# Comparing Cell Broadcast and Text Messaging for Citizens Warning

**Simone Sillem**
Safety Science, Delft University of Technology, The Netherlands
s.sillem@tudelft.nl

**Erik (J.W.F.) Wiersma**
Safety Science, Delft University of Technology, The Netherlands
j.w.f.wiersma@tudelft.nl

## ABSTRACT

In life-threatening emergencies, citizens need to be warned. The currently used method for citizens warning in The Netherlands is a siren. AT this moment, research is being carried out into using new technologies as an addition to this siren for citizens warning. Modern telecommunication technologies have great potential for informing the public. Especially the use of text-based features of mobile phones is considered for this function. Advantages of such a system are that these technologies overcome problems of hearing the siren and that text-based messages provide possibilities for giving more and more detailed information. In a number of pilot studies, Delft University of Technology has gained experience with the possibilities of these technologies for citizens warning services. This paper compares two text-based mobile phone technologies that can be used for citizens warning as an addition to the siren.

### Keywords

Cell broadcast, SMS, text messaging, citizens warning, siren.

## INTRODUCTION

When there is an emergency situation, citizens in the potentially exposed area need to be warned. In The Netherlands, citizens are warned by sirens in case of a life threatening emergency. The Dutch siren is tested every first Monday of the month at noon, to familiarize people with the sound of it. When the siren sounds at another time than the monthly siren test, people have to do three things:

- Go indoors;
- Close all doors and windows, and
- Listen to local radio or TV station.

When a very small area needs to be warned, a sound car can also be used. This is a car with a microphone that can be used to warn people and to tell them what to do. There have been many complaints about the siren. If a siren is to be detected, the presence of other noise has to be overridden for detection of the tone to take place (Corliss and Jones, 1976). This mainly considers the audibility of the siren indoors and in big cities with a lot of background noise. For example, Jansen (2003) has found that the sound of the siren is 5 dB lower than is specified by manufacturers. The sirens are not designed to be heard indoors, but this is reason for many complaints (Vos and Geurtsen, 2003). Previous research by the authors of this article shows that an average of 37 % of people did not hear the siren on three different test occasions in 2004 (Sillem, Wiersma and Ale, 2005b). This was determined using several research methods. The siren in the Netherlands is tested every first Monday of the month at noon. All 726 participants of a pilot study were sent an SMS message a few minutes after the monthly siren test (three times during the course of three months in 2004). In this message they were asked if they had just heard the siren. Moreover, two questionnaires were sent to the participants before the start of the pilot and after the pilot asking them how often they had heard the siren the past 3 months. The data that was gathered in this way and from other research performed in the Netherlands (for which no reference can be found, unfortunately), indicate the same percentages. Another limitation of the siren is its information conveying capacity. The only information the siren provides people with, is a warning that something is going on. People have to remember what actions they have to take to avoid being exposed to the risk for which the siren is sounded. Evaluation of an incident in Vlaardingen (Temme, Bekkers, Geveke, Lemmer, Stuurman and Erp, 2003) in which a large amount of the chemical substance orthocresol was

spilled, shows that many people do not know what to do when the siren sounds and that there are problems in communicating what is happening and what should be done during an emergency situation. This is a problem, since it is very important to provide information to people in an emergency that allows them to make a correct decision about getting control over the situation or bringing themselves and others to an area of safety (Proulx and Sime, 1991). Humans are very capable receivers of information and usually use this information in accordance with the intentions of the supplier. However, they have to get the information to be able to do something with it. The successful design of warning messages maximizes the probability that each step on the warning process will be completed (Rousseau, Lamson and Rogers, 1998). Combined, the problems mentioned above lead to the recommendation made by Temme et al (2003) to investigate the possibilities for alternative means of communication following the siren that can reach more people and are able to give more information than the siren does.

In this paper, two mobile phone technologies that can be used to warn citizens are described. Two pilot studies have been performed into these two technologies. These studies will be briefly discussed and the two technologies will be compared.

