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Preliminary study of wireless balloon network using adaptive position tracking technology for post disaster event

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Abstract

Limited resources in post-disaster areas, one of which is a communication where coordination needed for aid distribution in disaster areas. Wireless balloon technology as a solution for use in post-disaster areas. Bandwidth limitations and high delay in communication systems on wireless balloons create limitations in aid coordination, especially mobile device tracking on BPBD volunteers or officers. This research develops an effective communication system at the wireless balloon to track personal device officers in disaster areas that use cellular devices. This mobile device tracking system utilizes a wireless balloon using a publish-subscribe system on their mobile devices, namely volunteers as publishers and those responsible for disasters or communities as subscribers. To overcome the limitations of communication resources on cellular devices and wireless balloons using the Adaptive method on publish-subscribe called UM-Disaster. The results of this study, the UM-Disaster system for multi-cell tracking has an average efficiency of 40-63% for bandwidth and processor use on mobile devices at 51-70%.

Keywords: *disaster, mobile device, tracking, wireless balloon*

1. Introduction

The rapid development of information and communication technology, especially on the internet and cell phones or mobile devices has changed the way people interact with their environment [1, 2]. One of the interaction processes needed in a mobile environment is the tracking process. In general, the tracking process is the process of observing people or objects that move continuously where the objects observed are continuously monitored both their position and activities. The tracking process is said to be ideal if it can send location changes properly in changing conditions [1]. Several studies on manual tracking have conducted by proposing dynamic tracking to update location. Tracking By dynamically reducing overheat on the server by reducing the sum of updates, but still has an accuracy value that is still less relevant [2, 3]. For information on natural disasters, a internet of thing (IoT) of research and development has done both from the area of small-scale disasters to the international level, both carried out privately by international agencies responsible for disasters among systems, namely IGaDs [4], EPIC [5], BRIDGE (Bridging Resources and Agents in Large-Scale Emergency Management) [6], UN-SPIDER [7], and MRCCFR [8]. This information system requires large resources, especially electricity and internet connections. The existing system also has no interaction in the form of tracking between personnel/volunteers in the disaster area, those responsible for disasters and the surrounding communities.

Several existing studies have proposed tracking dynamically to update the location of [1]. Dynamic tracking minimizes overheat on the server by reducing the sum of updates, but still has the value of relevant accuracy. In his research [1-3] studying tracking was based on time and distance that needed accuracy on moving objects. Simulation is done by carrying out some updates on several tracking techniques to measure accuracy. The tracking research developed into EnTracked [1], is an efficient tracking system in a single target cellular device environment. This system can detect when location updates are needed to use GPS or not adaptively. Motion detection using accelerometer sensors embedded in mobile devices.

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The GPS sensor is used in a moving condition or has exceeded the time limit determined by a model error. The remaining location will be estimated using the approximate speed of movement. The results of this tracking will be stored in the Encrypted Server, then sent to clients who need [1]. This mechanism is not efficient enough to become a multi-target tracking infrastructure on mobile devices. Point-to-point and synchronous communication causes applications to be rigid and static, and make large-scale development difficult and requires large resources [5]. To reduce the load on applications, communication schemes are loosely coupled. Publish-subscribe has the advantage of separating time, space and synchronization. Interactions like this make the publish-subscribe system ideal in large-scale dynamic communication. Publish-Subscribe is an interaction paradigm in which customers have an interest in the form of an event, for each event that matches the interest of being notified by the publisher [6-9].

Infrastructure in the form of a balloon wiring network is still not widely developed, especially in disaster areas for volunteer personnel with many target models. Several studies on wireless balloons have been conducted. Some constraints on the wireless balloon are limited resources used in infrastructure and also limitations on cellular devices on users' mobile devices [7-10]. The flexibility of resources also exists on mobile devices, especially in continuing communication with servers in updating tracking information. On cellular devices and wireless balloons, there are obstacles, namely Determination of location capture methods in tracking, which affect energy efficiency. The method with a GPS sensor provides higher precision values than other methods and requires higher energy as well. Therefore a tracking system is needed that considers context aware. Events that contain tracking information can be used to describe the entity's situation. Entities can be people, places, or objects that are considered relevant for interactions between users and applications [8-15].

This research develops communication between cellular and wireless balloon devices to track mobile devices such as multi-object tracking in disaster areas. The communication method is as follows: voluntary mobile device publishes the location to the server, the wireless balloon. Then the wireless balloon sends tracking location data to the cloud server, the internet. The user or person responsible for disaster subscribes to the system to determine the position of voluntary mobile devices. Users of this system tracking do not have to track all mobile devices but can choose which mobile devices to track and tracked mobile devices to send data so that the use of resources is minimal on wireless balloons and other mobile devices.

