been used to build a sensor network and functionality has been tested with LEACH protocol.

II. DESCRIPTION OF PSoC

A. PSoC Architecture

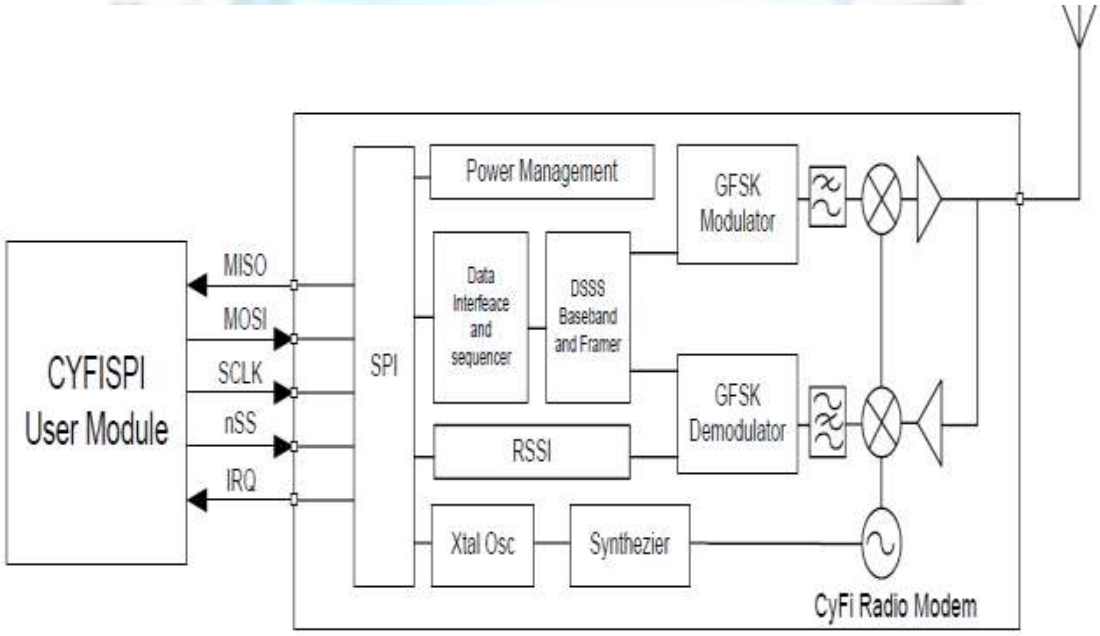
PSoC is a reconfigurable, embedded, mixed signal system on chip from Cypress Semiconductor. PSoC architecture is described [2].



The PSoC 1 core includes: The M8C MCU, Flash memory, SRAM, Sleep and watchdog timers, Multiple clock sources that include a PLL, Internal main and low-speed oscillator, External crystal oscillator for precision, programmable clocking. PSoC 1 devices can have up to two multiply–accumulate modules (MACs), which provide fast 8-bit multipliers or fast 8-bit multipliers with 32-bit accumulate, up to two decimators for digital signal processing applications, I²C functionality for implementing either I²C slave or master, and availability of a full-speed USB interface [1].

B. RF module in PSoC

The CyFi (radio frequency) module is low cost device targeted and designed for low power embedded wireless application.



The CYRF7936 contains a 2.4-GHz CyFi radio modem, which features a 1-Mbps GFSK radio front-end, packet data buffering, packet framer, DSSS baseband controller, and RSSI.CYRF7936 features a SPI interface for data transfer and device configuration.

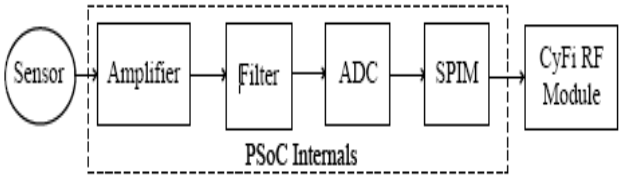
B.1 CyFiSPI User Module and its Application Programming Interfaces (APIs)

In PSoC to develop any application, pre-characterized analog and digital peripherals are dragged-and-dropped within the PSoC designer software development environment. In order to use the RF module, the CyFiSPI user module is placed. CYFISPI user module takes input as MISO (Master in Slave output) and provides MOSI (Master out Slave input) output which acts as input to RF SPI. These MOSI and MISO are used for data transfer (serial single byte or multiple bytes) between an application microcontroller unit (MCU) acting as a master and RF acting as a slave. The other inputs such as nSS (negative slave select) is

an active low pin used to select the slave device and SCLK is synchronous clock to RF which runs at half the crystal frequency. After receiving the data from SPI the baseband performs DSSS spreading/dispreading, adds headers like SOP (Start of Packets), length and 16-bit CRC (Cyclic Redundancy Check) which are then transmitted by radio modem. The baseband can be configured to automatically transmit Acknowledge (ACK) packets whenever a valid packet is received indicating successful transmission and reception of data. In an application, if a data rate of 1Mbps is required then GFSK (Gaussian Frequency-Shift Keying) is used. Communication is successful if channel is free from noise and has good signal strength. CYFI RF has RSSI (Receive Signal Strength Indicator) which automatically measures and stores (as five bit value) the relative signal strength when an SOP is detected in receive mode. Channel is changed if RSSI level falls below the threshold value.

