Report on the use of cell broadcast as a citizen alert system

Lessons from a two-year study in the Netherlands (2005 – 2007)

J.W.F. Wiersma
Dr. H.M. Jagtman
Prof. B.J.M. Ale

Delft University of Technology
Safety Science Group
May 2008

Commissioned by the Expertise Centre for Risk and Crisis Communication, Ministry of the Interior and Kingdom Relations

Summary

In the period from 2005 to 2007, a study was conducted in the Netherlands on the use of cell broadcast as a citizen alert system. This report will describe the conclusions and lessons derived from the evaluation performed by Delft University of Technology as part of this study and the follow-up steps that will apply if cell broadcast is introduced.

The central question to the study was whether cell broadcast for citizen alert systems would be a useful addition to the present siren system, in terms of effectiveness and efficiency. To answer this central question, four themes were studied: *reach*, *acceptance, technology and content*.

Part of the study was performed on a transmission infrastructure that had been set up on a 'best effort' basis. This infrastructure was not really suitable for the performance of long-term tests on cell-broadcast reach. Many of the messages transmitted were not sent by all cells, or not by all providers. The final test (in 2007) was performed on a transmission infrastructure with increased vigilance.

Citizens participated in the study. In most tests they used their own telephones, which they had to set for cell broadcast themselves. In these tests, many problems were experienced in relation to the receipt of messages on the mobile phones being used by participants. In the test with increased vigilance, citizens participated with a handset selected specifically for the test, which was handed out to them. Cell broadcast had already been set on this handset. Participants were allowed to keep the handset after the test.

The study shows that the reach achieved by cell broadcast was low in the first tests (25-51%). This can be explained by problems with both the infrastructure and with the mobile handsets. During the final test, the reach achieved by one-page cell-broadcast messages was high (72-88%).

Cell broadcast makes it possible to warn citizens of a disaster and inform them as well. In these situations, it is important to make sure that the message indicates what the threat is and what action is expected from the citizen.

The acceptance of cell broadcast amongst citizens, after experiencing the system, and administrators is high (80-94%). However, there is a big risk factor when the system does not meet expectations. Because citizens themselves are part of the alert chain, careful management of the expectations that they have is very important.

The tests have shown that the technical problems encountered with cell broadcast can be resolved. It was found to be easy to set up the transmission infrastructure in a way that was reliable. It is also possible to set up mobiles phones to receive cell-broadcast messages, although there were problems reading messages consisting of more than one page in the test with increased vigilance.

Given the above, the central question to the study can be answered in the affirmative. Cell broadcast can form an effective and efficient addition to the siren system used for citizen alerts. Added to this, acceptance amongst citizens is high. However, care must be taken during implementation. Cell broadcast is a complex system, both technically and in terms of

organisation. Where the vulnerabilities that exist in various parts of the cell-broadcast alert cycle are recognised and managed, cell broadcast is an appropriate tool for citizen alerts.

The biggest challenge for the successful introduction of cell broadcast will lie in the organisation of citizen participation in cell broadcast. Cell broadcast is only effective with complete citizen cooperation. This means that citizens must have handsets suitable for cell broadcast and must have set them. Added to this, citizens must have their handsets switched on and with them 24 hours a day. This is the only way citizens will receive cell-broadcast messages and the only way that cell broadcast can be an effective citizen alert system.

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1 Introduction

In the period from 2005 to 2007, the Dutch government commissioned a study into the use of cell broadcast as a citizen alert system. Besides technical feasibility and practicability, the study focused on citizen response and acceptance. The study consisted of a number of tests, which were used to ascertain the extent to which cell broadcast is technically feasible as a citizen alert system and what citizen acceptance is.

Test evaluation was carried out by the Safety Science Group at Delft University of Technology. The central question for the evaluation is:

As a citizen alert system, is cell broadcast a useful addition to the current siren system, in terms of effectiveness and efficiency?

To be able to answer this central question, four themes were studied: reach, acceptance, technology and message content. Each of these themes looks at a specific part of the alert cycle in which cell broadcast is used.