### Mobile phone technology

In recent years the use of mobile phones for text communication has grown explosively. Two billion text messages were sent in The Netherlands in 2002. This is an average of 125 messages for each inhabitant. In 1999, this number was only 500 million, which is 4 times less (Consumentenbond, 2003). In 2004, about 84% of Dutch society actively used a mobile phone (Derksen, 2004). This market share will most likely continue to increase in the coming years, but probably not up to 100%. This high coverage makes mobile phone technologies an interesting possible addition to the siren. However, the limitations of mobile phone technology, such as the possibility of running out of battery and not constantly carrying a mobile with you implies that this technology can only be used as an addition to the current siren, and not as a replacing alternative.

Research by Vilella, Bayas, Diaz, Guinovart, Dies, Simon, Munoz and Cerezo (2004) shows that mobile phone text messages (known in The Netherlands as SMS, which stands for Short Message Service) can improve the transmission of information. Their results show that SMS can be used to increase compliance with vaccination schedules and very probably with other preventive or therapeutic measures.

Mobile phone providers have the possibility to send large groups of identified users a specific message simultaneously. Advantages of mobile phone technology as an addition to the siren are:

1. Mobile phone text messages offer the opportunity to send more information than the siren can give. The siren is only an alarming sound without further information. Instructions can be added to the text messages.
2. Mobile phone text messages offer the opportunity to send differentiated messages to different target groups. For example it is possible to differentiate between the professionals who have specific roles in an emergency situation and the general public.
3. Mobile phones can be equipped with a vibrating alert. This is a possibility to inform the hard of hearing and deaf about an emergency situation through the use of text messages.
4. Mobile phone text messages offer the opportunity to inform other people that cannot hear the siren, such as people that live in remote areas.

There are two main methods for sending a text message to large groups of mobile phone users: text messaging (known in The Netherlands as SMS, which stands for Short Message Service) and cell broadcast. In both alternatives a text message will appear on the screen of the mobile phone user. There is no difference in this part of the technology. There are, however differences between the two systems, these differences in technology will be explained in the next paragraphs.

### Text message function or SMS

The first alternative uses the text message function, which is a well known mobile phone function. With the SMS service, a message is sent point-to-point to a specific predefined set of phone numbers. In this case, the people that receive the message are known, but their location at the time of receiving is unknown. Messages are stored in a buffer between the sender and the receiver, so that a message can also be received at a later point in time when the mobile phone of the receiver was turned of at the time of sending. Because of the technology used, the capacity of

the network for SMS is limited. This could be a problem in a crisis-situation, when the network is easily overloaded (Cel@lert). Research is being performed into finding more intelligent and dynamic routing infrastructure in SMS networks and finding more efficient short message transmission (mBalance, 2006, Naor, 2004, NeoMatrix, 2006, Prieto, Cosenza and Stadler, 2004, Prieto and Stadler, 2005), but it is not likely that this problem will be completely solved soon. Because of privacy laws in the Netherlands, a mobile phone user has to apply for the SMS service before messages can be received. It is not possible to send people SMS messages without their permission. Moreover, the areas for which people want to be warned have to be known, otherwise an SMS message has to be sent to the whole country, as the location of people is not known. When people apply for the SMS service, a certain number of areas are applied for (for example zip code areas). When something happens in those areas, all users that have applied for that area are warned. SMS messages will be received independent of location. This means that the messages will also be received when the user is not in one of the applied areas. To summarize, in order to be able to receive an SMS warning message, a mobile phone user has to:

- Apply for the SMS service;
- Apply for the area for which the warning message is relevant;
- Switch on his mobile phone, and
- Be connected to a network that does not suffer from network congestion when the message is sent.

### Cell broadcast

The second alternative is cell broadcast. Cell broadcast uses a message service in which a message is sent point-to-area to all users within a certain cell. A cell is a geographical area around a certain mobile phone antenna or a set of antennas. Every phone in contact with that certain antenna or set of antennas will receive the message. The term broadcast is used because of its similarity to radio broadcasting. It is a one way communication system. Using this technology, the warned geographical area is known, but not the people that have received the message, just like radio broadcasting. This makes this service anonymous and free of cost for the receiver. With cell broadcast, again like with radio, the messages are not stored in a buffer before sending, but only real time received by switched on mobile phones. If a phone is switched off, the message will not be received when the phone is switched on later. This problem can partly be solved by a repeat rate. The same message can be sent out a number of times with a certain repeat rate. The message will only be received by a mobile phone once. Unfortunately, because of lack of standardization, some mobile phones will also receive all the repeated messages.

