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Reliable Data Transmission to Mobile Cloud Computing From Wireless Sensor Network

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Abstract : *The combination of ubiquitous wireless sensor Network (W.S.N.) and powerful mobile cloud computing M.C.C. is an investigation topic that is fascinating growing attention in both academic and usefulness. In this new example, WSN delivers data to the cloud and moveable users demand data from the cloud. To provision applications involving W.S.N.-M.C.C. combination, which need to dependably offer data that are more useful to the moveable users from W.S.N. to cloud, this paper first recognizes the critical problems that disturb the helpfulness of sensory data and the dependability of W.S.N., then suggests a novel W.S.N.-M.C.C. integration scheme called T.P.S.S., which contains of 2 main parts: 1) time & priority based selective data transmission T.P.S.D.T. for W.S.N. gateway to selectively transfer sensory data that are more valuable to the cloud, seeing the time and priority features of the data demanded by the mobile user and 2)PSS algorithm which is priority based sleep scheduling algorithm for W.S.N. to save energy depletion so that it can gather and transmit data in a More trustworthy way. Diagnostic and investigational results demonstrate the efficiency of T.P.S.S. in improving usefulness of sensory data and reliability of W.S.N. for W.S.N.-M.C.C. integration.*

Keywords: *WSN: Wireless Sensor Network, MCC: Mobile Cloud Computing*

I. Introduction

Wireless sensor network (W.S.N.) is a distributed network, containing of independent sensors that supportively monitor the physical or ecological conditions (e.g., sound, temperature, humidity, shaking, etc.).[1]-[3] With the pervasive data gathering ability of sensors, W.S.N. has great prospective to enable a lot of substantial applications in numerous areas of industry, resident and military (e.g., industrial process observing, forest fire detection, battleground surveillance, etc.) which could alter how people get connected with the physical world. A good example is forest fire discovery by deploying a large no. of dispersed sensors into the forest to continuously monitor high temperature, moisture and gases, forest fire could be sensed in a well-timed manner and how a fire is 84 probable to spread out could be strong-minded, without the physical remark from employees on the ground.