2. Research Method

In general, the tracking process is the process of observing people or objects that move and sequentially send location data and other information. This process is closely related to GPS (Global Positioning System) and other location sensors. Because of its sequential nature, an efficient tracking process is needed but still accurate. The tracking process is said to be ideal if it can send location changes firmly in changing conditions. Several previous studies [1-3] have proposed tracking dynamically to update location. One study of the EnTracked system [1] is an efficient tracking system in a single target cellular device environment. This system can adaptively determine the precision requirements to determine the location of the mobile environment. Location determination can use GPS sensors or approximate speed of objects.

EnTracked systems can adaptively carry out reporting protocols. The EnTracked system uses an accelerometer sensor to minimize GPS usage. When the device moves, speed estimation is made so that the next location is known. When it reaches a certain time limit, the GPS sensor used again. The EnTracked system applied to a single tracking system. Tracking targets can involve one or more objects. The more objects that tracked, the more energy is needed and the position updates that occur. Differences in the direction of movement, variations in speed and connectivity on unreliable networks are the main factors in tracking many objects [15]. In his research [10] proposed a method of tracking kinematics targets in the WSN (Wireless Sensor Networks) environment. The tracking process is only active when an object enters a specific area. Only in the tracking area, the WSN sensor node is active. It can reduce energy use and reduce latency on the network [15].

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the main factors in tracking many objects. In this study propose kinematics tracking methods I n the WSN (Wireless Sensor Networks) environment [15]. The tracking process is only active when an object enters a specific area. Only in the tracking area, the WSN sensor node is active. It can reduce energy use and reduce latency on the network [15-17]. In this research, a protocol used where it is assumed to update a copy of information from a moving object based on the primary object information. The aim is to guarantee the accuracy given. Protocol updates can be classified into three types, namely: query, reporting, and aggregation. Update protocols affect mechanisms to update information and which party starts. In this study, the tracking process has a need called the location model [18, 19]. Location models are expressive, flexible and efficient representations of location information. Location information is not separated by coordinates, which are markers that determine the position of objects about the reference coordinate system given [20, 21]. The coordinate system divided into two, namely:
a) Geometric coordinates that refer to geometric points or multi-dimensional spaces such as cartesian coordinates or geographical coordinates (latitude and longitude).
b) Symbolic coordinates, defining locations in the form of symbols or abstract names. Examples: "Jakarta," "Surabaya," "Malang" and others.

From the two coordinate systems above, the location model divided into three types, namely: Geometric, Symbolic and Hybrid [22, 23]. Geometric location models based on geometric coordinate system references symbolic location model based on symbolic coordinates. The combination of both is called the hybrid model location. In the process of communication between trackers and objects that are tracking targets, there is an exchange of data. Modeling of the data sent required shown in Table 1. In Table 1 the modeling of the data in question is shown. Each tracking target has an id, code, user, lat, long and time. The description of each attribute explained in the description column. Location modeling used is a combination of hierarchical Geometric and Symbolic [24-26].

This study developed a multi-tracking object in the area labeled UM-Disaster. This system functions as follows: Interactions between the publisher (the entity that is the target of tracking) with the customer (the entity that tracks or tracer) can be presented in Figure 1. The Pb(publisher) will publish the event to the PS (publish-subscribe) system in the form of tracking information. Although customers send subscriptions that set in the subscription language for PS systems, Sb (subscribers) will only be notified according to their interests through the tracking evaluation process. ST (Subscription translator) will interpret existing subscriptions. The Wireless Ballon as broker will handle notifications to user. In the ad (adaptive) method, some unemployed managers set the status of the publisher to publish the event to the wireless balloon actively or not as shown in Figure 2.

Table 1. Data Model

Attribute	Type	Information
id	Integer	Identifier
code	String	Protocol response status (OK or ERR)
action	Strin	Response action protocol received
user	String	The name of the tracked object
lat	Double	Value of latitude
lng	Double	Longitude value
time	Timestamp	Information about the time the data sent

