A Proposal on Broadcast based Information Sharing System over Disaster and Congestion Tolerant Ad Hoc Network

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Abstract – In a disaster situation, since existing communication infrastructure will be unavailable, it is difficult to share information such as text, image, and audio data with neighboring mobile communication devices. To enable information sharing without using existing communication infrastructure in communication infrastructure unavailable areas, we propose a novel method Broadcast-Based Information Sharing System (BBISS) in this paper. In addition, the paper shows the preliminary performance evaluation of the proposed method.

Keywords: information sharing, broadcast, ad hoc communication

1 Introduction

Owing to the growth in the number of smart phones and tablet PCs, our lives depend on the information stronger than before. On the other hand, large-scale disasters often happen and disable existing telephone networks and mobile networks for many hours. Such disasters cause not only physical destruction of communication infrastructures but also serious traffic congestions. Since many people wish to access the existing network, the traffic congestions become more and more serious. Once the situation happens, our mobile communication devices do not work as usual. Although communication techniques in the infrastructure unavailable situations has been required and studied for a long time, no major techniques exist today.

An example of assumed applications in the infrastructure unavailable situations is shown in Fig.1. In the infrastructure unavailable area, people with wireless communication devices collect disaster information and broadcast evacuation instructions. In addition, cars and emergency vehicles with the wireless communication devices will disseminate information which is collected at the infrastructure available area to the unavailable area. The application will enable to collaborate with the Internet, social media, and mass media. Therefore, it will contribute to the information collection and dissemination by polices, fire-fighting, and local governments.

This paper is concerned with the realization of the above application. In fact, existing ad hoc network architecture [1], cannot be applied in the infrastructure unavailable situations because IP addresses and servers are not available. To realize the application, we propose a novel method, Broadcast-Based Information Sharing System (BBISS), a part of our research Infrastructure-less Broadcast Information Delivery Architecture. In this paper, the preliminary performance evaluation of the proposed method is demonstrated through network simulation to show the effectiveness of the method.

Below Section 2 introduces related works of the ad hoc network which has been expected to apply as a networking technique in the infrastructure unavailable situations. Section 3 describes a detailed methodology of the proposed method BBISS. Section 4 shows the preliminary performance evaluation of the proposed method through the network simulation. Lastly, Section 5 concludes this paper.

2 Existing studies and their problems

The existing ad hoc network architecture has been studied as the networking technique in the infrastructure unavailable situations, and many routing protocols have been proposed. In general, available IP addresses must be assigned at nodes in the network to communicate using routing protocols. However, the IP addresses cannot be available in the infrastructure unavailable situations owing to the large-scale disaster. Moreover, some servers must be required to collect and disseminate the information to adopt the existing client-server applications. Considering the above problems, the existing ad hoc network architecture cannot be applied to the applications discussed in the Section 1.

Related studies of the ad hoc network architecture are introduced below. Epidemic routing has been proposed in [2]. In this method, a contents holder copies the contents to its neighboring nodes. Although the methods have been proposed to deliver the information to the destination node, method cannot be applied to disseminate the information to whole the area.
The Simple Flooding (SF) has been implemented in ad hoc network routing protocols to deliver routing messages in the broadcasting manner [3]. Although, Simple Flooding is one solution to disseminate the information to the whole network, it has problems below. In this method, when a node receives a packet, the packet is re-broadcast if the packet was never received before (non-identical packet). Therefore, many nodes re-broadcast the packet in the network, and data frame collisions are occur, the packet reachability is degraded.

Probabilistic scheme and Counter-based scheme has been proposed as the methods without HELLO packet exchanges and dedicated devices such as GPS (Global Positioning System) [4][5]. Since the above methods do not assume to deliver the information consisting of multiple packets such as data files, they do not consider the communication reliability. In other words, the packet reachability is not assured in the methods.

Considering the above, the proposed method in this paper, BBISS, is in the area where has not been studied yet.

3 Proposed method

3.1 Assumed environment

This paper assumes the following environment. The large-scale disaster happens, and public telephone networks and mobile networks are unavailable. Although users in the disaster area have mobile phones and tablet PCs, the devices cannot be assigned available IP addresses and cannot obtain gateway information. At the time, the devices support the broadcast communication by the IEEE802.11 wireless LAN on ad hoc mode. Therefore, this paper studies the information sharing system by the broadcast communication. The information sharing system assumes to deliver text data (several kBytes – hundreds kBytes) and image data (hundreds kBytes). Developments of dedicated applications and implementations to the devices are our future issues to be tackled.

3.2 Requirements and solutions

The requirements of the proposed method are as follows.

(Requirement #1) The IP addresses and the routing protocols are not needed:

Since IP addresses and gateway information are not available, and it is difficult to develop servers to configure that information. Therefore, the proposed method uses only broadcast transmission without routing protocol.

(Requirement #2) TCP and unicast transmission are not used to assure the reliability:

To deliver the information consisting of the multiple packets, the packet reachability must be assured. In general, in the Internet and LAN (Local Area Network), the communication reliability is assured by TCP. However, in the ad hoc communication environment, the communication using TCP cause many retransmission requests and its reply, then many packets are lost due to collisions.

