

An SMS-Based Fault Dispatching System: An Additional Utilisation of a Mobile Phone Infrastructure

Wattanapong KURDTHONGMEE¹ and Pongwirat KEMAPANMANAS²

*School of Engineering and Resources¹,
Postgraduate Student in Management of Information Technology²,
School of Informatics,
Walailak University, Thasala, Nakorn Si Thammarat 80160, Thailand.*

ABSTRACT

The mobile world has grown continually in accordance with Moore's law. That is to say the new models of handset have been developed and marketed with twice the features within the same period of time. The new features of handsets, both general applications and entertainment, are added in order to assist users. At the same time the mobile service providers are also trying to add more and new features to support the powerfulness of the handsets and the demand of users. A short message service, or SMS for short, is another fundamental service which is provided by almost every service provider around the globe. This simple approach of leaving a message can be employed in another application of business which is an SMS-based fault dispatching system.

Key words: Short message service - Dispatching system

INTRODUCTION

The mobile world has grown continually in accordance with Moore's law. That is to say the new models of handset have been developed and marketed with double the degree of complexity within an equal period of time. The additional complexity of the system not only makes the handset more convenient to use and reduces power consumption, but it also increases the features to assist users. From the predecessor handsets with similar capabilities to the wire phone, the successor handsets currently available on the market have been developed to integrate such features as: an alarm clock and a personal diary which are specific to the handsets and are independent of the service providers. Also the handsets now incorporate many features which must be served by the service providers such as: a messaging service both in textual and multimedia based formats. The mobile service providers integrate these features to their handsets in order to support the powerfulness of the handsets, themselves, and the demand of users.

A short message service, or SMS for short, which is the main focus of this paper is another fundamental service which is provided by almost every service provider around the globe. Although, this service at the moment has been upgraded to a user-friendly counterpart which is the Multimedia service (MMS), it is still an effective and simple means of communication between mobile users with a loss-free guarantee. In this paper, we present a new application area of the short message

service: an SMS-based fault reporting system for a phone operator. The organization of this paper is as follows. We present the principle of operation of an SMS service. The details of the system, both hardware and software, are then described. The implementation, experimental results and discussion are also given

The Principle of Operation of an SMS Service

SMS (1,2) is the ability to send and receive short messages of up to 160 characters at a mobile phone. SMS was conceived as part of the Global System for Mobile communications (GSM) digital standard, originally only at 900 MHz but later also at 1800 MHz (also known as DCS1800), 1900 MHz (also known as PCS1900) and 800 MHz (E-GSM). These facilities can therefore, in principle, be used on any GSM or “Personal Communications Network” (PCN, which is also GSM). In Thailand, these networks are run by Orange, DTAC and AIS, as a few examples.

SMS can be used for any purpose where vocal communication is not the easiest or best communication medium. For example, it is very difficult to remember phone numbers and re-key them – the phone number can be sent via SMS and usually the phones provide an easy way to extract the number from the Short Message (SM) and store it in the memory. Having established that the mobile user has a suitable digital phone, the user needs to check the exact facilities offered by the phone and the network. SMS Mobile Terminated (MT) is almost much ubiquitous and has been integrated into all the mobile phones on the market at the moment. This is the ability to receive text messages at the phone.

SMS Mobile Originated (MO) is only on a few phones. This is the ability to send text messages from the phone. Keying messages into a phone is a little arduous as several keys per character need to be pressed, but it can be mastered after a few attempts. Right now, an external device can be attached to some phones, which have full QWERTY keypads and allow proper typing.

The networks can choose which (if any) of these services to provide, and whether subscribers have to pay to have the use of the service. Having established that subscribers have SMS facilities, the next thing is to look at how to get messages to and from the phone. One important aspect subscribers need to know is the Service Centre (SC) number. Sometimes called the “Message Centre”, this is a store-and-forward machine which keeps messages until they can be delivered.