A message can be sent from one cell, a set of cells within one area up to an entire network. With cell broadcast a certain channel on each mobile phone has to be activated in order to be able to receive messages, just like tuning in to a radio station. Cell broadcasting places a very low load on the network; a cell broadcast message to everybody in the network is equivalent to sending an SMS message to a single phone. Network loading problems can cause severe problems in emergency situations when network usage is likely to be very high anyway and in these circumstances SMS messages can be delayed for hours or days or even be lost altogether. Cell broadcast messages are sent with different technology, they can still be sent when the network is overloaded. To summarize, in order to be able to receive a cell broadcast warning message, a mobile phone user has to:

- Have predefined the channel of the message that is sent (citizens warning channel);
- Have his mobile phone switched on at the time of sending, and
- Have to be in the geographical area in which the message is sent at the time it is sent.

### Research experience

In a number of pilot studies (Jagtman, Wiersma and Sillem, 2006, Sillem, Jagtman, Wiersma and Ale, 2006, Sillem, Wiersma and Ale, 2004a, Sillem, Wiersma and Ale, 2005a), the Safety Science group of Delft University of Technology has gained experience with the possibilities of using both mobile phone technologies for citizens warning services. The study into SMS was finished in 2004. The pilot studies into cell broadcast are still running and will be finished by the end of the year 2006. The cell broadcast studies that have been finished until now were run in the city of Zoetermeer, a city in The Netherlands with 116.000 inhabitants. In the year 2006, the pilots will be run in the province Zeeland (over 300.000 inhabitants) and the city of Amsterdam (over 800.000 inhabitants). This paper discusses the differences between SMS and cell broadcast and will discuss some differences in research results. The full research context of the overall project is described in the PSAM paper by Jagtman, Wiersma and Sillem (2006).

### Research questions

The purpose of the cell broadcast and SMS research is to determine whether SMS and cell broadcast are efficient and effective additions to the current siren in The Netherlands. Several sub questions have been raised to answer this main question. The questions that are relevant for this paper are:

- How many people can be reached by SMS and cell broadcast?
- How many people can be reached more than by the siren alone?

## THE DIFFERENCES AND SIMILARITIES BETWEEN CELL BROADCAST AND SMS

First, the two different pilot studies will be considered. Note should be taken that these were both implementation tests and not laboratory studies. The conditions under which the participants work are not very well controllable. This resulted in some problems and difficulties that will be described. Then, the similarities and differences between cell broadcast and SMS will be considered.

### Pilot SMS

In the SMS pilot, 726 people from the city of Vlaardingen participated in the research. The report on this research is only available in Dutch (Sillem, Wiersma, Ale and Eysink Smeets, 2004b), but there are also some publications available in English (Eysink Smeets and Sillem, 2005, Sillem et al., 2004a, Sillem et al., 2005a). All participants received 6 SMS-messages over a course of 4 months (March to June of 2004) and were asked to reply as quickly as possible to these messages by sending back an SMS message as soon as they had read the warning message. Besides the messages, people received two questionnaires, one before the start of the pilot and on at the end, to determine the acceptance and opinions of the participants about the SMS service. Special attention was paid to people with auditory impairments, as they are not at all able to hear the siren. This means that SMS may be a first source of information when there is an emergency. There was an interview with some deaf people (with a deaf interpreter) to determine their special needs in a citizens warning service.