- *Reach* focuses on the question of how many citizens will be reached using cell broadcast.
- *Acceptance* concerns both acceptance by citizens and by administrators of the use of cell broadcast as a citizen alert system.
- *Technology* focuses on those links from the chain that relate to the technical chain (with attention paid to both networks and mobile phones). This subject describes the applicable technical preconditions to ensure citizens receive cell-broadcast messages.
- *Content* of messages focuses on the information offered in cell-broadcast messages and on its effect on correct citizen action.

Most tests were carried out on a transmission infrastructure for cell-broadcast messages that had been set up by three providers on a 'best effort' basis, as a '*proof of concept'*. This means that the infrastructure was suitable for the demonstration of cell broadcast, but was not intended for long-term tests. During the first tests in Zoetermeer, it soon became clear that the infrastructure was not reliable enough for this. During the follow-up tests, improvements were made to the infrastructure, where possible. However, results remained under par even for these tests. Tests performed using this infrastructure are referred to as 'best effort' tests.

In the final test in 2007, the infrastructure from just one provider was used, whereby increased vigilance in the transmission system ensured that messages were sent properly. During these tests, the transmission infrastructure worked considerably better. The test with this infrastructure is referred to as the 'increased vigilance" test[1].

Structure

This report is structured as follows. The most important results and conclusions for each of the themes will be indicated in the next section. Section 3 will subsequently indicate which significance the evaluation results have for the possibilities of cell broadcast as a citizen alert system in the Netherlands and describe the follow-up programme. The report has two

[1] Stage 1 to 6: tests on a best effort basis
Stage 7: test on the basis of increased vigilance

appendices. Appendix 1 explains a number of terms. Appendix 2 translates the test results for the Dutch population as a whole.

2 Results and conclusions for the four themes

2.1 Reach

During the tests, steps were taken to ascertain the number of citizens that are reached with cell-broadcast messages. To this end, citizens took part in the tests, who were sent cell-broadcast messages at unexpected times. These messages contained information on how citizens were to respond. The response usually consisted of sending a text message to a freephone number. In the tests, researchers recorded the number of citizens that responded to the cell-broadcast messages. In addition to this, follow-up phone calls were used to find out whether there were citizens who had received a message, but who had not responded. The message reach was determined by the number of participants that responded to the message in the appropriate manner.

During the test with increased vigilance (test in 2007), the receipt of a cell-broadcast message was recorded on the handset. As a result, it was possible to establish whether a message had been received on the handset independent of citizen response.

In the study by Delft University of Technology, the reach of a cell-broadcast message was defined as *the number of participants in a test that progress through the entire alert chain when a cell-broadcast message is sent*. Reach is expressed as a percentage of the number of participants in a test. According to this definition, a cell-broadcast message only reaches the citizen when all of the links in the transmission chain are working:

1. The message must be sent properly;
2. The message must be received properly on the mobile handset;
3. The citizen must read the message;
4. The citizen must act accordingly.

If each of these four steps occurs successfully, the alert will be fully effective. The failure of just one link will result in a loss in the reach of the whole chain. The extent of this loss will depend on the link that fails. Mistakes in sending the message (between the cell-broadcast transmission infrastructure and the provider networks) will have a bigger impact than mistakes at mobile-phone level. Failed receipt on a mobile handset as a result of the wrong settings will only have consequences for the owner of the handset.

In the practical tests conducted on a ‘best effort’ basis, disruptions in various links in the chain had a strong impact on the reach observed. As such, the reach measured in these tests says more about the infrastructure used than about the reach expected of cell broadcast, where implemented. In the test with ‘increased vigilance’, it was possible to attribute the loss of reach to different links in the chain. In this test, considerable gains were achieved in regard of the technological links in the alert system as a whole.

The most important results achieved by the study on the subject of ‘reach’ are as follows:

- With the ‘best effort’ implementation of cell broadcast and using current mobile phones, between 0% and 29% of participants were reached. In the messages in which no participants were reached, the problem was found to occur when sending the message. If only those messages are counted that all participating providers sent in a large part of the transmission area, between 14% and 29% of all participants are reached. Moreover, when attention is focused solely on handsets that were set properly, the reach achieved is between 25% and 51%.

