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A Routing Scheme Considering Mobility in Mobile Peer-to-peer Networks

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Abstract

Recently, with the development of wireless communication technology and the wide usage of mobile devices such as PDAs, netbooks, and smart phones, interests on mobile P2P networks have been increased. Location based routing schemes considering the mobility of mobile devices in order to provide mobile P2P services were proposed. However, the existing schemes cause high communication costs since they broadcast the messages to a whole network to create routing paths. In this paper, we propose a new location based routing scheme to efficiently create routing paths along with the mobility of mobile devices. The proposed scheme maintains the information of peers within 2-hop in order to reduce the costs of routing path searches. The proposed scheme searches the routing path considering the directionality of the destination peer and maintains it using the connectivity of peers. It was shown through performance evaluation that the proposed scheme outperforms the existing schemes.

Keywords: *Mobile P2P, location based routing, mobility, connectivity*

1. Introduction

With the development of internet since the mid-90s, many services for interchanging and processing music, video, and text among have been developed. Generally, since these services are based on the client/server architecture, the load of the server is significantly increased and the problems such as the scalability, reliability, and flexibility occur in accordance with the increase of users. In order to solve such problems, P2P networks have been vigorously studied. The P2P network is a two-way communication model that complements the characteristics of the existing client-server architecture and effectively exchanges information among peers. In the P2P network, peers autonomously configure the network as each peer performs the functions of a client and a server and peers shares the distributed information each other [1].

With the development of short-range wireless communication technology and the expansion of mobility service, studies on mobile ad-hoc network have been actively conducted. As a result, the existing P2P services have been used as mobile Ad-hoc based P2P services. Especially, interests on mobile P2P networks with mobile devices such as PDA, Netbook, and Smartphone have been concentrated. The mobile P2P networks provide file-sharing, recommendation services, and content delivery using short-range wireless communication technologies such as IEEE 802.11, Bluetooth, and UWB(Ultra Wide Band). Peers of mobile P2P network have the limited CPU capability,

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memory volume, and communication bandwidth over the wired P2P network topologies are dynamically changed due to the mobility of peers. Therefore, the wired P2P technologies are difficult to directly use for the mobile P2P network[1, 2].

In order to provide the mobile P2P services, the routing scheme that adapts to the variants of the network topology and stably transmits data from a source peer to a destination peer. [3, 4] proposed the routing schemes using super peers. [3] proposed a technique to generate routing paths using the remaining energy capacity of the peer and the number of hops. [4] proposed a technique to replace a super peer in routing paths in consideration of its remaining energy. In the [5], it proposed techniques to create the optimal routing path in consideration of connection time among peers. LPBR[6] proposed techniques to create routing paths with minimum hop-counts by performing broadcasting communication to all of the peers in the mobile network. [7] proposed techniques to create a new routing path by using broadcasting communication when the connection failure of peers occurs.

The existing schemes spend high communication costs since they transmit messages to the whole network in order to create and maintain a routing path. They also need the additional costs to create a new routing path when it is impossible to transmit the data through the established routing path. In this paper, we propose a new location based routing scheme to efficiently create routing paths along with the mobility of mobile devices. The proposed scheme maintains the information of peers within 2-hop in order to reduce the costs of routing path searches. The proposed scheme searches the routing path considering the directionality of the destination peer and maintains it using the connectivity of peers. It was shown through performance evaluation that the proposed scheme outperforms the existing schemes

The rest of this paper is organized as follows. In Section 2, we propose a location based P2P routing scheme in mobile ad-hoc networks. In Section 3, we show the superiority of our proposed scheme through performance evaluation and analysis. Finally, we conclude in Section 4.