The GSM principle is that each network provides one or more Service Centres and each of these can send to any GSM mobile on any network. In practice, however, there are no agreements to allow SMS to travel between networks, although in many cases this is working at present. So the ultimate goal is to set the Service Centre number to the one provided by the subscribers’ network. Subscribers can then enter any number and send a message, just like making a voice call.

Technically, when a mobile originated SMS message is sent, part of the message tells the local cellular exchange where to send the SMS message. This is the “Message Centre” or Service Centre address. The SC address is normally stored on the phone and/or SIM card. The cellular exchange routes the SMS message in an Simple Client Control Protocol (SCCP) packet. International SCCP messages are routed based on a Global Title. The Global Title used for SMS is the Service Centre address. The SCCP packet is passed from exchange to exchange until it reaches the destination Service Centre. Each exchange along the route inspects the Global Title and uses this to route the message to the next exchange in the chain. Some exchanges look at the

first few numbers (e.g. 66=Thailand) and simply pass the message on. Others expect to see valid ranges (e.g. 44802 is OK and 44860 is not OK). So not all messages reach their intended Service Centre because either one exchange along the route doesn't know where to pass the SCCP packet on, or an exchange thinks that the number is not valid and refuses to pass the packet on.

Once the message is received at the SC, it sends back a confirmation code. This is put into another SCCP packet, either at the SMSC or at the nearest exchange. This is routed in a similar fashion back to the original cellular exchange and on to sender's mobile. Again, this code can be lost somewhere in the mobile network for the above reasons, or occasionally rejected by the destination exchange because it is not understood (incompatible implementations). This results in a failed message indicator on the sender's phone, but the message has been received by the SC and will be sent to its destination.

When the SC tries to send a message back to a mobile, it must first ascertain where that mobile is. It needs to ask the mobile's Home Location Register (HLR) for location information. It has no knowledge of where the HLR is, only the mobile number. So what it does is to send a location request SCCP packet, routed to the mobile number. The international SCCP network routes this packet not to the mobile, but to the appropriate HLR. Again, such packets can go astray because of incomplete routing. This has been evident recently when people have tried to send from overseas SCs to Orange mobile numbers - with 44973 reaching the mobile and 44976 not reaching the mobile. This failure is simply an absence of SCCP routing for 44976 between the overseas SC and the Orange network, at one or more exchanges along the way.

If the HLR is successfully sent the HLR returns the location information in another SCCP packet. This too can go astray or be incomprehensible for the reasons described above. The SC then sends the message to the cellular exchange local to the mobile (as received from the HLR). This is addressed via another Global Title. The routing for this part is normally OK. If roaming is to work properly for voice, every cellular exchange global title has to be reachable. But of course the cellular exchange can in some cases be unhappy with the received packet and not pass the message on to the mobile. Once the mobile has received the message, the local cellular exchange sends a confirmation SCCP packet back to the SC. Routing may again fail for this, or the SC may not understand the received packet format.

From the principles of operation of SMS, it is obvious that this is the easiest and safest approach to sending a message amongst the mobile phone subscribers. The applications of SMS in the field of the fault report system related to this research have been cited in only a few publications. The Metropolitan Electricity Authority of Thailand has developed an in-house system to send an SMS concerning electric supply failure to its on duty maintenance officers. The system, (3) Mobile Paging, is a web-based application which accepts an input from the user and automatically forwards the message to the mobile network.

In the next section, we describe the details of our (as-is) fault reporting system and propose a new system in order to employ the benefit of SMS to reduce the workload of officers and at the same time increase customer satisfaction.

The Details of an “As-Is” and the Proposed System

According to the current workflow of the organization (TT&T PCL), in case of any failure to a phone line which is serviced by the company, the owner of the phone notifies by dialling 1177 and reports the failure directly to the operator. Subsequently, in order to correct the problem, the 1177 operator forwards the message to the maintenance division either by writing a notification report or by notifying via mobile phone. The process of an (as-is) fault reporting system is shown in **Figure 1**. Both notification approaches involve unavoidable faults and cause delay to the owner of the phone. In addition, for the latter approach of fault report, via mobile phone, which is a faster approach a further problem could still exist. That is to say the operator might not be able to connect to the maintenance officer who might be on duty in a mobile carrier signal free area. This gives another job to the operator to keep on notifying. All of these difficulties are an origin of customer dissatisfaction to the service of the company as a whole.