- When using the infrastructure with ‘increased vigilance’, one type of mobile phone and one-page messages, the reach is between 72% and 88%, based on all the messages sent.
- The reach for the two messages in this test that consisted of more than one page is between 32% and 43%. In the case of multipaging messages in this test, the reach was significantly lower than for messages with just one page. This difference is largely due to the presentation of cell-broadcast messages of more than one page on the handset. Messages were received on the handset, but participants often did not respond to them, because they did not know how to read the whole message, due to implementation on the handset.
- In the test with ‘increased vigilance’, messages were received on the handsets in most cases. In this test, test messages were received on 86% to 94% of the handsets.
- Of the number of people reached as part of the ‘best effort’ implementation, an average of 37% responded in the first seven minutes after the cell-broadcast message was sent. Two hours after sending, this increased to an average of 76%. In the test with ‘increased vigilance’, in which each participant had the same mobile phone, an average of 59% responded after seven minutes and an average of 82% of the participants within two hours.
- Where participants in the test did not respond, or responded later, this was mainly because the message was received at an inconvenient time.
- Another reason not to respond, or not to respond immediately, was because the participant cancelled the text too soon, as a result of which it was unclear which response was to be sent, or the receipt of an incomplete message.
- The way that people use their mobile phones can have a strong influence on the reach of the citizen alert system. Messages are only read when people have their mobile phones with them. Many people do not always have their phones with them. As such, the effectiveness of cell broadcast varies throughout the day, depending on the type of day (working day, weekend or public holiday) and the time of day (during working hours, free time or during the night). Indications in the questionnaires show that 16% of participants only have their mobile phones on at specific times. 12% indicate that their telephones are always switched off at night. Added to this, another 28% indicate that they do not have their mobile phones in the bedroom at night. Just 44% of participants say that they can hear their mobile phones at night.
- In one of the practical tests, cell-broadcast messages were sent to alert citizens, but also other information messages. In this test, this did not result in any notable effect on the total number of participants that responded to citizen-alert messages. However, as the number of additional messages sent increases, the speed at which citizens respond to the citizen-alert messages does decrease. This effect can already be measured when sending the smallest number of extra messages in the test (two messages per week).
- In the practical tests in which participants participated using their own telephone handsets, older people (65+) were found to respond to cell-broadcast messages less often than the other participants. In the test where a handset was provided, no difference was observed in the number of responses (reach) to one-page messages between the different age categories. However, older people (65+) do have more difficulty responding to the multipaging messages. Responses to multipaging messages from older people are slower to get going as well.
- No difference was observed in the response received by men and women. Nor was a difference found in the speed at which men and women responded.
- Specific attention is required for alerts to people who are situated on the boundaries of the transmission area for a cell-broadcast message (both within and outside it). A

significant number of people did not receive a message, although they were within the area. There were also people who did receive a message, although they were outside this area. From an organisational point of view, this problem will be the most difficult to resolve at country borders, where people situated in a transmission area within the Netherlands may have a foreign provider.

- The transmission area for cell-broadcast messages never corresponds exactly to the reception area. Because of this, this technology is not generally appropriate when sending messages in limited, intricate geographical areas.

These results lead to the following conclusions about reach:

1. *The reach of cell-broadcast messages in the tests with 'best effort' implementation is low. This is due both to the transmission infrastructure and the receiving handsets.*
2. *The test with 'increased vigilance' showed that the problems with the transmission infrastructure and with the receipt of messages on mobile phones can be resolved from a technical point of view.*
3. *Even when messages are received on a handset, this does not guarantee that citizens will read the message immediately (and in full). In the tests, cell-broadcast messages were not always read straight away or responded to immediately. This may be because people know that the messages are not urgent, because they are taking part in a test. There are also citizens who are unable to read messages, because of the poor user interface on their handsets.*
4. *Correct use of the mobile phone is a necessary condition to be able to receive cell-broadcast messages. Citizens will only be able to receive messages if they have their phones switched on. Citizens must also be able to check whether they have set their handset correctly.*
5. *The use of cell broadcast in border regions deserves specific attention. This applies to both regional and international borders.*
6. *The effectiveness of cell broadcast as a citizen-alert system depends largely on the willingness of citizens to have handsets with them and have them switched on. In this respect, the results obtained from the tests cannot be applied directly to the Dutch population as a whole, because the participants know that they are taking part in a test (also see Appendix 2).*

2.2 Acceptance

In the study, a distinction was made between acceptance by citizens and acceptance by administrators.