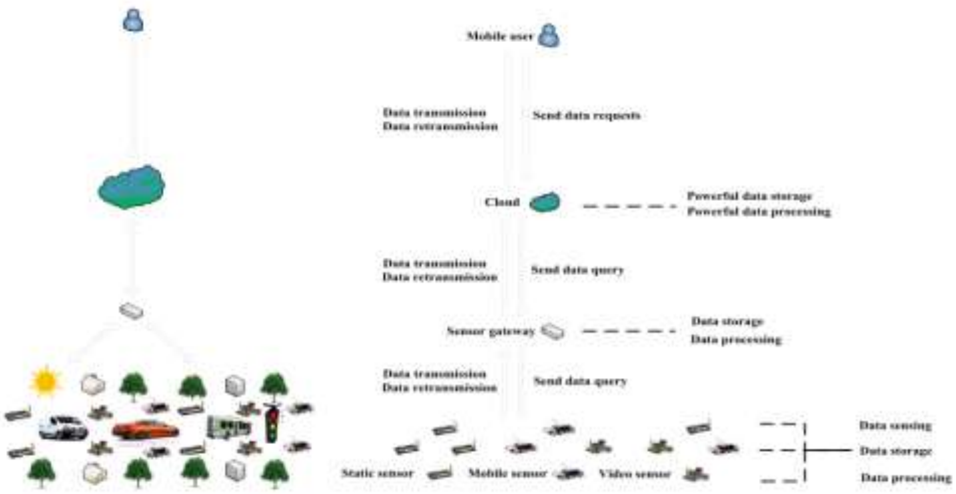

Fig 1: Existing System Architecture

Furthermore, congenital from cloud computing (C.C.), which is a new computing example enabling users to elastically consume a shared pool of cloud resources (e.g., processors, storages, applications, services) in an on-demand fashion, mobile C.C. (M.C.C.) further transfers the data storage and data processing tasks from the mobile devices to the powerful cloud.[4]-[6] Thus, M.C.C. not only eases the limitations (e.g., battery, processing power, storage capacity) of mobile devices but also improves the performance of a lot of outdated mobile (e.g., mobile learning, mobile gaming, and mobile health). For example, mobile gaming can exploit M.C.C. to change the game engine that requires considerable computing resources (e.g., graphic rendering) from mobile devices to great servers in the cloud to significantly reduce the vigor usage of the mobile devices and increase the gaming performance (e.g., sound effect, image definition, refresh rate). Lately, motivated by the potentials of supplementing the pervasive data gathering capabilities of W.S.N. with the influential data storage and data processing capabilities of M.C.C., the integration of W.S.N. and M.C.C. is fascinating increasing attention from both academia and industry. Particularly, as illustrated in Fig. 1 about the general scheme (G.S.) to gather and transmit sensory data for W.S.N-M.C.C. integration, the sensory data (e.g., traffic, humidity, weather, house monitoring information) collected by various types of always on sensors (e.g., mobile sensors, static sensors, video sensors,) after data processing, data storage and, data sensing are transferred first to the W.S.N. gateway in a hop-by-hop manner. The gateway then moreover stores, processes and transfers the received sensory data to the cloud. Lastly, the cloud stocks, processes and transfers the sensory data to mobile user's on-demand. During the whole data communication process, if the data communications to the gateway from the sensor nodes or to the cloud from the gateway or to the mobile user from the cloud are not successful, data are retransmitted till they are successfully transported.

For this new W.S.N.-M.C.C. combination paradigm, the W.S.N. acts as the data source for the cloud and mobile users are the data supplicants for the cloud. With just a modest client on their mobile devices, mobile users can have access to their required sensory data from the cloud, wherever and whenever there is network communication. Evolving as the concept of ``sensor cloud", the integrated W.S.N.-M.C.C. is an substructure that allows truly pervasive calculation using sensors as an interaction between cyber and physical worlds, the data compute clusters as the cyber backbone and the internet as the communication media"[7], [8].
And consequently reports any event to a location aware cloud service in real time. In case of an interruption event, another cloud service alerts the user with a S.M.S. conversation of mobile users, C.L.S.S. dynamically controls the awake or asleep status of each sensor node to decrease energy consumption of the combined W.S.N.

II. Related Work

There are a several workings associated to W.S.N.-M.C.C. integration. They mainly focus on the following two aspects:
1) Improvising the performance of W.S.N., and
2) Making Better use of the data collected by the W.S.N.
Specifically, with respect to:
1) Improving the performance of W.S.N. with W.S.N.-M.C.C. combination, it is claimed in [9] that the integration of W.S.N. and M.C.C. is able to provision the dynamic loads that are produced by environmental W.S.N. applications. It is illustrated in that the combination of W.S.N. and M.C.C. could address the challenge of data organization in W.S.N. for patient supervision. Moreover, it is recommended in that the cloud could possibly improve the visualization performance of a W.S.N. for living environments. A cooperative location based sleep scheduling procedure is proposed in to increase the network lifetime performance of the combined W.S.N. This algorithm addresses the WSN dependability issue to some extent by increasing the network life. Nevertheless, the helpfulness of sensory data is not considered. In addition, about 2) better utilizing the data collected by the WSN with WSN-MCC integration, the focus of [10] is to propose a framework to utilize the ever-expanding sensory data for various next generation community-centric sensing applications on the cloud. Similarly, the motivation of [11] to facilitate the shift of data from the WSN to the cloud computing environment so that the scientifically and economically valuable W.S.N. data may be fully used. Furthermore, cloud design for user-controlled storing and processing of sensory data is planned in [12] to make data owners trust that the management of the sensitive data is secure. Finally, [13] puts forward a framework providing desirable sensory data to users faster with data analysis techniques, so that the sensory data could be better utilized with cloud computing.