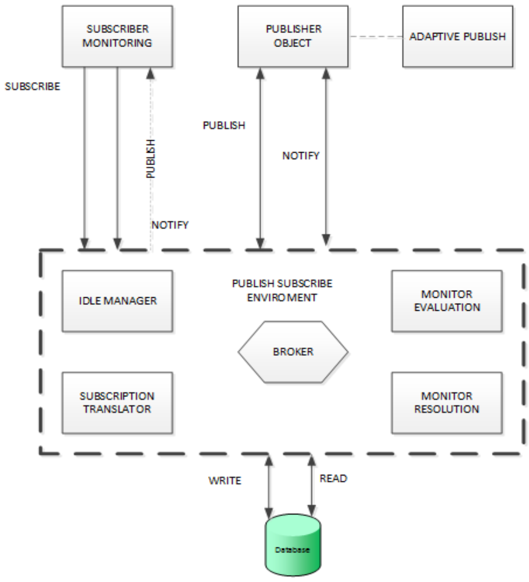

Figure 1. UM-disaster system design architecture

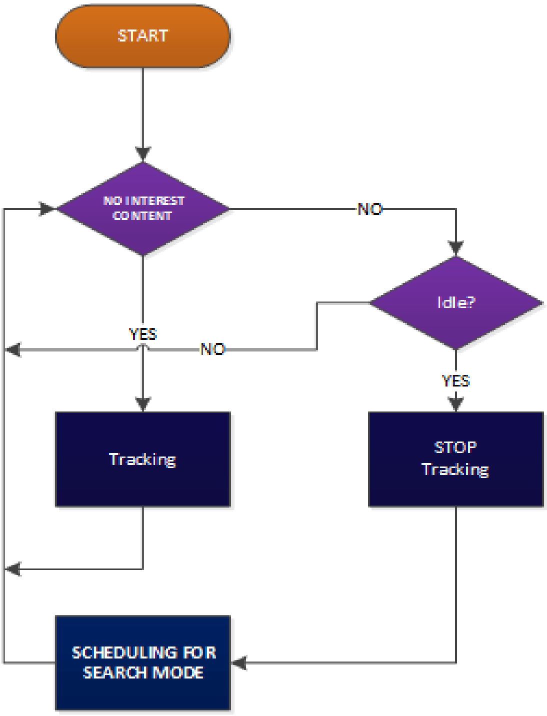

Figure 2. Flow chart of adaptive methods at UM-disasters

3. Results and Analysis

In UM-Disaster systems, tracking information packages from data are modified with additional protocols so that the event publishing process will only occur for the required location information package (adaptive methods such as Figure 2). In Table 2, the differences in event publications that occur between ad (adaptive) and no-ad (non-adaptive) methods in the test shown. For no-ad methods, the sum of publications not influenced by the sum of customers. Simulation is carried out for 20 minutes with 1-second publication interval. So the sum of programs issued on no-ad methods can be calculated by some publishers x 20 (minutes) x 60 (seconds). In addition to the number of published events observed, several performance parameters were observed, including server CPU usage on a wireless balloon and bandwidth usage. Scan of this experiment was conducted to see the effect of the number of publisher events on performance efficiency. Tests carried out on 4G networks and WF (Wi-Fi). Retrieving data packet information using a Wireshark application as shown in Figure 3 and testing processor usage on a wireless balloon and mobile device using an application on the operating system to check processor usage as shown in Figure 4.

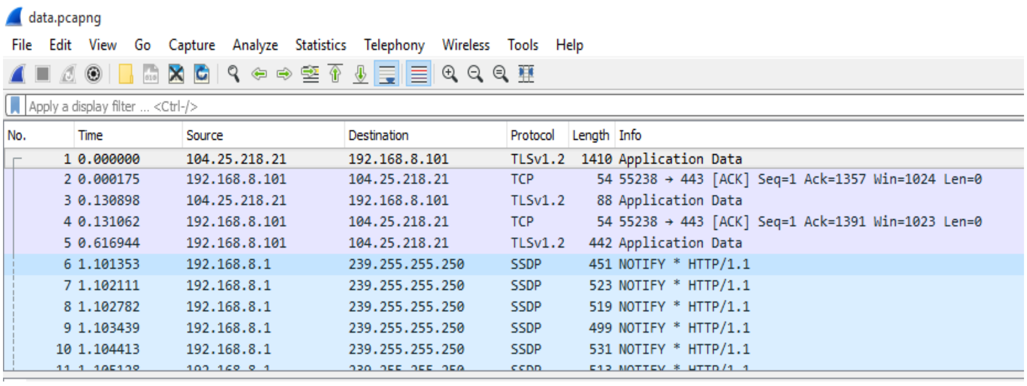

Figure 3. The Wireshark application captures data via wireless balloons during the multi-object tracking process