Acceptance by citizens

The acceptance of cell broadcast by citizens was measured by administering questionnaires to participants before and after the tests. Acceptance of the use of cell broadcast as a citizen alert system is high. Citizens have high expectations of this system. However, there is a risk factor for acceptance where performance of the system is not in line with the expectations that citizens have, for example because the system is not (yet) able to live up to the unrealistic expectations created.

Acceptance of the system must lead to action by citizens. To be able to receive messages, citizens must have a mobile phone that has been set correctly, which they always have with

them and which must also be switched on. Where use by citizens is not in line with these preconditions, cell broadcast will have a limited reach as a citizen alert system.

The most important results on acceptance from the study are:

- After having gained experience with cell broadcast, 80% (best effort) and 94% (increased vigilance) of participants assess cell broadcast as a useful addition to the current siren system.
- After the tests, the number of participants that say that cell broadcast can replace the WAS is 9% for the 'best effort' tests and 24% for the 'increased vigilance' test.
- Before the tests, participants have a more positive expectation of the possibilities of cell broadcast as a citizen alert system than after the tests. By taking part in the test, expectations are adjusted downwards. This applies both for the tests with participants' own phones ('best effort') and for the test using a telephone provided specifically for this purpose (and the infrastructure with 'increased vigilance'). In the latter test, this decrease was smaller.
- Participants vary in their acceptance of cell broadcast based on their experience of cell broadcast during one or more tests. The differences are particularly evident between participants who responded to cell-broadcast messages sent to them and participants who did not do this. Acceptance was influenced negatively where messages were not received during the tests.
- Participants in the 'additional services' test say that they do not like receiving more than two additional messages a week. Due to the short duration of this test, this was the lowest number of additional messages used in the test. As such, the number cannot be regarded as an absolute lower limit the control messages sent.
- During all of the practical tests carried out in 2005-2007, it was found from responses from participants and other interested parties that many people confuse cell broadcast with texting. Despite the explanation given about cell broadcast technology, many use the term 'texting' in observations about the test. Because texting is a completely different technology, this confusion can lead to the wrong expectations of the possibilities and limitations of cell broadcast. Examples are being able to receive messages later (not real-time) and the need to set handsets to a specific cell-broadcast channel before it is possible to receive messages.

These results lead to the following conclusions about acceptance by citizens:

7. *Citizens see cell broadcast as a useful addition to the current siren system. However, replacement of the siren system by cell broadcast is regarded as undesirable.*
8. *Cell broadcast only works when citizens participate in the system, by setting the telephone and having it with them. As such, acceptance of cell broadcast by citizens is a precondition for an effective system. Citizen acceptance of cell broadcast as a citizen alert system is very high. However, when the system does not meet expectations, poor experience with cell broadcast, such as the non-receipt of messages, or the receipt of incomplete messages, leads to reduced acceptance. If cell*

broadcast were to be introduced, careful management of the expectations that citizens have will be an important condition for its success.

Acceptance by administrators

Acceptance amongst administrators of the use of cell broadcast as a citizen alert system was determined on the basis of interviews with a number of mayors and other parties responsible in crisis situations. This acceptance is also high where cell broadcast is introduced as an addition to existing resources. The proper positioning of cell broadcast within the existing range of warning resources is necessary to ensure that this acceptance is not affected adversely. Clear positioning and acceptance are preconditions for the decision to actually use cell broadcast in the event of a disaster or crisis.

