Development and Implementation of Internet-of-Things Framework

Arpit Neema, Vaskar Raychoudhury
Department of Computer Science & Engineering
भारतीय प्रौद्योगिकी संस्थान रूड़की
Indian Institute of Technology Roorkee

Introduction

➢Internet-of-Things (IoT) is an interconnection of smart objects. It has huge number of potential applications
➢IoT is driven by innumerable sensing devices. So the amount of data generated will be in Petabytes
➢To handle this massive amount of data, an aggregation algorithm for devices in IoT is needed
➢Data aggregation aims to combine and summarize data packets of several sources so that amount of data transmission and data redundancy is reduced and as a result, battery life of energy constrained devices is increased

Research Objectives

➢Investigate important applications of Internet-of-Things, and identify the requirements with challenging issues for developing such a platform
➢Design a framework for IoT so that physical objects can be searched in real time
➢Develop such system using data aggregation to optimize the overall performance
➢Develop a prototype with applications for the demonstration and critically analyze those applications for a deeper understanding of the Internet-of Things paradigm

Work Done so Far

System Architecture

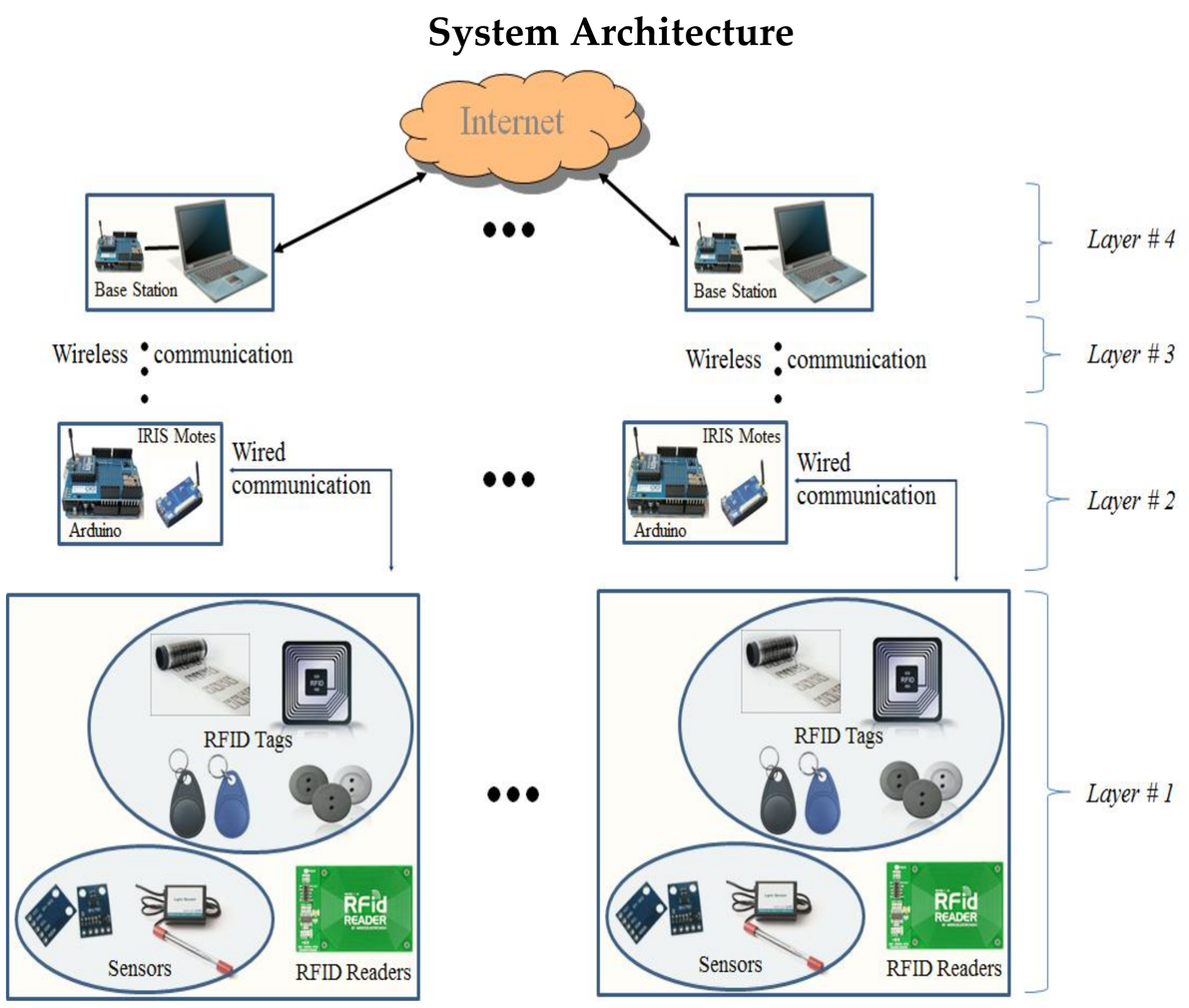


Figure #1:System Architecture

➢This is a hierarchical system
➢Layer 1 consists of objects embedded with RFID Tags, sensors, RFID readers
➢Layer 2 consists of Arduino boards with wireless capability
➢Layer 3 is the one which consists of intermediate nodes. These nodes perform the aggregation task
➢Layer 4 consists of the base station, the node which is connected with the PC and the PC itself
➢Arduino boards and iris motes communicate wirelessly using ZigBee protocol
➢RFID readers connected with arduino boards reads the tags connected with objects in the vicinity & sends this reading to the layer 1 node
➢Hence the physical location of any objected embedded with tag, can be detected
➢Aggregation protocol is used in the system to reduce transmissions redundancy
➢Lights sensors, temperature sensors, force sensors are also connected with Arduino boards to tell physical environmental characteristics
➢The system can also detect some event, activity or action based on the object location, sensor readings and the inference rules
➢The system can communicate with the internet
➢It can be operated from anywhere via internet using a smart phone

Functional Diagram of the System

➢Figure 2 depicts the functional diagram of the system
➢Hardware Layer deals with the communication of various sensors and tags with the Arduino board
➢The second layer multi-hop communication deals with communication between various Arduino boards and iris motes
➢This layer is the fundamental and the most important layer
➢Then aggregation protocol is used over it to reduce the transmission and data redundancy
➢Physical object searching takes place using the below layers' functionalities
➢Above this system various application scenarios can be developed