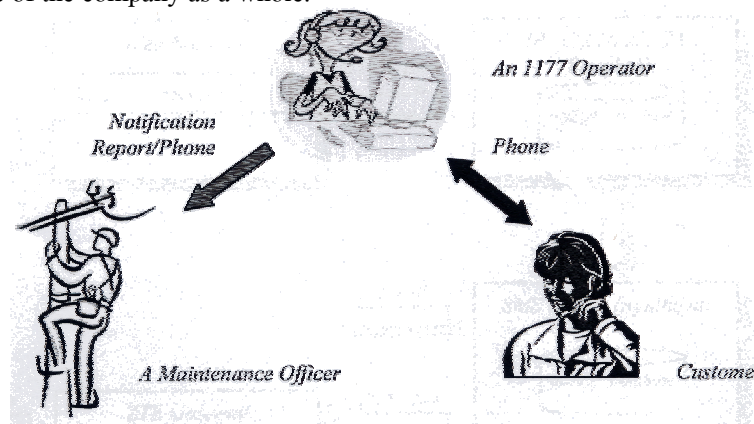


Figure 1. The current workflow of an As-Is fault reporting system.

As a result, an SMS-based automatic fault dispatching system has been developed to alleviate the problems described previously. There are several benefits resulting from the SMS-based system proposed and developed in our research which are:

- Time reduction in forwarding the fault messages from the 1177 operator to the maintenance officer
- Duty reduction in delivering the fault messages to the maintenance officer
- Increasing user satisfaction
- Reduction in manpower (the number of relating officers)

The context diagram of the proposed SMS-based automatic fault dispatching system is illustrated in **Figure 2**. Notice that there is a slight difference between **Figure 1** and **Figure 2**. The workflow in **Figure 1** still relies on an operator to directly communicate with a customer during a fault complaining session. We have found during the analysis phase of our research that another system to store the cause of the fault automatically can be developed in parallel with our work. This system is called “an automatic fault complaining system” in the context diagram shown in **Figure 2**.

The system outputs the fault number to our system, at the center of the context diagram, which is, in turn, dispatched to the staff of the fault repairing division via SMS. The result of repair is reported directly to the head of the maintenance division who is also responsible for updating the fault and repairing details into the database of the proposed system.

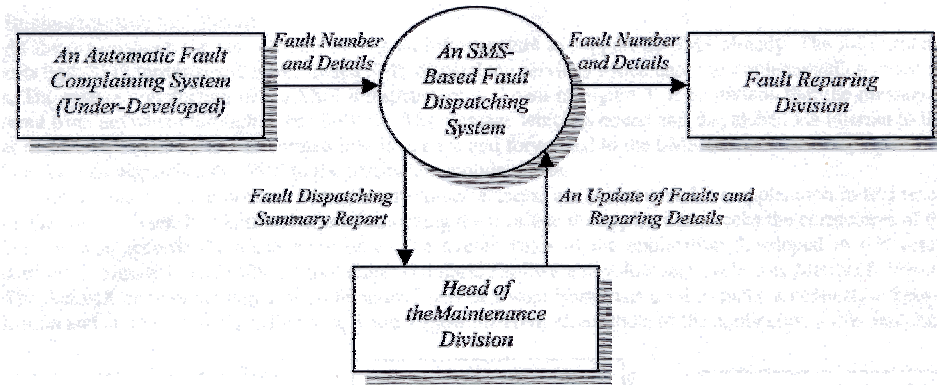


Figure 2. The context diagram of the proposed SMS-Based automatic fault dispatching system.

