http://ansinet.com/itj

ITJ

ISSN 1812-5638

INFORMATION TECHNOLOGY JOURNAL

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Information Technology Journal 12 (23): 7255-7259, 2013
ISSN 1812-5638 / DOI: 10.3923/itj.2013.7255.7259

Distributed Mobile Computing Mechanism Based on Opportunistic Communication

Hao Wei and Zhang Xing
Department of Computer Science and Engineering Henan University of Urban Construction,
Henan, China

Abstract: With the advance of the mobile terminals and the wireless communication technology, the number of mobile terminals increases rapidly and these devices are more and more powerful. The appearance of plenty of intelligent devices equipped for short-range wireless communications boosts the fast rise of wireless ad hoc networks application. However, in many realistic application environments, nodes form a disconnected network for most of the time due to nodal mobility, low density, lossy link, etc. Conventional communication model of mobile ad hoc network (MANET) requires at least one path existing from source to destination nodes, which results in communication failure in these scenarios. Opportunistic networks utilize the communication opportunities arising from node movement to forward messages in a hop-by-hop way and implement communications between nodes based on the "store-carry-forward" routing pattern. This networking approach, is totally different from the traditional communication model, captures great interests from researchers. Therefore, it becomes possible to deploy a distributed computing system on these mobile devices as an extension of the traditional one which is mainly composed of computers. We proposed an opportunistic communication based distributed mobile computing mechanism, which is appropriate for those large-scale computing that can be separated into many small subtasks and have a high tolerance of delay. A task is divided into M subtasks by a server at first, then be sent to wireless APs located somewhere through the internet. The mobile terminals (nodes) will download some subtasks while they meet the APs and after the nodes move out of the communication range of the APs, they spray the carried subtasks to some other nodes they meet which don't take any subtask. The subtasks will be performed until the number of subtasks in a node is 1. The nodes then send results to the APs on opportunistic communication approach and all of results will be sent back to the server. We also discuss some strategies about routing and energy saving.

Key words: Opportunistic communication, distributed computing, mobile device, dissemination, eneryg saving

INTRODUCTION

With the rapid development of chip technology and integration technology, the number of mobile terminals such as mobile phones, PDA, tablet PCs and other equipments is increasing so fast. These devices are more portable and have more powerful operation capabilityw (Ramanathan *et al*., 2007).

On the other hand, the wireless communication protocols as WiFi, the third generation Bluetooth, UWB and others continues to improve, making wireless data transfer rate between mobile devices gradually increase and the transmission stability enhance greatly. At the same time, as the related research of the mobile ad hoc networks (MANET) continued in-depth, a new and more realistic network model was proposed-opportunistic networking, which was very similar to the DTN (delay tolerant network).

According to the mentioned above, we believe that it will be much more convenient to make the MANET turns into an extension of the internet. Based on this idea, we are trying to design a mechanism that take full advantage of these abundant of mobile computing resources to actualize a distributed mobile computing system through the opportunistic communication way. This would be an effective expansion of traditional distributed system with the computers as the main (Ramanathan *et al*., 2007).

Due to the traditional distributed computing environment for scientific computing used a lot of the large clusters, almost all the implementations of background are based on cable network after the client-side requesting, especially using the internet as a communication support platform. However, with the increasing development of the wireless communication technique and the rapid upgrade of Private Mobile

Corresponding Author: Hao Wei, Department of Computer Science and Engineering Henan University of Urban Construction, Henan, China

Table 1: Comparison between mainstream PC and Smartphone

	PC	Smart phone
CPU	2.66GHz	1GHz
RAM	2GB	512MB
Hard disk	500GB	8-32GB (SD card)
Boot Time	Boot when need	Even 24 h

terminal performance, an exploratory attempt is building distributed computing environment on the Private Mobile terminal performance. With the upgrade of the related technologies and protocols, the more powerful of the ability of computing for these Private Mobile terminal performances, the more stable and rapid performance will be had by the wireless network equipment (Zhang *et al*., 2007).