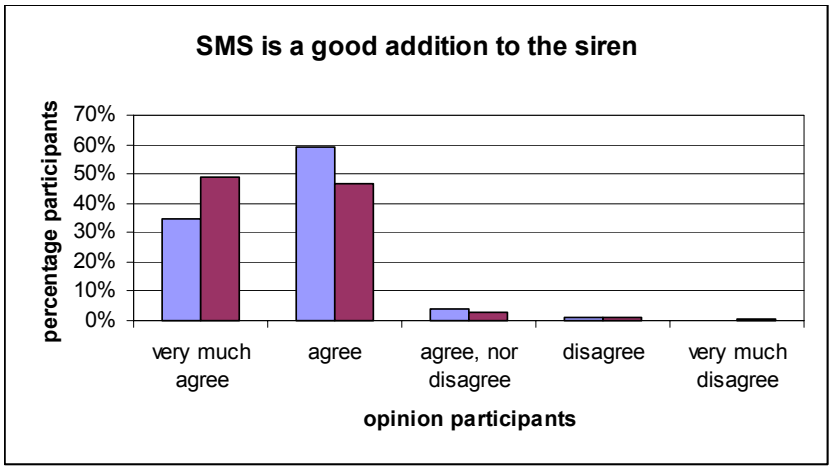


**Figure 1. Opinion about the usefulness of SMS as an addition to the current siren.**

On average, 74 % of the 726 participants replied to the messages. Within the first 7 minutes (this is the time the siren sounds in case of an emergency, so this is the time in which everybody should be warned), an average of 42% have responded. Within 7 minutes, 10 % of the total group of participants has responded and indicated that they did not hear the siren. These people would not have been warned without SMS. This indicates that within the first 7 minutes the profit of SMS is 10 % / 37 % (the overall percentage of people that does not hear the siren) = **27%**. This means that 27 % more people are reached by SMS than by the siren alone within the first 7 minutes.

The acceptance of the SMS service is very high, 95% of the participants say it is a good addition to the current siren. The left columns in Figure 1 are the answers to the questions asked in the questionnaire sent before the start of the pilot and the right columns are the answers to the questionnaire sent after the end of the pilot study (1 = very much agree; 2 = agree; 3 = nor agree, nor disagree; 4 = disagree; 5 = very much disagree).

### Pilot cell broadcast

In the cell broadcast pilot, 1135 people from the city of Zoetermeer participated in the research. The report on this research will be available in Dutch in February of 2006, but there are some publications that will be available shortly in English (Jagtman et al., 2006, Sillem et al., 2006). All participants received 11 cell broadcast messages over a course of 3 months (October to December of 2005) and were again asked to reply as quickly as possible to these messages by sending back an SMS message. As in the SMS pilot, all participants received two questionnaires: one before the start of the pilot and one at the end, to determine the expectations beforehand and their opinions afterwards about the cell broadcast service. The number of participants that responded to the cell broadcast messages was lower than the number of participants that responded to the SMS messages. This can be explained by the fact that some people were not in Zoetermeer at the time of sending the message, or that these participants had their phone switched off. In order to determine how many people were outside of Zoetermeer or did not have their mobile phone switched on at the time of sending the messages, all participants were called once after a message. They were asked whether they had received the message, whether they had their mobile phone switched on, whether they had succeeded in activating the warning channel, whether they were in Zoetermeer at the time of sending the message and some other questions. If the number of people that was not in Zoetermeer, the number of people that did not succeed in activating the cell broadcast channel, and the number of people that had their phone switched off is subtracted from the number of people that did not reply, the response is as high as that of the SMS research.

### Comparing SMS and cell broadcast

The acceptance of the cell broadcast service is somewhat lower than that of SMS, after the pilot 80 % of the participants say it is a good addition to the current siren. The left columns in Figure 2 are the answers to the questions asked in the questionnaire sent before the start of the pilot and the right columns are the answers to the questionnaire sent after the end of the pilot study (1 = very much agree; 2 = agree; 3 = nor agree, nor disagree; 4 = disagree; 5 = very much disagree).