To the best of our knowledge, currently there is no research work focusing jointly on issues about the usefulness of sensory data and reliability of W.S.N. in W.S.N.-M.C.C. integration. Our proposed TPSS is the first work that considers together the usefulness of sensory data and reliability of WSN for WSN-MCC integration. Particularly, TPSS incorporates TPSDT and PSS to improve both the usefulness of sensory data and reliability of WSN.

III. System Architecture

Fig 2 shows the proposed T.P.S.S. scheme to collect and transmit sensory data for W.S.N.-M.C.C. integration, towards reliably offering data which are more valuable to the mobile users from W.S.N. to cloud. The thorough steps of T.P.S.S. for each W.S.N. to gather and transmit sensory data for each corresponding mobile user are depicted as follows.

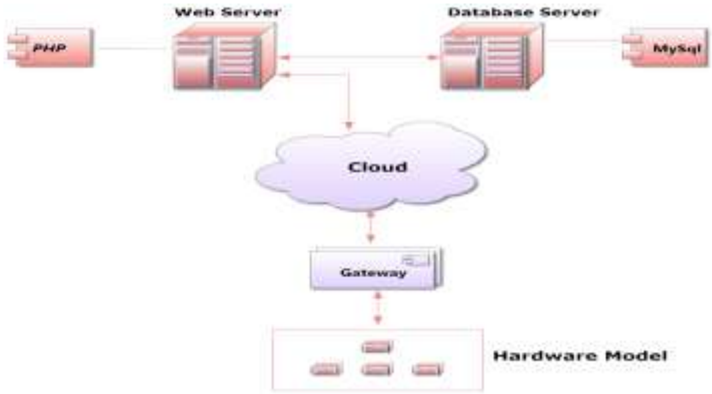

Fig 2: Proposed System Architecture

1) Sensor nodes govern their awake and asleep states with P.S.S.
2) Sensor nodes sense the environmental data with a fixed frequency and stock the sensory data plus process the sensory data.
3) Sensor nodes send the managed sensory data to the gateway '*g*' with the hop-by-hop many to one and pattern.
4) Gateway '*g*' stores the acknowledged sensory data and then manipulates the sensory data.
5) Gateway *g* selectively transmits the sensory data to the cloud *C* with TPSDT.
6) Cloud *C* additional stores and processes the received sensory data.
7) If data transmission from *i* to *g* or *g* to *C* practices data losses or failures, *i* or *g* performs data retransmission until the data broadcast is positive.
8) Mobile user *u* concerns data requests to cloud *C* and cloud *C* transfers the demanded sensory data to the mobile user '*u*'.
9) If data communication from *C* to *u* meets data losses or failures, *C* implements data retransmission till the data communication is successful.
10) Cloud *C* vigorously updates the P.T.P. table with equation (1) if the priority and time features of the demanded data of the mobile user are changed and sends the updated P.T.P. table to gateway in each time period

3.1 Scheme Characteristics And Analysis

Relating Fig. 1 and Fig. 2, based on the above introductions, we can see that our proposed T.P.S.S. shares the similar technique with G.S. (i.e. data retransmission) to mitigate data transmission losses or failures in sensory data transmissions for improving the dependability of W.S.N. during W.S.N.-M.C.C. combination.
In addition, we can detect that T.P.S.S. varies from G.S. to collect and transmit sensory data for W.S.N.-M.C.C. integration, with respect to the following two aspects.

