Exchanging of Information between Cloud Computing Server and Sensor Node for Effective Application Development

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ABSTRACT
Cloud computing is now becoming very popular in today's business world. The small businesses which are not capable of bringing in the new technology due to the shortage of fund, they can easily get their services from cloud computing in exchange of nominal charges. In this paper I have tried to extend the facilities of cloud computing to sensor networks.

The sensor node has limited processing capacity and memory. So if some tasks from the sensor nodes can be uploaded to the server of cloud computing then the battery life of the sensor nodes can be extended. The cloud computing can be used both for processing of aggregate query and storage of data. The cloud service provider can use different sensor network at different time to create new service. For establishment of the shortest path between sensor networks and cloud servers, ant colony optimization technique is used. Determination of shortest path facilitates efficient query processing and data storage. In case of any failure of sensor nodes or server nodes, alternative path can be selected for faster response time, compromising the shortest distance for the time being, and then ant colony optimization technique can be used again to find the shortest path.

Keywords
Sensor nodes, ant colony optimization technique, cloud service provider, cloud service

1. INTRODUCTION
The sensor network consists of sensor nodes with a short-range radio. The sensor node typically contains signal-processing circuits, microcontroller and wireless transmitter/ receiver antenna and is characterized by limited resources: low memory, reduced battery power and limited processing capability [1]. Similar to popularity of sensor network, another application area is now a buzz word and that is cloud computing. The cloud service providers are catering many services to their clients; the basic services provided by them are like Platform as a Service, Software as a Service, Infrastructure as a Service. Clouds storage involves delivery of data storage as a service, including database service.

Now if these two areas can be merged together, both can be benefited from each other. For example uploading of sensor data to the servers of cloud service providers will allow new applications and services in combination with significantly increased number of network users to create new traffic patterns and will put new requirements on the underlying networks. This is particularly significant for wireless networks where radio resources are limited and where networks are not currently designed for such scenarios, new applications and services can be provided to sensor nodes.

Different applications may require data from the same sensor networks. To avoid multiple end-to-end network data exchange, we see a need for an intermediary entity. The entities will take care of interaction with individual sensor networks on one side, caching data for certain period of time to minimize network using network resources and can also answer to spatial query. On the other hand in some scenarios, like community and social networks, the sensor owners might be willing to bear that cost in return for the access to the community/ social network applications as well as easing their process of query execution.

Commercial sensor application providers could deploy their own sensor networks and basically create a closed business system.

Although feasible, with the mass deployment of sensors we see a need to provide mechanisms and incentives to everyone to contribute the information they have to ensure as large coverage and diversity of information possible. The cloud service providers will in such a scenario use different sensor networks at different times to create new services [5].

The following paper is organized as follows. In section 2 the related work in the field of sensor network for efficient query execution is discussed. In section 3, I have discussed about a new approach where the benefits of cloud computing and sensor network can be merged with the help of ant colony optimization. The way to handle failure in the proposed model is discusses in section 4. Finally the paper is concluded in section 5.

2. RELATED WORKS
In sensor network, the nodes can coordinate to perform distributed sensing of environmental phenomena. In the paper "Directed Diffusion for Wireless Sensor Network", Govindan, Intanagonwiwat, Estrin, Heidemann and Silva

[8] has discussed about directed diffusion, where all nodes here are application aware, which enables diffusion to achieve energy savings by selecting empirically good path and by processing data in network i.e data aggregation.

"Link Reversal Routing" by Miia Vainio [9] has also proposed the routing protocol that can be used in ad hoc networks which saves power and be scalable and adaptive. This routing algorithm tries to localize the effect of topology change and react when necessary.

In the paper "Connected Sensor Cover: Self Organization of sensor networks for efficient query execution" by Himangshu Gupta, Samir Das and Quinyi Gu [1], a self organization of a sensor network is discussed to reduce energy consumption.

The above papers have tried to solve the problem by devising new algorithm within the sensor network itself, but in this paper I tried to integrate sensor network with cloud computing, and using an efficient ant colony optimization technique to find the shortest path between the sensor node and cloud server node. So that all the data from the sensor node can be uploaded to nearby cloud server, and if necessary efficient query execution is done when required by sensor nodes, this relieves the burden of the sensor nodes to some extent, and at the same time helps the sensor nodes user to get a flavor of applications which would otherwise be impossible for the sensor nodes to execute on its own, i.e. the types of application which may involve a lot of processing power and lots of memory requirements.

3. PROBLEM DISCUSSION

For every sensor node connected to the cloud service provider, one has to ensure that the data are traveling to the cloud service provider server at the shortest distance and also the answer to aggregate query from the sensor nodes. For satisfying both the above criteria, the data have to travel through the shortest path because the limited battery power of the sensor nodes and also the response time of the cloud server have to be taken into consideration, because the latter has to satisfy a large number of clients. In this paper finding out the shortest path between one such sensor network and cloud server of the cloud service provider is discussed and this assumption can be extended to all sensor networks connected to the cloud server.

Each sensor nodes has an associated sensing region around it, if two sensor nodes are at a minimum distance of **'d'** apart then they are assumed to be in same sensing region. For convenience we assume the sensing region to be circular. The sensor nodes in the close vicinity are assumed to be in the same circle. Here total of number of sensor nodes belonging to different sensing region is '**n-1**'.