The Smartphone for example: recently, not only the hardware of mobile phone had a quick development, but also the operate system become gradually perfect with the increasing quantity of supported software. According to so quick development of Smartphone, most of the daily work and entertainment can be conducted on a mobile phone that has a 3-4 inches screen. Moreover, the operation the mobile phone will become increasingly similar with the computer (Xiong *et al*., 2009). Recently, in US, one person between two is using a Smartphone, people tend to complete most assignment by mobile phone instead of by computer. The hardware products following the tendency have begun to come out. For example, MOTO company launched a new product which was similar to laptop but without any computing power, it can be connected with a Smartphone, which made the Smartphone had the same screen and keyboard with laptop, thereby improving the work efficiency of Smartphone effectively. The simple engineering design made the gap between Smartphone and computer completely eliminate.

In order to display the computing power of Smartphone more intuitively, a simple parallel compare is made between the current mainstream PC and Smartphone on hardware configuration, Table 2.1.

From the last table we can see that Smartphone is approaching to the computer increasingly. Moreover, the user group of Phone is larger than that of computer. Taking an ordinary family of three as an example, usually, there is a PC in family; everyday boot time is erratic, mostly in the evening. However, generally, everyone has a mobile phone and it is starting up all the time from morning to evening. From the Table 2.1 and the simple comparison we can draw a conclusion as following: (1) the number of mobile phone is more than PC. (2) The majority boot time of mobile phone is longer than that of PC. (3) The function of mobile phone is approaching gradually. Moreover, in the age of 802.11a/b/g, there were still a lot of shortages in the Wireless communications equipment networking, which is disparity relatively with Ethernet and then limit a more extensive application. For example, a data transfer rate isn't high enough, the transmission distance is restricted and the blind area is still a lot. etc. With the rapid spread of the wireless communication equipment accord with the standard 802.11 n, so that the transmission rate of wireless communication equipment is improved from theoretical 54Mbps supported by 802.11g to 150Mbps even 300Mbps.Meanwhlie,the coverage area is enlarged effectively. In a manner of speaking, the remarkable improvement of wireless communication equipment has an effective safeguard for constructing with Ad hoc network momentarily by handheld mobile equipment (Leontiadis and Mascolo, 2007). In that case, if the numerous mobile devices which has a certain operation ability can be as some computing resource, there will be the strong supplementary computing resources, supporting more extensive computation for the existing distributed computing systems.

The Industry top businesses such as Apple, Google and QUALCOMM, which concentrate on hardware and software technology in mobile Internet domain, turn to research and develop mobile phone supporting P2P and technology of Ad hoc and wireless network. In sum, we can see that the above conclusion has some hardware foundation. Moreover,In 2010 global mobile Internet meeting,it is widely believed that mobile phone will be likely to replace the current mainstream PC and become the next new computing center. In Japan, the flow of mobile internet had exceeded that of internet based on PC in the early 2008. While Analyses International, the largest Internet information research consultancy organization of in china, had forecasted in 2007 that there would be 2 billion Mobile Internet users in 2011. However, actually, there had been 2.43 billion Mobile Internet users by the end of 2010, which speed of development had been well beyond the industry expected (Daly and Haahr, 2007). Relative to the traditional distributed computing system, the feasibilities of the mechanism we proposed are: (1) the amount and the power of mobile equipments are still increasing continually, which means the great potential of operation capability of the whole. (2) The mobile devices are always power-on, which can be fit for receiving and performing tasks. (3) The mobile devices can move randomly, which makes the task dissemination more efficient and the date interaction agility.

The distributed mobile computing mechanism applies to large-scale scientific computing of high tolerance for delay, but also may be used in P2P computing, information collection, data sharing or distributed storage technology, as well as other fields.

```
Server dicides a task M into f (M) subtaks.
Server sends f (M) subtasks to Aps.
If (node_subtask num ! = 1)
Subtask dissemination{
From AP to node () {
While (node X meets AP && (X_subtask num = 0)
                && (AP_subtask num ! = 0)) {
X_subtask num = f (AP_subtask num)
AP_subtask num = f (M)-f (AP_subtask num)
}
}
From node to node () {
While (node Y meets node Z && (Y_subtask num>1)
                && (Z_subtask num = 0)) {
Z_subtask num = f (Y_subtask num)
Y_subtask num = Y_subtask num-f (Y_subtask num)
  }
 }
}
els Subtask implement
//Different return strategy leads to different description.
Result return
From node to AP()
From AP to serve()
 }
```