B.2 PSoC as a Sensor Node

A conventional microcontroller needs to be interfaced with external analog circuits and sensors to build a sensor node. But as described earlier, PSoC consists of built-in analog and digital blocks and thus no external components would be required excepting for sensors.



For example, as shown in above figure 2 above, all signal processing related to sensor output can be done within the PSoC. Also, Serial Peripheral Interconnect Master (SPIM) can be used as the master block to control CyFiSPI.

C. LEACH Protocol

The basic objective on any routing protocol is to make the network useful and efficient. A cluster based routing protocol groups sensor nodes where each group of nodes has a CH or a gateway. Sensed data is sent to the CH rather than send it to the BS, CH performs some aggregation function on data it receives then send it to the BS where these data is needed.

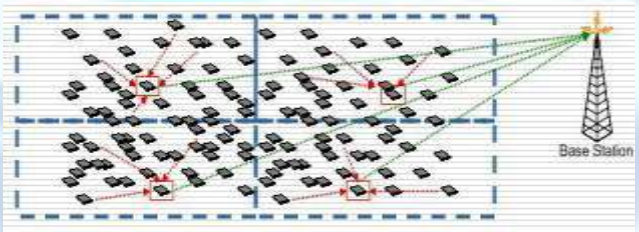


Fig. 1: Clustering

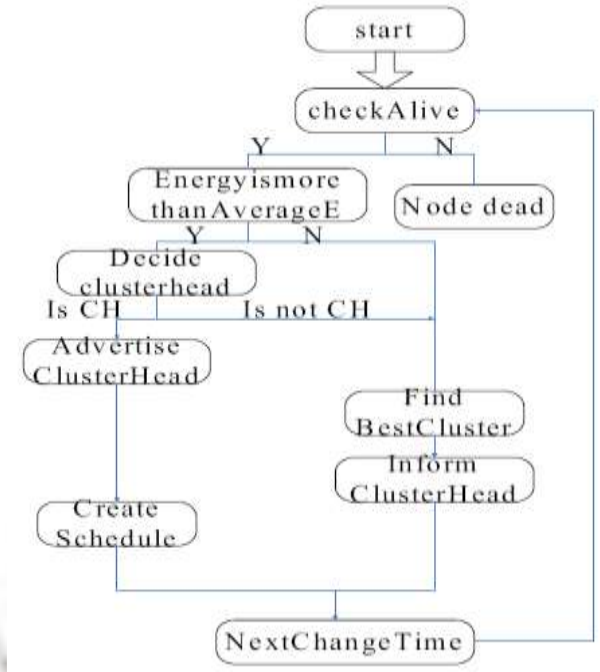
This protocol is divided into rounds; each round consists of two phases;

Set-up Phase
(1) Advertisement Phase
(2) Cluster Set-up Phase

Steady Phase
(1) Schedule Creation
(2) Data Transmission

C.1 Set-up Phase:

Each node decides independent of other nodes if it will become a CH or not. This decision takes into account when the node served as a CH for the last time (the node that hasn't been a CH for long time is more likely to elect itself than nodes that have been a CH recently). In the following advertisement phase, the CHs inform their neighborhood with an advertisement packet that they become CHs. Non-CH nodes pick the advertisement packet with the strongest received signal strength. In the next cluster setup phase, the member nodes inform the CH that they become a member to that cluster with "join packet" contains their IDs using CSMA. After the cluster-setup sub phase, the CH knows the number of member nodes and their IDs. Based on all messages received within the cluster, the CH creates a TDMA schedule, pick a CSMA code randomly, and broadcast the TDMA table to cluster members. After that steady-state phase begins [3].



C.2 Steady-state phase:

Data transmission begins; Nodes send their data during their allocated TDMA slot to the CH. This transmission uses a minimal amount of energy (chosen based on the received strength of the CH advertisement). The radio of each non-CH node can be turned off until the nodes allocated TDMA slot, thus minimizing energy dissipation in these nodes. When all the data has been received, the CH aggregate these data and send it to the BS. LEACH is able to perform local aggregation of data in each cluster to reduce the amount of data that transmitted to the base station. Although LEACH protocol acts in a good manner, it suffers from many drawbacks such like;

- CH selection is randomly, that does not take into account energy consumption.
- It can't cover a large area.
- CHs are not uniformly distributed; where CHs can be located at the edges of the cluster.

III. CONCLUSION

Till now we have simulated the leach protocol using NS-2 and we would be modifying the leach protocol by adding some key features of CyFi in it, Also we would try to deploy that on WSN.

IV. ACKNOWLEDGMENT

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