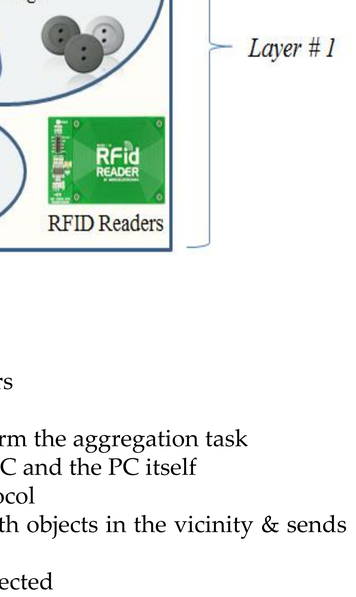


Figure #2: The Functional Diagram

Multi Hop Communication

➢Have completed the work of bottom two layers of the functional diagram
➢The layer 1 entities the RFID reader sense the tags in their vicinity and send the tag ids to the layer 2 nodes
➢Other sensors which are also layer 1 entities send their readings to layer 2 nodes
➢The layer 2 nodes send this data to base station doing multi-hop communication
➢This is very important step since all nodes can not be in direct range of the base station
➢So data is sent from the layer 2 nodes to the base station via multiple intermediate nodes
➢This is the basic building block of the architecture over which other functionalities of the system will be established

Tools, Devices and Platforms Used

Arduino Board

➢It is a single board microcontroller based on ATMega328
➢It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button

Iris Mote

➢It has IEEE 802.15.4/Zig-bee compliant RF transceivers for wireless communication.
➢The transmission speed: *250 kbps*, RAM: 8KB, Ash memory: 128KB
➢Can work as router for wireless communication

MTS 400 Sensor

➢Offers five basic environmental sensors
➢Also has a gps module

RFID Reader

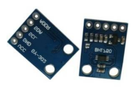
➢It's a low range RFID reader module which has 5 pins
➢It can connect with an Arduino board and can give the RFID tag value of a tag in its vicinity

Xbee Radio Module

➢Xbee is a radio module, which uses IEEE 802.15.4 protocol
➢Can be used as a wireless communication medium between two Arduino boards
➢ It has pins for vcc, ground, data in, data out and reset

Xbee Wireless Shield

➢Act as interface between an Arduino board and an Xbee radio
➢Can be used as a serial/usb replacement



Light Intensity Sensor

➢It's a low power light intensity sensor
➢It can give the light intensity reading between 0 to 1000 where 0 represents complete darkness

RFID Tag

➢Small barcode which can be easily attached with any object to track its location
➢They have a 15 digit tag value which can be easily read by a RFID reader

Along with these some other tools and platform were also used
➢nesC
➢Arduino IDE
➢Tiny OS
➢Processing

Future Work

Aggregation Protocol
➢An efficient aggregation algorithm is to be proposed. It has to be very efficient and should take into consideration that IoT devices are energy constrained
➢It should consider the heterogeneity of the system, the security and privacy aspects, computation complexity and other resource optimization issues

Defining Inference Rules
➢The System will be able to detect events, action or activity after getting the readings from various sensors
➢To perform this task inference rules like "if this and this and this or this.. then this" have to be defined
➢Rules have to be such that they make the correct the inference out of the given situation

Implementation
➢The implementation of aggregation protocol over the system developed uptill now
➢The decision making logic based on inference rules

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