IMPLEMENTATION AND RESULTS

The organization we are working for has an infrastructure to support an SMS already. The infrastructure also supports both SMS terminal and a web-based SMS dispatching services which eases the implementation process of our work. The system architecture of the SMS infrastructure is shown in **Figure 3**. It is obvious that the message can be delivered from anywhere through a web browser. The message which is coded and dispatched via internet to the main server in Bangkok where it is transformed into Java code and forwarded to the SMS center at Ayutthaya province. The SMS center then dispatches the SMS to the destination mobile phone.

In order to automate the process with guaranteed correctness, we implemented the application in this research to bypass the web browser. In addition, before dispatching the message the application checks the correctness of the fault number and also records the dispatching time. The overall roles of the application developed in this research are summarised in **Figure 4**. The software tool employed during the software development cycle was Microsoft Visual Basic 6.0. The ActiveX component which is an integrated part of Visual Basic was used to make a connection between the application and all remote servers. **Figures 5, 6 and 7** show different screenshots of the application's user interface.

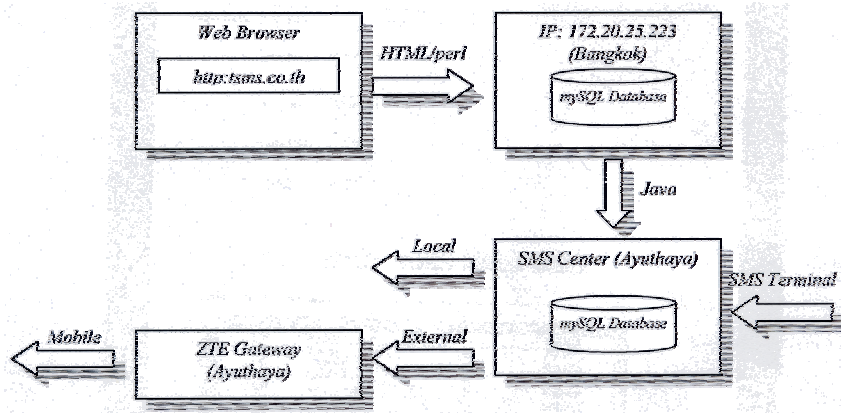


Figure 3. The system architecture of the SMS infrastructure.

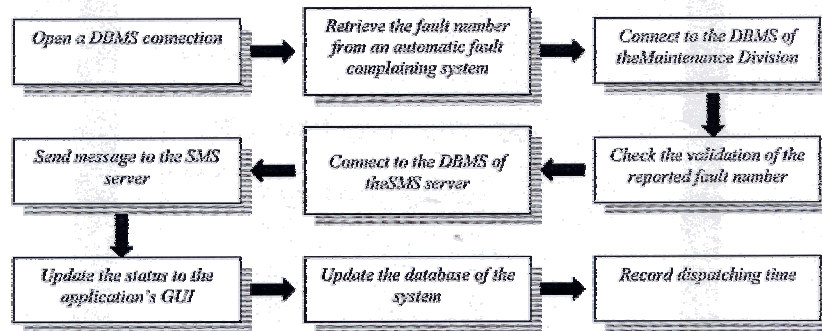


Figure 4. Summary of the overall roles of the application developed in this research.

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4020	นายณัฏฐ์ อภิรักษ์	06	098733107
4036	นายณัฏฐ์ อภิรักษ์	07	098733109
4333	นายณัฏฐ์ อภิรักษ์	10	098733120
4334	นายสุภากร พงษ์	09	098733119
4386	นายสุภากร พงษ์	07	010796661
4441	นายสุภากร พงษ์	06	098733118
4508	นายสุภากร พงษ์	04	098733108

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Figure 5. The screenshot of the application's user interface: Maintenance officer's data entry form.