Fig. 1: Work flow description of the mechanism

DISTRIBUTED MOBILE COMPUTING MECHANISM

In this mechanism, a task is divided into M subtasks with minimum size by a server at first and then the server sends these subtasks to each AP through internet. The APs transmit these pieces to some mobile devices (nodes) while these nodes positioning in their communication range until all subtasks are sent out. Each node passed through the AP will receive 1-N (N<M) subtasks. In the situation N≥2, the node sends some carried subtasks to other no-task nodes which it meets opportunistically for computation reducing. The subtask will be implemented until there's only one in each node. After all subtasks are completed, the results then are sent back to the APs still on opportunistic communication way. At last, the server gathers all results together from the APs. A simple work flow description is given in Fig. 1.

An actualization of the mechanism is consists of server, AP and mobile device. The server's duty is to divide a task into many small executable subtasks and aggregate all of the results.

The AP will receive subtasks coming from the server and communicate with the mobile devices for the subtasks' sending and withdrawal of the results. The mobile device acts as performer for subtasks acquired and then sends results back to the AP. Another important work of the mobile device is disseminating subtasks to others and forwarding the results along the direction to AP. Figure 2 shows the frame for actualization.

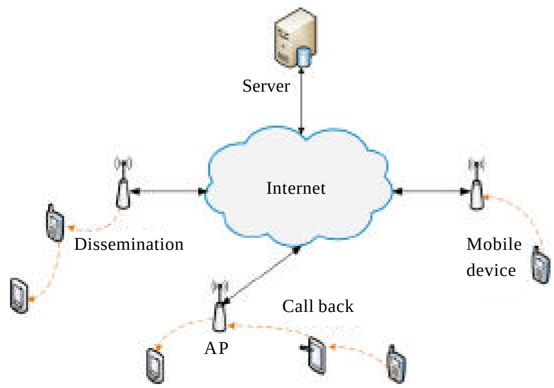

Fig. 2: An actualization structure of the mechanism

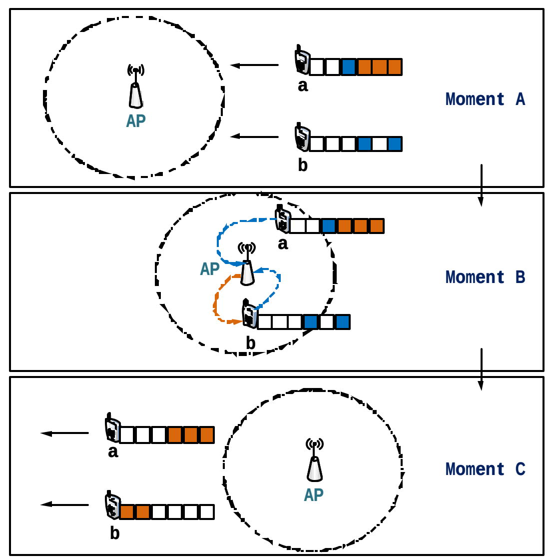

Fig. 3: Communication between AP and mobile devices

One of our purposes is to let the carried subtasks reduced to 1 in a mobile device as soon as possible, so we formulated the basic strategy which is, if a mobile device has taken at least one subtask already, it can not receive any task but result from others. Figure 3 and Fig.4 are demonstration of this strategy. In Fig. 3, two nodes a and b are moving toward a AP. The node a has three subtasks and one result and node b only has two results with no any subtask at moment A. While they are able to communicate with the AP at moment B, node a sends the result to AP simply but node b not only sends results to AP but get subtasks from it.