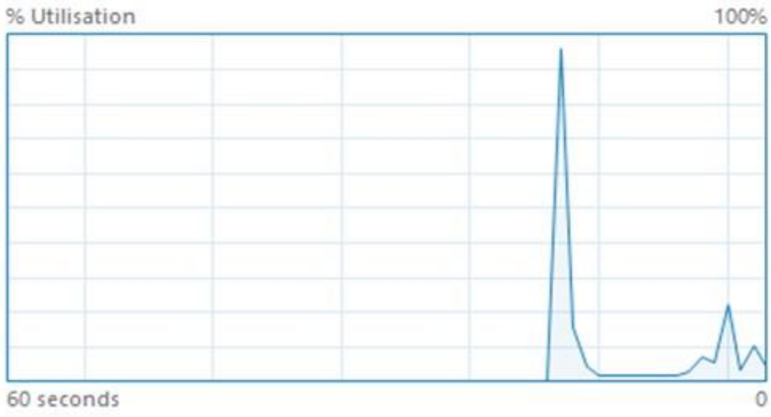

Figure 4. operating system application to see processor usage on wireless balloons in the UM disaster system

Table 2. Number of Publish Events

Publisher	Adaptif		Non-Adaptif
	5 Subscriber	10 Subscriber	
5	644	644	1500
10	712	1284	3000
15	794	1366	4500
20	864	1447	6000
25	945	1505	7500

Evaluation by looking at the observations are shown in Table 3. Implementation evaluation results with the Wireshark application indicate that multi-target adaptive tracking is to obtain efficiency for performance. It show by bandwidth savings of 40-63% as shown in Figure 5 and CPU savings of 51 - 70% as shown in Figure 6. In the UM-Disaster, the amount of published tracking information is affect by attraction or not of interest in tracking information by user.

Table 3. Average Performance Test Data

Nomina	Net	Ad (Adaptive Subscriber)		No-Ad (Non-adaptive Subscriber)		Unit
		5	10	5	10	
Processor	4G	3,3826	5,7406	14,6032	18,2527	%
	WF	3,9236	74.088	12,9963	17,6835	
Bandwidth	4G	1.805.975	2.872.634	45.985.996	52.469.726	bytes/s
	WF	18.133.332	29.167.608	4.584.952	52.346.618	

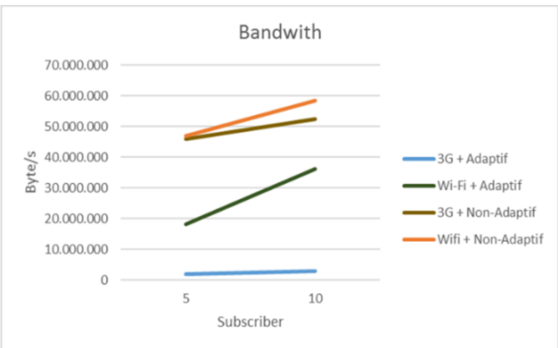

Figure 5. Bandwidth graph for multi-object tracking

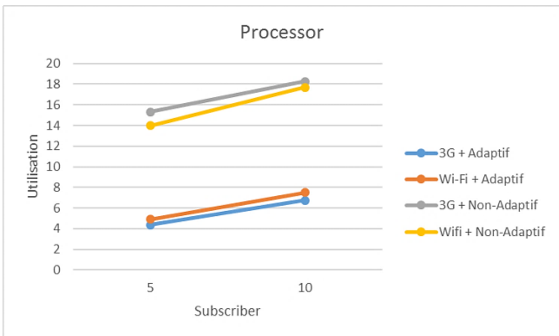

Figure 6. Processor graphics for multi-object tracking

The multi-target tracking test developed is illustrated in Figure 7. subscribers as users, that is, mobile devices have an interest in the information contained in the form of all publishers within the UM Campus area symbolized in the area=UM. All publishers who publish location information in the UM Campus area will be displayed. When a new publisher publishes location information that matches it interests, it will be displayed without changing the desired content. Publishers send related content to Wireless Balloon as a broker and send it to the internet cloud server. Users as customers track cellular devices based on information related to the publisher.

Figure 7. Implementation of multi-object tracking using UM-Disaster

4. Conclusion

This research develops communication between mobile devices and wireless balloon networks to track mobile devices as multi-object tracking in disaster areas. This communication method is called UM-Disaster, which is a cellular device as a publisher that publishes the location of the publisher to the server, namely the wireless balloon network. Then the wireless balloon sends tracking location data to the cloud server, the internet. The user or person is responsible for the disaster area as a customer to subscribe to this system to find out the position of the voluntary mobile device. The results of this study indicate that the UM-Disaster system for tracking cellular devices has an average efficiency of 40-63% for bandwidth and savings in processor usage on mobile devices 51-70% thus reducing overheating on the device.

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