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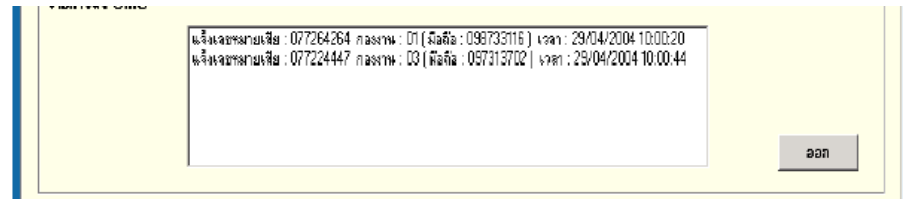
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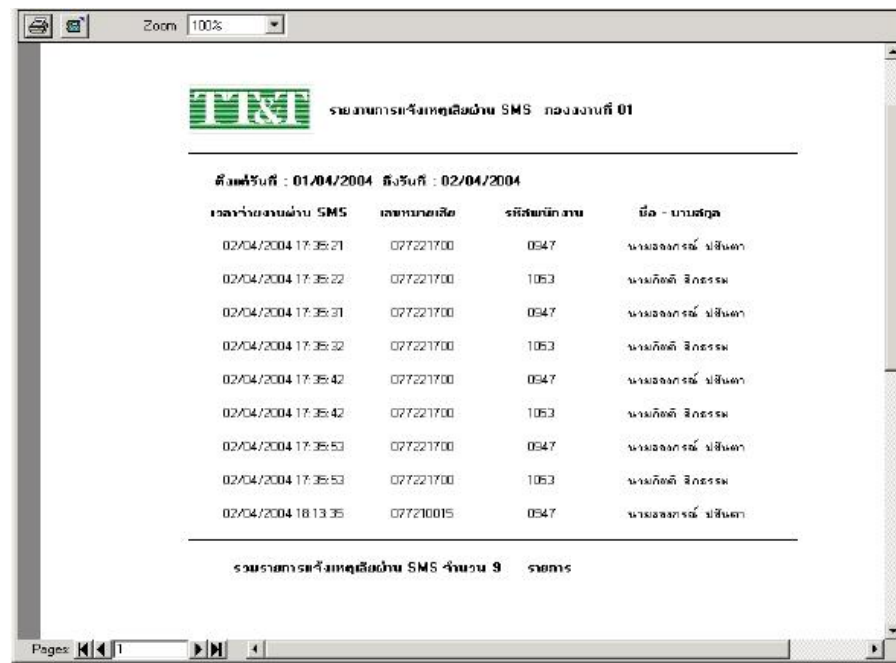
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0101-00	01	องค์การบริหารส่วนตำบล
0101-01	03	สำนักปลัดเทศบาล
0101-02	03	กองช่าง
0101-03	01	กองช่าง
0101-04	01	กองช่าง
0101-05	03	สำนักปลัดเทศบาล
0101-06	03	สำนักปลัด
0101-07	04	สำนักปลัด
0101-08	05	กองช่าง
0101-09	01	กองช่าง
0102-00	05	กองช่าง
0102-01	05	กองช่าง
0102-02	05	กองช่าง
0102-03	07	กองช่าง

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Figure 6. The screenshot of the application's user interface: Area of responsibility data entry form.



(a)



(b)

Figure 7. The screenshot of the application's user interface: (a) Sample dispatched SMS and (b) Summary report.

Finally, **Figure 8** shows a series of screenshots from the mobile phone. The messages shown on the screen are the details of fault report together with the timestamp. These are invaluable information for a maintenance officer who is most of the time on duty in a remote area.

In order to compare the superior ability of the newly developed system with the current process, we developed user satisfaction questionnaires to accumulate feedback from users of the system. The questionnaires were sent to two groups of users of the system which include 7 members of 1177 operators and 10 members of staff of the maintenance office. The results of the survey from two such groups are averaged and summarised as illustrated in **Tables 1 and 2**, respectively. According to the tables, the satisfaction levels are arranged from high to low levels which correspond to 5 and

1 levels, respectively. It is obvious that with respect to the questionnaires related to the speed of fault dispatching, the correctness of fault reporting, and the time and cost reduction of the newly developed system, users of the system are satisfied with the performance of the newly developed system.