Besides demonstrating the basic strategy, Fig. 4 shows the dissemination between mobile devices too. Three nodes a, b and c are moving randomly at moment A

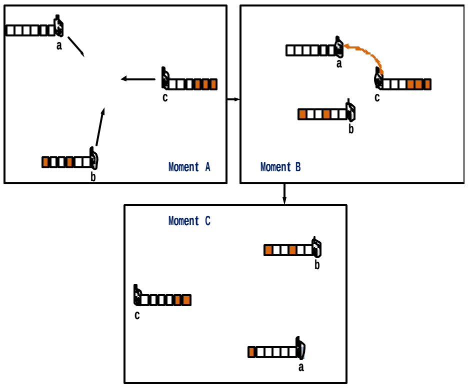

Fig. 4: Dissemination between mobile devices

and encounter each other at moment B. Science node a doesn't have subtask and the task number of node c is more than node b, node c then assigns node a subtasks in a measure. This process is an application of opportunistic networks and when the mission is achieved, to send the results back to the AP efficiently is also depend on the opportunistic communication (Liao *et al*., 2006). Figure 5 represents the whole course. Node a and b need submit the results to the AP. They and node c can not get in touch with each other at moment A. At the moment B, node b meets node c and evaluates node c has more probability then itself to meet AP according to special principles. Then node b sends all data to node c. The same as this, node c forwards the results to node a again at moment C. Finally, node a transmits all of the results to the AP including its own and node b's at moment D.

OPPORTUNISTIC COMMUNICATION APPROACHCHALLENGE

The main challenges we need to consider in the designing progress are: Because of the limit of computing power and energy for each single node, the traditional mission disassembling algorithms don't fit to our mechanism. We need to seek a new algorithm for those tasks which can be applied to the mechanism.

The dissemination progress and the data callback progress. We know it is unpractical to deploy enough APs to cover all of the area. How to make subtask dissemination more effective and so does callback progress? Researchers have proposed many routing, data dissemination schemes for opportunistic networks [3], but most of them still stay at theoretical level and may not be suitable for this mechanism.

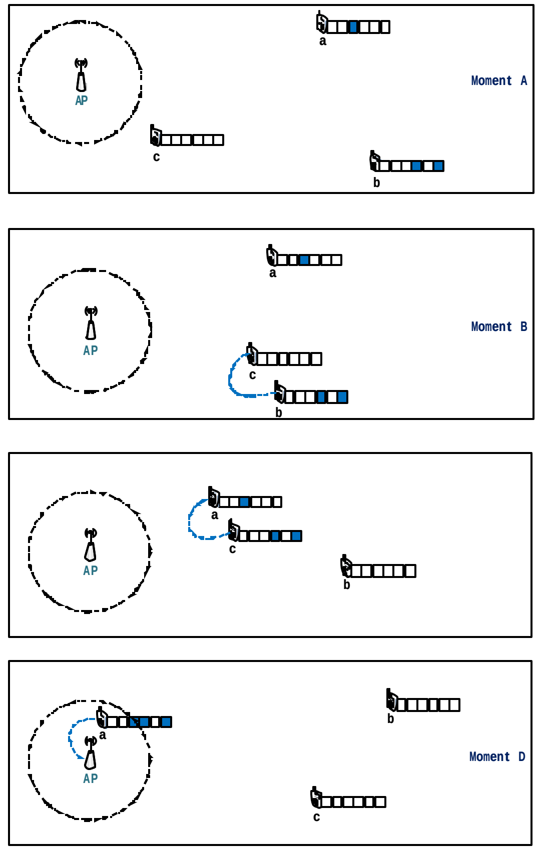

Fig. 5: Results are sent back to the AP on

It is clear that the more nodes participate in, the more computing power upgrades. Actually the most of the mobile devices are powered by the battery. That the extra mission must accelerate the consuming of the devices' energy may reduce the owner's wish taking part in the system. In order to encourage more nodes join the system, we need to think out of an effective incentive.

As mentioned in (3), because of the limitation of battery, energy saving is always an important problem.

Moreover, the challenge also comes from security, heterogeneity of the devices, QoS, middleware design and so on.

WORKING IN PROGRESS

We have been preparing to validate practicability of a routing strategy based on geographical location information. We suppose the location of each AP is known definitely and each node also can be located by GPS. Then we can estimate the meet probability between node and AP through the moving track of node. Here two parameters need to be considered, in which one is moving speed of the node and the other one is the angle formed by mode's trajectory and the AP. This probability can be regarded as basis of data forwarding.