To assure the information reachability (i.e. reliability), the proposed method does not use the transmission using TCP and does not require retransmission request and its reply by the unicast transmission, but assures the reachability using only the broadcast transmission.

(Requirement #3) The energy consumption of node should be reduced.

Since the users’ communication devices are usually battery driven, it is quite difficult to assure the stable power supply for many hours. Therefore, the power consumption at the nodes should be reduced as much as possible.
To reduce the power consumption, the proposed method reduces redundant relay transmission in the proposed method.

### 3.3 Design of the proposed method

#### 3.3.1 Packet format

Three types of packet formats: Normal packet, Retransmission packet, Retransmission request packet are defined in this method as shown in Fig. 3. The roles of each field are explained below:

a. Packet type: The packet type (Normal packet, Retransmission packet, Retransmission request packet) is recognized by this field.

b. Initiator node ID: The ID of the information initiator is recognized by this field.

c. Information ID: The field shows the ID of the information.

d. Packet Total: The number of packets that consists of the information is recognized by this field.

e. Packet sequence number: The sequence number of the packet in the information is recognized by the field.

f. Data: Divided data is contained in the field. The size of the field is determined by the parameter \( \text{payload}\_\text{size} \).

In addition, Retransmission request packets contain the following:

g. Unreached packet sequence numbers: If the node receives information but it has any unreached packets,
the all sequence numbers of unreached packets are described, and transmitted to the neighboring node.

3.3.2 Operation of the proposed method

This subsection explains the operation of the proposed method. The proposed method consists of 4 parts: 1. **Initiation part**, 2. **Receiving part**, 3. **Relay part**, and 4. **Retransmission part**, as shown in Fig.4. The detailed procedure in the each part is explained below.

**1. Initiation part:** shown in Fig.5(1)

1.1. The initiator node divides an information into several “data” according to payload_size, put each data into each packet and broadcasts all the packets with send_interval. The each packet contains initiator ID and Information ID.

1.2. After the transmission, the initiator waits during retrans_wait_time. During the wait time, if the initiator receives the Retransmission request packet(s) from neighboring nodes, the node retransmits lost packets designated in the Retransmission request packet(s) by broadcast after the wait time.

**2. Receiving part:** shown in Fig.5(2a)

2.1. Neighboring nodes receive the packets.

2.2. If the nodes receive the packets of the information during req_wait_time, they proceed to the 3. **Relay part**.

2.3. Otherwise, they proceed to the Retransmission process. (The num. of the retransmission request trials must be less than req_threshold)

**3. Relay part:** shown in Fig.5(2b)

3.1. The nodes waits during relay_wait_time.

3.2. During this wait time, the nodes count the num. of the relaying nodes.

3.3. After the wait time, If the num. of relaying nodes is less than relay_threshold, the information is re-broadcast. Otherwise, the relay transmission is canceled.

3.4. After the relaying, retransmission requests are accepted with the same manner in **1. Initiation part**

**4. Retransmission part:** shown in Fig.5(3)

4.1. The node transmits the Retransmission request packet(s).

4.2. Then, the sender broadcasts the lost packets. The receiving node receives the packets with the same manner in **2. Receiving part**.

4.3. If the node receives all packets, proceeds the 3. **Relay part**.

4 Preliminary evaluation

To show the effectiveness of the proposed method, the preliminary evaluation is demonstrated through the network simulator OPNET[6] in this paper. The evaluation compare the number of transmitted packets and received packets for the existing method SF with the proposed method BBISS. Then we confirm that the proposed method can contribute to the reduction of the transmitted and received packets. The simulation condition is really simple: the number of initiator nodes is 1, and the number of initiated packets at the initiator node is 1. In the condition, since the generated packet was delivered in whole network in a short time, the node mobility is negligible.

We assume a network with 100 nodes (this includes 1 initiator node), a IEEE802.11b node MAC layer, and a data rate of 11 Mbps. The transmitted power is 0.005 W, and the received power threshold is -85 dBm. The initial positions of the nodes are assumed to be random. Two simulation areas...
are defined: 1000m×600m (space A) and 2000m×1200m (space B). Dense and sparse networks are considered in each case. The initial positions of the nodes are assumed to be random. The average is found for 10 simulation runs at every initial node positions. We consider nodes receiving packet from initiator nodes to compare SF and BBISS. Three values of relay_threshold, 4, 3, 2 are set for the proposed method. The waiting time for information retransmission in both methods is 1s to simplify the evaluation.

The simulation result is described as follows. Figure 8 and Fig.9 show the number of transmitted packets and received packets, respectively. The result showed that BBISS reduces 72%-94% of the transmitted packets and 76%-94% of the received packets.

5 Conclusions

This paper proposed a novel infrastructure-less broadcast information delivery system, BBISS, to share the information such as text contents and image contents. Then the number of transmitted and received packets for the proposed method was compared with that for the SF through the network simulation. The simulation result can conclude that the propose method can contribute to the reduction of transmitted packets and received packets. The reduction will contribute the congestion avoidance.

In future, we plan to evaluate the delivery performance through the network simulation. In addition, we plan to develop applications and implement it in existing PCs, cell phones, and Tablet PCs.

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7 References