The most important conclusions about acceptance by administrators are:

9. *The use of cell broadcast to alert citizens makes different demands on the system than its use to inform citizens (See Appendix 1 for an explanation). Administrators vary in their perception of the choice to use cell broadcast.*
10. *Cell-broadcast technology is still being developed. Because of this, administrators do not want to make a decision on replacing the current siren system yet.*
11. *According to a number of people interviewed, scrapping of the warning and alert systems [Waarschuwings- en AlarmeringsStelsel] would not be advisable even where cell broadcast was to be used primarily for the alert disaster-control process (see Appendix 1 for an explanation).*
12. *Responsibilities for deployment of cell broadcast as a citizen alert system must be organised according to the structure already laid down in the Disasters and Major Accidents Act [Wet rampen en zware ongevallen (WRZO)] and, as such, depending on the GRIP level. Central government will play the role of facilitator in relation to the implementation and maintenance of the system.*
13. *The use of cell broadcast as a citizen alarm system means that availability must be monitored precisely when use of the technology is required: in a crisis or disaster situation.*
14. *Standard messages must be made available, particularly with a view to alerting people quickly. Added to this, there is always the possibility of formulating customised citizen alert messages. Each form of message must contain an action aspect.*
15. *Cell-broadcast messages must be recognisable as citizen-alert messages and contain an authorisation.*
16. *Where cell broadcast is to be introduced as a citizen alert system, commercial application of this technology will be inadvisable.*

2.3 Technology

The infrastructure used for sending cell-broadcast messages was designed on a ‘best effort’ basis by three providers, as a ‘proof of concept’. This means that the infrastructure was suitable for the demonstration of cell broadcast, but was not intended for long-term tests.

During the first tests in Zoetermeer, it soon became clear that the infrastructure was not reliable enough for this. Improvements were made to the infrastructure, where possible. However, the results achieved for these tests remained under par as well.

In the 'increased vigilance' test in 2007, the infrastructure of just one provider was used, whereby increased vigilance ensured that messages were sent properly. During these tests, the transmission infrastructure functioned considerably better.

The learning process applicable throughout the various tests shows that the transmission infrastructure can be managed using network management and alignment between government and technology providers.

During the tests, a development was also achieved in relation to mobile phones. During the first tests, citizens participated with their own handsets, which they had to set themselves to be able to receive cell-broadcast messages. Implementation of cell broadcast on citizens' own handsets generated a wide variety of problems. Various handsets were not able to receive cell-broadcast messages, or only in part. This applied particularly for messages consisting of more than one page. On other handsets, users were not alerted, or not clearly alerted, that a message had been received.

Added to the above, there were many citizens who were unable to set their handsets properly, or who lost their settings during the test, when replacing their batteries or SIM card, for example.

During the follow-up tests, considerable attention was given to the question of whether the handsets had the proper settings and whether citizens were able to receive messages.

A different concept was used in the test with increased vigilance (test in 2007). For this test, citizens were given handsets with the appropriate cell-broadcast settings already in place. Incoming cell-broadcast messages were announced by means of a special tone. The sound of the siren was used for this purpose. Incidentally, even on these handsets, it was not easy for everyone to read messages of more than one page. The use of one type of mobile phone during this test does not provide a completely realistic reflection of the possible future implementation of cell broadcast, but has proved to be very useful for the purpose of this study.

The most important results yielded by the study in relation to technology are:

- In the tests that were performed on the basis of 'best effort' implementation, less than half of messages sent by all of the participating providers, throughout the transmission area. In the test with 'increased vigilance', no noticeable disruptions to the network were observed from the response received. An instance was reported where one message was not broadcast by four of the 181 cells addressed.

- In the tests in which participants participated with their own mobile phones, it was observed that approximately 80% of participants were able to implement the settings for their own handsets.
- There were problems receiving multipaging messages on different models of handset, both on older and new models. On many handsets, messages were not received, or only in part. As regards the receipt of multipaging messages, the use of repeats when sending cell-broadcast messages was found to be essential.
- During the tests, it was found that cell broadcast settings can be lost on various models of mobile handset for unclear reasons. 10% to 12% of questionnaire respondents indicated that when checking the settings on their handsets, they were found to be no longer correct or respondents were not entirely certain of their correctness.
- On various models of mobile phone, the receipt of cell-broadcast messages was not easy to recognise due to the absence of a tone, or as the result of the use of a very soft tone.
- In the test with 'increased vigilance', an average of 92% of the handsets in the area received the cell-broadcast message.
- In the test with 'increased vigilance', it was found that telephones that are connected with a cell within the transmission area, but do not receive a message, did not receive the message as a result of a transmission error between the cell and the mobile phone or because the mobile phone was switched off.
- Although cell broadcast is included in standards for handset design, its implementation on various handsets has not proved to be user friendly. It was not possible to implement cell-broadcast settings on various handsets, both older and newer models. On other models, implementation was not optimal, as a result of which cell-broadcast messages are not noticed, are noticed late, or cannot be read in full.