Another approach is to recur to the public traffic tools, such as bus or subway. If APs are deployed at bus stop or subway station, then it will be quite efficient to transfer the results to public transport when they and nodes pass each other or APs directly when a node locates at a stop. The only question is that how to make sure the forward nodes will pass a bus in the next period of time. After all, it's not everybody will ride bus or pass through bus stop everyday. Anyway, this strategy is worth to validate.

We proposed a strategy called "Frequency Control", in which we have tried to reduce the frequency of mobile phone's signal measurement report to the base station instead of controlling transmit power of phone during its leisure time. A phone will communicate with the nearest base station or the best signal one every 480 MSEL (Chen and Chen, 2007). If the phone's owner stays or moves just at a fixed area which can be covered in the range of the same base station, we let the phone stop sending measurement reports. This can cut down the phone's energy consumption. However, we must compare the result in this way with energy consuming when phone estimate its change of location to confirm if the approach is viable. This is one of our current works (Pelusi *et al.*, 2006).

Face a great deal of heterogeneous equipment, the task is how to quickly distribute and deployment. When copying MD and transmitting task in the network, it is now our difficulty how to determine the number, namely how to control the news redundancy namely not to cause excessive network traffic, at the same time won't bring larger network latency and packet loss rate; how the unified interface relaying messages between heterogeneous equipment. The core problem related to successful operation of this system is that design routing forwarding mechanism to ensure MD can send results to AP efficiently and improve the packet transmission ratio. We mainly focus on above points now. And we plan to consummate the whole work to accomplish the mechanism in the next year.

CONCLUSION

In this study we described a distributed mobile computing mechanism based on opportunistic communication which combines both distributed computing and opportunistic networking technologies. We proposed some strategies about routing and energy saving which we have been validating their availability. Although there still are lots of problems needed to be figured out, we believe this model will contribute to the development of the distributed computing.

ACKNOWLEDGMENT

This study is supported by the Fundamental Research Funds for the Central Universities (lzujbky-2009-64).

REFERENCES

Chen, C. and Z. Chen, 2007. Evaluating contacts for routing in highly partitioned mobile networks. Proceedings of the 1st International MobiSys Workshop on Mobile Opportunistic Networking, June 11-14, 2007, USA., pp: 17-24.

Daly, E.M. and M. Haahr, 2007. Social network analysis for routing in disconnected delay-tolerant manets. Proceedings of the 8th ACM International Symposium on Mobile Ad Hoc Networking and Computing, September 9-14, 2007, Montreal, Canada, pp: 32-40.

Leontiadis, I. and C. Mascolo, 2007. Opportunistic spatio-temporal dissemination system for vehicular networks. Proceedings of the 1st International MobiSys Workshop on Mobile Opportunistic Networking, June 11-14, 2007, USA., pp: 39-46.

Liao, Y., K. Tan, Z. Zhang and L. Gao, 2006. Estimation based erasure-coding routing in delay tolerant networks. Proceedings of the International Conference on Wireless Communications and Mobile Computing, July 3-6, 2006, Canada, pp: 557-562.

Pelusi, L., A. Passarella and M. Conti, 2006. Opportunistic networking: data forwarding in disconnected mobile ad hoc networks. IEEE Commun. Mag., 44: 134-141.

Ramanathan, R., R. Hansen, P. Basu, R. Rosales-Hain and R. Krishnan, 2007. Prioritized epidemic routing for opportunistic networks. Proceedings of the 1st International MobiSys Workshop on Mobile Opportunistic Networking, June 11-14, 2007, USA., pp: 62-66.

Xiong, Y.P., L.M. Sun, J.W. Niu and Y. Liu, 2009. Opportunistic networks. J. Software, 20: 124-137.

Zhang, X., J. Kurose, B.N. Levine, D. Towsley and H. Zhang, 2007. Study of a bus-based disruption-tolerant network: Mobility modeling and impact on routing. Proceedings of the 13th Annual ACM International Conference on Mobile Computing and Networking, September 19, 2007, USA., pp: 195-206.