2. The Proposed Routing Scheme

In this paper, we propose a new location based routing scheme for stable data transmission from a source peer to a destination peer. We call a peer that forwards a RREQ message to generate routing paths through multi-hop communication a forwarding peer. A peer that actually transmits data according to routing paths is called a delivery peer. In the proposed scheme, each peer maintains a routing table and location table about its two-hop peers The location table of each peer has the location information of its neighboring peers that is represented in the structure <*pid*, *pos*, *pvv*>, where *pid* is the identifier of a neighboring peer, *pos* is its location, and *pvv* is a vector indicates the direction of movement. The routing table includes the connection information of two-hop peers that is represented in structure <*hop*, *pid*, *pass*>, where *hop* communication with the *pid* is the number of communication hops with *pid* and *pass* is the information list of the neighbor peers.

As shown in Figure 1, the proposed scheme selects a forwarding peer to transmit the RREQ message by considering the direction of each peer and the destination peer. As a result, since the RREQ message is not transmitted in the entire network, the network transmission cost is reduced.

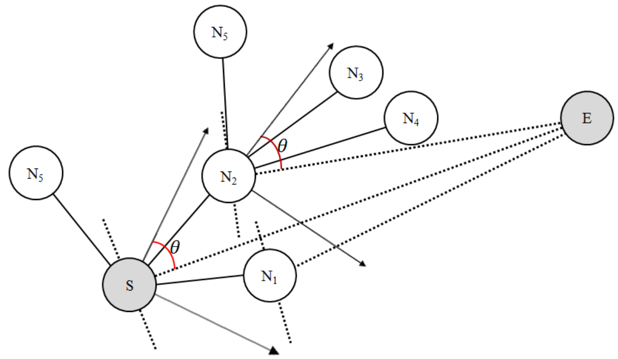

Figure 1. Selecting a forwarding peer

A peer that receives the RREQ message chooses the neighboring peer that satisfies the following conditions as a forwarding peer.

(Condition 1) If the neighboring peers within the 1-hop of the peer satisfy the communication threshold, they can be chosen as a forwarding peer.

(Condition 2) If the directions of the neighboring peers within the 1-hop of the peer are the same as that of the destination peer, they can be chosen as a forwarding peer

(Condition 3) The neighboring peers of a forwarding peer satisfy the direction of the destination peer.

We suppose that the position of the peer N_r receiving the RREQ message is (x_r, y_r), the position of the destination peer Ne is (x_e, y_e), the position of the neighboring peer N_i within the 1-hop of N_r is (x_i, y_i). The direction of the destination peer means direction between the forward peer and the destination peer. It must satisfy (Equation 1) and (Equation 2), where U_e is (x_e-x_r, y_e-y_r), U_i is (x_i-x_r, y_i-y_r), and R is 1-hop communication distance.

$$\sqrt{(x_i - x_r)^2 + (y_i - y_r)^2} \leq R \quad (1)$$

$$\cos\theta \leq \frac{U_e \bullet U_i}{|U_e||U_i|} \leq 1 \quad (2)$$

The proposed scheme selects the optimal routing path by considering the number of hops and connectivity. Network connectivity means the possible connection time among peers on the routing path. If a problem occurs when a particular peer transmits data, we must create an alternative path. When communication between peers is not performed, a forwarding peer on the routing path checks whether the peer connected to the destination peer is or not by using the RREP message from the destination peer. If the peers that can be connected to the destination peer exist, one of them becomes a forwarding peer and transmits the data. Otherwise, we explore the routing path again that satisfies Equation 1 and Equation 2.

3. Performance Evaluation

To show the superiority of our approach, we compare the performance of the proposed scheme with the existing scheme, LPBR [6]. We conduct our experiments on a development area of 400m×400m. The number of nodes is set from 150~250. The initial location of each node is generated randomly. The communication radius of each mobile node is set to 40m. The moving speeds and directions of the mobile nodes are set randomly. We conducted our experiments on a desktop PC running on Windows 7 Ultimate K OS. The PC has a Intel Core(TM)2 Duo CPU and 6GB memory. All of the experiments were coded in Java. In order to make an equal simulation environment, the proposed method and the existing LPBR method used the same communication radian.