These results lead to the following conclusions about technology:

17. *During the tests, there were a large number of disruptions when sending messages. However, it is definitely possible to organise the infrastructure for sending cell-broadcast messages in a way that provides complete coverage. Agreements must be made with providers on the reliability and availability of the transmission infrastructure.*
18. *Various problems exist in relation to the use of cell broadcast with some of the mobile phones on the market at the current time. These problems relate to setting up the cell-broadcast channel, receiving messages of more than one page and the recognisability of the tone when messages are received.*

2.4 Content

The content of cell-broadcast messages was studied by means of experiments with texts and via questionnaires focusing primarily on text used in messages. The strength of cell broadcast as a citizen alert system is that citizens can be directly presented with an action aspect in a message. This means that citizens are directly alerted to the action required. Citizens set

preconditions on the content of alert messages and the receipt of these messages on mobile phones.

Besides the text, another important factor is how a message is received on a mobile phone: how are citizens alerted to the receipt of a message. Each handset has its own way of doing this. In the test with 'increased vigilance', in which all participants were issued with a handset, the handsets used announced the receipt of a cell-broadcast message with a siren sound.

The most important conclusions obtained about message content from the study are:

19. *The use of cell broadcast makes it possible to provide concrete information about the action necessary and/or advisable in the event of a threat or disaster. As a result, information provision during the alert process is more direct than when using the siren.*
20. *Besides indicating a threat or disaster and the location of the incident to which a citizen-alert message relates, the message must include a description of the action to be taken by citizens (action aspect).*
21. *Citizens attach the least importance to the question of where more information can be found (reference to other media). This part of the message can be omitted.*
22. *Citizens have a strong preference for short texts in cell-broadcast messages as part of a citizen-alert system. As far as participants are concerned, content may be presented in a telegram style.*
23. *Participants say that they would like to receive a date and time indication in or with cell-broadcast messages.*
24. *Based on the various experiments, it is not possible to establish whether citizens will actually act after reading a cell-broadcast alert message, further to an actual threat or disaster.*
25. *A cell-broadcast message used as part of a citizen-alert system must be clearly recognisable when received. The use of a specific tone is a possibility, which participants indicate is an advisable option. Although the use of a distinctive tone is experienced as advisable, this did not lead to large number of faster reactions during the practical tests than when using a standard tone (a beep when a cell-broadcast message is received).*

3 Answer to the central question and follow-up

3.1 Answer to the central question

The central question for this evaluation study was: Would cell broadcast be a useful addition to the present siren system, in terms of effectiveness and efficiency? In this context, the term ‘effective’ refers to the question of how many citizens can be reached using cell broadcast and which information can be provided. The term ‘efficiency’ refers to the relationship between the effort needed to reach citizens and the result achieved.

The answer to this question is: yes, cell broadcast could be an effective and efficient addition to the siren system used to alert citizens. Added to this, acceptance amongst citizens is high. However, careful implementation will be necessary. Cell broadcast is a complex system from both a technical and organisational point of view. It would be an appropriate citizen-alert system if the vulnerabilities that exist in different parts of the cell-broadcast alert cycle were recognised and managed.

Cell broadcast can be a useful addition to the existing range of tools used to alert and inform citizens of a crisis or disaster situation. Cell broadcast could be used both to alert citizens (at times where a threat or disaster is imminent) and inform them (the provision of information about a crisis or disaster). However, these two different applications do place different demands on implementation. Cell broadcast has a place between the alerts issued via the siren system and the information provided via various media (including TV, radio and the Internet). This is possible because an action aspect can immediately be included in a cell-broadcast message. By presenting citizens with this action aspect, an appeal is made to the self-reliance of citizens.