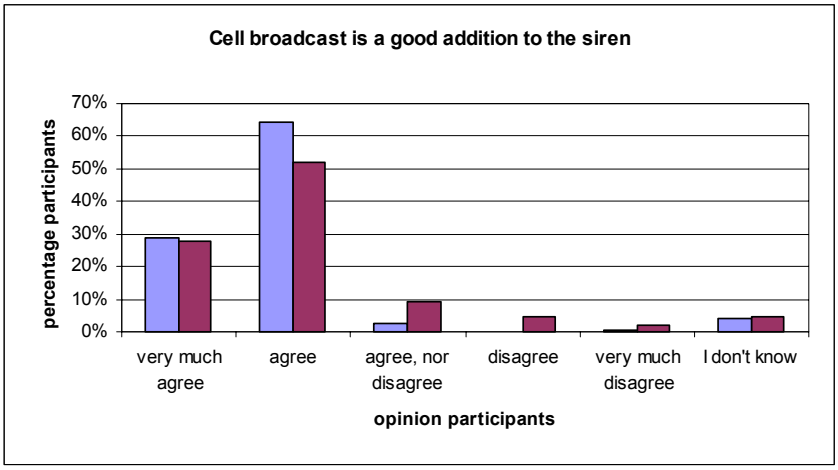


**Figure 2. Opinion about the usefulness of cell broadcast as an addition to the current siren.**

The reason that the participants are a little less satisfied with the cell broadcast service could be that a lot of people had trouble activating the cell broadcast channel on their mobile phone. It is very easy to apply for the SMS service; people only have to send an SMS message to a certain phone number. Most people are used to doing this. To activate a cell broadcast channel, most people need help to find the right menu in their telephone because they have never done this. Until now, no provider in the Netherlands has used cell broadcast to send messages, most people have never even heard of it. To help the participants, they were sent a letter with the steps they had to take to activate the channel for the most popular brands of mobile phones. Then, there was a link in the letter to a website where a manual for many specific phone types can be found (http://www.cb-diensten.nl, in Dutch). Finally, there was an e-mail address on the website for people who could not find their mobile phone type on the website. Still there were many complaints that it was too difficult to activate the channel. 22% of the participants indicate it was hard to activate the channel. Most problems arose in finding the right menu in the telephone and finding the right

instructions for a certain telephone type when it was not on the website. It is very important that before implementing this service, the communication about activating the cell broadcast channel is optimized, to make sure that as many people as possible succeed in activating the citizens warning channel. There may be a possibility to set the alarm channels in all new mobile phones, but this is not the case up until now.

## PRELIMINARY CONCLUSIONS

It seems that people are very keen to participate in research into citizens warning. The responses to all interactions are high. People are open for new technologies and appreciate being warned by SMS and cell broadcast.

With SMS there were no problems in applying for the service. For cell broadcast, activating the warning channel was a big problem for many people.

The cell broadcast pilot is still running and in the current phase, more research is being done into what the main problems in the activating of the cell broadcast channel are; into how it can be made easier for the participants, and into what communication options people need to activate this channel.

## ACKNOWLEDGMENTS

The authors would like to thank Citizen Alert Services and the Expertise Center for Risk and Crisis Communication of the Ministry of the Interior and Kingdom Relations of The Netherlands for making this research possible.

## REFERENCES

1. Cel@lert (2005) Cell broadcasting. http://www.cell-alert.co.uk/cell_broadcasting.htm,
2. Consumentenbond (2003) SMS-tarieven in Nederland veel te hoog (SMS tariffs much too high in The Netherlands). http://www.consumentenbond.nl/nieuws/persberichten/Archief/2003/320206?ticket=nietlid, last visited: June 2005
3. Corliss, E. L. R. and Jones, F. E. (1976) Method for estimating the audibility and effective loudness of sirens and speech in automobiles. *J. Acoust. Soc. Am.,* 60**,** 1126-1131.
4. Derksen, M. (2004) Penetratie mobiele telefonie stijgt naar 84% (Degree of mobile phone use increases to 84%). http://www.mediafact.nl/comments.php?id=P4020_0_1_0_C, last visited: December 20th
5. Eysink Smeets, M. W. B. and Sillem, S. (2005) Intelligent SMS as an effective public warning system: the inspiring results of a Dutch pilot project. In *2nd International ISCRAM Conference*, (Eds, Van de Walle, B. and Carlé, B.) Iscram, Brussels, Belgium, pp. 317-321.
6. Jagtman, H. M., Wiersma, J. W. F. and Sillem, S. (2006) Implementation issues on citizens alarming using mobile phone technology. In *PSAM8*, New Orleans, USA.
7. Jansen, H. W. (2003) Bepaling van geluidemissieniveaus van sirenes (Determining sound emission levels of sirens). TNO TPD, Delft, pp. 18.
8. mBalance (2006) SMS voting. http://www.mbalance.com/products/routing/voting.aspx, last visited March 20th 2006
9. Naor, Z. (2004) An efficient short message transmission in cellular networks. In *IEEE INFOCOM 2004: The conference on computer communications*, S 1-4 Hong Kong, pp. 641-649.
10. NeoMatrix (2006) The Orchid difference. http://www.neomatrix.com.au/orchsys0.html, last visited March 20th 2006
11. Prieto, A. G., Cosenza, R. and Stadler, R. (2004) Policy-based congestion management for an SMS gateway. In *Fifth IEEE International workshop on policies for distributed systems and networks*, Yorktown Heights, NY, pp. 215-218.
12. Prieto, A. G. and Stadler, R. (2005) Design and implementation of performance policies for SMS systems. *Ambient networks lecture notes in computer science,* 3775, 169-180.