Figure 8. The screenshots of the application's user interface illustrating the message on the mobile phone.

Table 1. Summary of the user's satisfaction questionnaires: the 1177 operator.

Questionnaires	5	4	3	2	1
Easy to use level of the new system			x		
Operational speed of the new system		x			
Efficiency improvement of the new system		x			
Cost reduction level		x			
Level of completeness of the fault report message		x			

Table 2. Summary of the user's satisfaction questionnaires: the maintenance officer.

Questionnaires	5	4	3	2	1
Easy to use level of the new system		x			
Operational speed of the new system		x			
Efficiency improvement of the new system	x				
Cost reduction level		x			
Level of completeness of the received fault report message		x			

CONCLUSIONS

In this paper we have presented an additional application of the short message service which is a fundamental service provided by almost every service provider around the globe. This simple approach of leaving a message with a fairly high level of delivery guarantee can be employed in business applications of a fault reporting system. The system prototype has been tested with customers, operators and maintenance officers. The results fulfilled all the requirements of every part. We are now working on a project to integrate our system with the automatic fault complaining system.

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บทคัดย่อ

วัฒนพงศ์ เกิดทองมี¹ และ พงษ์วิรัตน์ เขมะพันธุ์มันต์²

ระบบส่งข้อร้องเรียนความผิดพลาดของโทรศัพท์พื้นฐานผ่านบริการส่งข้อความสั้นของโทรศัพท์เคลื่อนที่: แนวทางการใช้ประโยชน์เพิ่มเติมจากโครงสร้างพื้นฐานของระบบให้บริการโทรศัพท์เคลื่อนที่

พัฒนาการของการสื่อสารผ่านทางโทรศัพท์เคลื่อนที่มีแนวโน้มเป็นไปตามกฎของมัวร์ กล่าวคือ โมเดลใหม่ ๆ ของโทรศัพท์เคลื่อนที่ที่มีความสามารถเพิ่มขึ้นเป็นสองเท่าได้ถูกพัฒนาและออกสู่ท้องตลาดด้วยระยะเวลาที่คงที่ ความสามารถของส่วนเพิ่มเติมของโทรศัพท์เคลื่อนที่ นอกเหนือจากการใช้งานพื้นฐานและการใช้งานเพื่อความบันเทิงมีส่วนช่วยให้ผู้ใช้งานสามารถใช้งานโทรศัพท์ได้ง่ายและหลากหลายมากขึ้น ผู้ให้บริการระบบโทรศัพท์เคลื่อนที่เองยังได้มีการปรับปรุงและเพิ่มเติมความสามารถในการให้บริการที่หลากหลายเพื่อตอบสนองต่อขีดความสามารถของโทรศัพท์เคลื่อนที่รุ่นใหม่ ๆ และความต้องการบริการจากผู้ใช้งาน บริการรับ/ส่งข้อความสั้น (Short Message Service – SMS) จัดเป็นบริการพื้นฐานที่ผู้ให้บริการระบบโทรศัพท์เคลื่อนที่ทุกรายได้จัดให้กับผู้ใช้บริการ ในบทความนี้ผู้วิจัยได้นำเสนอผลงานการวิจัยเพื่อจัดสร้างระบบต้นแบบที่นำเอาบริการรับ/ส่งข้อความสั้นมาใช้ในองค์กร เพื่อส่งข้อร้องเรียนความผิดพลาดในการใช้งานระบบโทรศัพท์พื้นฐานจากศูนย์รับข้อร้องเรียนไปยังเจ้าหน้าที่จัดซ่อม

¹ สำนักรักษาวิศวกรรมศาสตร์และทรัพยากร มหาวิทยาลัยวลัยลักษณ์ อำเภอท่าศาลา จังหวัดนครศรีธรรมราช 80160

² นักศึกษาระดับบัณฑิตศึกษา หลักสูตรเทคโนโลยีการจัดการสารสนเทศ สำนักวิชาสารสนเทศศาสตร์

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