The problem proceeds as follows:

In this case the destination for all sensor nodes is fixed, it is the cloud server (for convenience the cloud service provider server will be called cloud server). Here for simplification purpose, the cloud server is also assumed to be one of the nodes i.e. the n^{th} node. Any source node out of n sensor nodes can initiate the process of finding the shortest path. We assume a source node **'s'** within the sensing region initiates ant **'k'** to find the route to the destination. Each sensing node maintains a routing table containing node ID, the amount of pheromone deposit and heuristic information.

The source node selects the neighbor r within or across its sensing region with the probability

$$P_K(r,s) = \begin{cases} \frac{[\tau(r,s)]^{\propto}[E(r,s)]^{\beta}}{\sum_{r\in R}[\tau(r,s)]^{\propto}[E(r,s)]^{\beta}} & if\ k\ not\ in\ table_r \\ 0 & otherwise \end{cases}$$

……… (1)

Where $P_K(r,s)$ is the probability with which ant k choose to move from node r to node s [4], where ***table$_r$*** is the routing table containing the sensor node identification, pheromone value and heuristic value respectively.

τ (r, s) is pheromone value, the heuristic value E(r, s) is related to energy, α and β are the control parameters that control the relative weights of pheromone trail and heuristic value. The heuristic value energy E(r, s) of each sensor node is determined by the following equation

$$\frac{(1-e_r)^{-1}}{\sum_{r\in m} {}^{1}/_{(1-e_r)}}$$

………(2)

After all ants (we have assumed here m ants) have completed their tour, the updating process starts. The updating of pheromone involves two components, first is to reduce the trail value by a constant factor ρ and then to add an increment based on length of k^{th} ant's tour:

$$\tau(t+1) = (1-\rho)\tau_{rs}\ (t) + \sum_{k=1}^{m} \Delta\tau_{rs}^{k}\ (t) \quad \forall(r,s)$$

……..(3)

where

$$\Delta\tau_{rs}^{k}(t) = \frac{1}{l^k\ (t)}$$

..……. (4)

where $l^k(t)$ is the length of tour for ant k [4].

Each ant k contains in its memory the sensor node identification number through which it is traversing. This is applicable for all m ants. So after updation of the pheromone value, the latest value reaches the n^{th} node which in our case is the cloud server. The cloud server stores this updated path value, so that after computation of the query it can send the result to the desired sensor, and also exchange information with other sensor nodes along the path sensor.

4. HANDLING OF FAILURE IN SENSOR NODES

4.1 If any of the sensor nodes fails:

i) If a node 'r' fails, the source node '**s'** will consult the routing table and send a message to all the active nodes (according to figure 1, node 'p' and 'q'). The message will contain the information that whether any of these nodes (excluding the nodes already in the path) has a connection to the destination node 't' and set a timer (figure 1).

Other nodes upon receiving this message, will send their reply containing the information regarding the path to sensor node t (along with their identification number, heuristic value, pheromone value) to the source node s, and update the failure of sensor node r in their routing table.

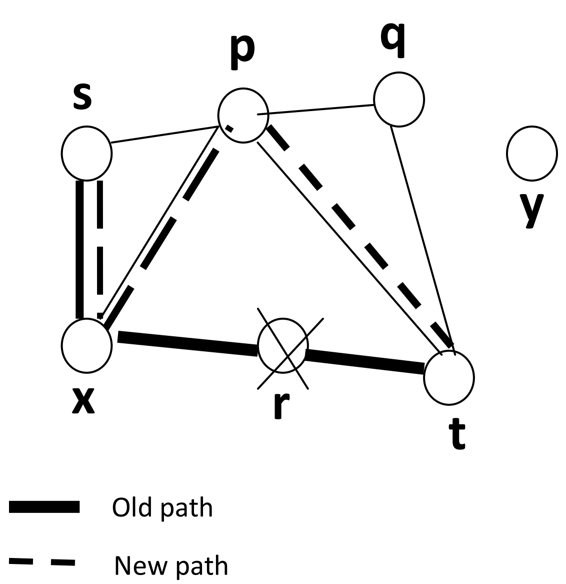

Fig 1: Setting the new path from source to destination node after the failure of a sensor node (other than the cloud server node)

ii) Node s upon receiving the path to the t from more than one node (in our example p and q), will determine the node whose pheromone deposit is maximum.

iii) The node s will update this entry in the routing table, and inform other nodes on the path about the new node and its pheromone value and heuristic value.

iv) If there is a timeout, within which the source node s fail to receive the reply the message will be is resent.

The above algorithm may not find the shortest path all the time for exchanging the information and response to spatial query, but it helps in exchanging the data where response time is crucial. As periodically ant colony optimization has to be run to take care of the addition and deletion of sensor nodes, automatically the shortest path will be followed most of the time.

4.2 If the cloud server (n^{th} node) fails:

If for some reason the cloud server is down, any standard routing protocol can be used to bypass the failed server and bring in the backup server. And once the backup server is in its place ant colony optimization technique can be run again with new server as node n.

5. CONCLUSION

In this paper I have tried to discuss about the integration of cloud computing with sensor network, which not only helps the sensor nodes for efficient query processing and storing of data, but at the same time it allows the exchange of business information between the networks, thereby helping the sensor nodes users in getting more services than it can be provided by the sensor network alone. Some of the applications which need a substantial amount of resources to run cannot be implemented well in sensor networks, though the result of such application development may be necessary to the sensor networks user. Cloud computing will help in providing this service in exchange of minimal charges. Similarly the cloud computing service provider can use much functionality of sensor networks, which will help to cater to both the wired and wireless network functionality to clients; in return they can charge a substantial amount of money which will give them an economic advantage.

6. REFERENCES

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