3.1.1 Tpsdt For Wsn Gateway

In our suggested T.P.S.S., the gateway *g* selectively transmits the sensory data to the cloud *C* with T.P.S.D.T. This design is to enhance the effectiveness of sensory data, since TPSDT data transmission is based on the P.T.P. table inferred from the time and priority features of the data requested by the mobile user. Thus, generally the successfully transmitted sensory data to the cloud will all be utilized to answer mobile user data requests. In the case that the mobile user *u* concerns data requests for sensory data currently not stored in the cloud *C* in the time period *t* , as the P.T.P. table is dynamically updated with equation (1) if the time and priority features of the demanded data of the mobile user are altered in *t* (Step 10 of the T.P.S.S.), running the P.S.S. algorithm with the upgraded P.T.P. table in *t* makes the sensor nodes from which mobile user requires data awake (property 1 of PSS).That means, the cloud is capable of replying the unexpected data requests by dynamically updating PTP table. Furthermore, as the sensory data are selectively transmitted from W.S.N. gateway to the cloud with T.P.S.D.T., the bandwidth requisite and network bottleneck are reduced meanwhile.

This can also improve the reliability of W.S.N., as it eases the data communication loss failure or loss problem to some extent.

3.1.2 P. S. S. For W. S. N.

In our proposed T.P.S.S., the sensor nodes dynamically conclude their awake and asleep states according to P.S.S This design can greatly improve the reliability of W.S.N., Subsequently P.S.S. can greatly save the energy ingesting and prolong the network lifetime (property 3 of PSS) so that W.S.N. can collect and transmit data longer. Specially, when sensors normally work for a certain period of time, the energy of the sensors will be consumed quickly and sensor nodes will die and cannot work anymore. With P.S.S., sensor nodes are vigorously asleep and awake and only a subset of sensor nodes with more remaining energy are obligatory to be awake in each time period, this will greatly improve the sensory energy reduction issue that seriously shakes the reliability of W.S.N. and the life of W.S.N. will be greatly improved.

Algorithm 1 Pseudocode of PSS Algorithm

First: Run the following at gateway g during each time period t.

Step 1: Gateway g obtains PTP table.
Step 2: If $p_i^t > 0$, g sends flag A to node i.
Step 3: Run the second part at each node i.

Second: Run the following at each node i during each time period t.

Step 1: Get the current residual energy rank e_i.
Step 2: Broadcast e_i and receive the energy ranks of its currently awake neighbors N_i. Let E_i be the set of these ranks.
Step 3: Broadcast E_i and receive E_j from each $j \in N_i$.
Step 4: If $|N_i| < k$ or $|N_j| < k$ for any $j \in N_i$, remain awake. Go to Step 7.
Step 5: Compute $C_i = \{j | j \in N_i$ and $e_j > e_i\}$.
Step 6: Go to sleep if both the following conditions hold. Remain awake otherwise.
- Any two nodes in C_i are connected either directly themselves or indirectly through nodes within i's 2-hop neighborhood that have e more than e_i.
- Any node in N_i has at least k neighbors from C_i.
- It does not receive flag A.

Step 7: Return.

IV. Conclusion

In this paper, we have concentrated on W.S.N.-M.C.C. combination by incorporating the pervasive data gathering ability of W.S.N. and the influential data storage and data processing abilities of M.C.C Mainly, to support W.S.N.-M.C.C. combination presentations that need more beneficial data offered dependably from the W.S.N. to the cloud, we have recognized the critical issues that obstruct the usefulness of sensory data and dependability of W.S.N., and offered a novel W.S.N.-M.C.C. integration system named T.P.S.S. to address some of these problems. Precisely, T.P.S.S. consists of the subsequent two main parts:
1) T.P.S.D.T. for W.S.N. gateway to selectively transmit sensory data that are more beneficial to the cloud, taking in view the time and priority features of the data demanded by the mobile user
2) P.S.S. procedure for W.S.N. to save energy depletion so that it can gather and transmit data more reliably. Both investigative and experimental results regarding T.P.S.S. have been presented to demonstrate the effectiveness of T.P.S.S. in improving the usefulness of sensory data and dependability of W.S.N. for W.S.N.-M.C.C. integration.

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