13. Proulx, G. and Sime, J. D. (1991) To prevent 'panic' in an underground emergency: why not tell people the truth? In *Proceedings of the third international symposium on fire safety science*, 3 (Eds, Cox, G. and Langford, B.) lastvisited: 1. Elsevier Applied Science, 1991, Edinburgh, UK, pp. 843-852.

14. Rousseau, G. K., Lamson, N. and Rogers, W. A. (1998) Designing warnings to compensate for age-related changes in preceptual and cognitive abilities. *Psychology & Marketing,* 15, 643-662.

15. Sillem, S., Jagtman, H. M., Wiersma, J. W. F. and Ale, B. J. M. (2006) Using cell broadcast in citizens warning: characteristics of messages. In *PSAM8*, New Orleans, USA.

16. Sillem, S., Wiersma, J. W. F. and Ale, B. J. M. (2004a) Alarming the population using SMS. In *Proceedings of ASME-IMECE2004*, ASME, Anaheim, USA, pp. paper number IMECE2004-59686.

17. Sillem, S., Wiersma, J. W. F. and Ale, B. J. M. (2005a) Acceptance of SMS as a tool for alarming the population. In: *Human Factors in Design, Safety and Management* (Eds, de Waard, D., Brookhuis, K. A., van Egmond, R. and Boersema, T.) Shaker Publishing, Maastricht, The Netherlands, pp. 187-200.

18. Sillem, S., Wiersma, J. W. F. and Ale, B. J. M. (2005b) Het versturen van SMS-berichten als aanvulling op de sirene (Sending SMS messages as an addition to the siren). *Tijdschrift voor Veiligheid en Veiligheidszorg,* 4, 32-39.

19. Sillem, S., Wiersma, J. W. F., Ale, B. J. M. and Eysink Smeets, M. (2004b) Evaluatie Pilot SMS-alarmering Vlaardingen (Evaluation Pilot SMS-alarming Vlaardingen). TUDelft Risk Centre, Delft.

20. Temme, B., Bekkers, H., Geveke, H., Lemmer, L., Stuurman, M. and Erp, J. v. (2003) Stank en sirenes; crisismanagement in Vlaardingen, Evaluatie van het Vopak-incident op 16 januari 2003 (Smell and sirens; crisismanagement in Vlaardingen, Evaluation of the Vopak incident in January 16th 2003). B&A Groep Beleidsonderzoek & Advies BV., Den Haag.

21. Vilella, A., Bayas, J.-M., Diaz, M.-T., Guinovart, C., Diez, C., Simo, D., Munoz, A. and Cerezo, J. (2004) The role of mobile phones in improving vaccination rates in travelers. *Preventive Medicine,* 38, 503-509.

22. Vos, J. and Geurtsen, F. W. M. (2003) Een laboratoriumstudie naar de hoorbaarheid van sirenegeluiden. *In Dutch.*, TNO Technische Menskunde, Soesterberg, The Netherlands, pp. 26.