Figure 2 shows total message numbers of RREQ/RREP in the whole network as the number of peers is from 150 to 250 and communication direction is from 30 to 60radian. As shown in Figure 2, we can see easily that the number of messages increases exponentially as the number of peers and communication direction increases. The proposed scheme is very efficient to search and maintain the routing paths as the communication angle reduces. Our simulation results show that the proposed scheme outperforms LPBR by about 17%.

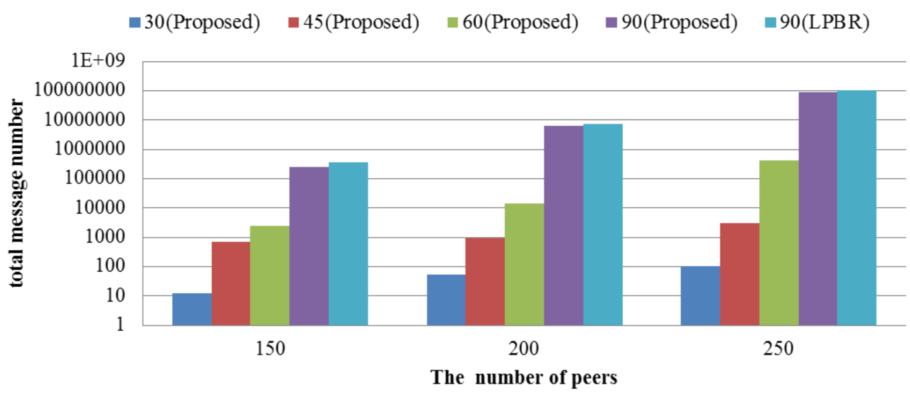

Figure 2. The routing cost according to the number of peers

Figure 3 shows the generated routing paths of the proposed method and LPBR when the number of peers is 250. The red colored lines represent the routing paths of the proposed method and the blue colored lines represent the routing paths of LPBR. The results show that all the possible routing paths between source node and destination node are generated by LPBR and only one optimal routing path is generated by the proposed method. However, only the optimal routing path is selected when performing data forwarding between source node and destination node. Therefore, the proposed method can reach the similar routing cost of LPBR with low transmitted messages.

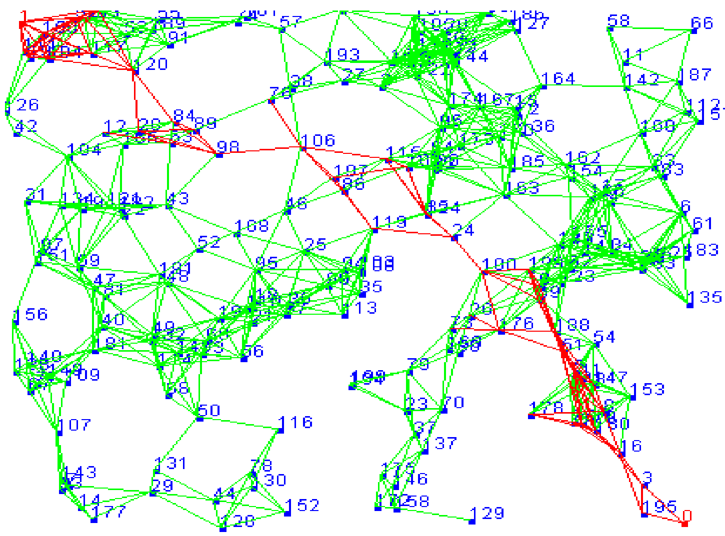

Figure 3. The generated routing paths

4. Conclusion

In this paper, we have proposed a location based P2P routing scheme to maintain a stable routing path to reduce routing creation costs in mobile P2P networks. The proposed scheme generates a routing path using 2-hop neighboring peer information. It considers the directionality and connectivity. It was shown through performance evaluation that the proposed scheme creates stable routing paths and reduces the routing path creation costs over the existing scheme. In the future works, we will study an optimal routing path generation scheme and a scheme to reduce the maintenance costs of the routing tables.

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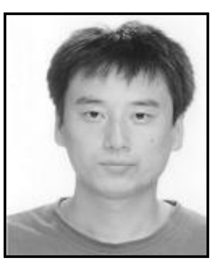

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