Cell broadcast forms a chain consisting of various links: the transmission infrastructure, mobile handsets and citizens. The best way for government to manage the transmission infrastructure would be by means of a service level agreed on in advance with providers of this technology. Opportunities would arise in relation to mobile handsets in time, if the government continues its active role in discussions with handset developers. Citizen involvement in the alert chain requires the ongoing attention of the government, so that citizens are able to receive cell-broadcast messages.

Cell broadcast reaches that part of the civilian population that cannot be reached using current methods, including the deaf and hard of hearing. The strength of cell broadcast used as a supplement for the siren is that redundancy is built into the system. This means that there are a number of ways in which citizens can be warned. Where one of these resources does not work in a crisis or disaster situation, another resource will be able to take over this function.

3.2 How to proceed with cell broadcast?

The study shows that cell broadcast as a citizen-alert system yields major opportunities. The system could be a useful and efficient addition to the current range of alert resources. The addition of cell broadcast would make it possible to reach more citizens better than is currently possible.

However, the study does reveal a number of vulnerabilities of cell broadcast when deployed as a citizen-alert system. These are not such that a follow-up step is impeded. However, these vulnerabilities do mean that cell broadcast as a citizen-alert system must be implemented carefully and via a regulated and staged process. In addition to the proper implementation of the transmission infrastructure, attention must be given to the development of handsets and to the provision of information to citizens about this new alert system. The study yields a large number of starting points for the substantiation of these points. This report is too short to discuss all of the various points, but several of them will be outlined per component.

The definition process for the *transmission infrastructure* has already reached an advanced stage. The tests carried out in recent years have yielded a large number of points for attention that have already been or will be incorporated in the further development of the transmission infrastructure. From the point of view of this study, the most important subjects are the reliability and availability of the system. The latter must be expressed in terms of the extent of availability during disaster and crisis situations. The availability of cell broadcast is only important when a disaster or crisis situation arises. Although these are rare events, these are precisely the situations in which systems generally fail. As such, a general measurement for availability is not relevant. This must be expressed in terms of a measurement that establishes the situations in which cell broadcast must function.

New *handsets* are launched on the market with great regularity. Partly as a result of the efforts made by government, the attention that cell broadcast received during the practical tests led to increased attention for cell broadcast in a number of new handsets introduced. Depending on the implementation of cell broadcast and its actual use, attention for the development of better implementations on handsets may increase in the years ahead. The role for government will be to promote and facilitate the above.

However, handsets will continue to be introduced that do not support cell broadcast, fail to do so properly, or on which cell broadcast has not been programmed. Added to this, there will be a large number of citizens that have old handsets on which cell-broadcast messages cannot be received or read, or cannot be read properly, in the years ahead. Although the turnaround time for handsets is high, the tests in which citizens participated with their own handsets showed that old handsets continue to circulate for a long time. All these handsets form a threat for the effectiveness of cell broadcast. The task for government will be to gain and maintain an insight into the possession and use of appropriate handsets. This insight will be necessary to be able to assess the effectiveness of cell broadcast.

During the practical tests, cell-broadcast technology transmitted via GSM was used. The evaluation by Delft University of Technology limited itself to this. Mobile telephony is developing continually. This dynamism means that the government will not be finished when cell broadcast has been implemented, but will need to continually respond to technological changes in the field of mobile telephony.

A cell-broadcast citizen alert system makes the *citizens* themselves part of the alert chain. The effectiveness of the system will depend on the willingness of citizens to buy appropriate handsets, ensure that the relevant settings are activated and that their handsets are switched on and that they carry these handsets with them. Messages can only be received where all of these conditions have been fulfilled. This is in line with efforts by government to make citizens more self-reliant and more responsible for their own safety. However, active participation by citizens cannot be enforced, but must be achieved by persuading people with information and, possibly, by giving people incentives to buy the appropriate handset.

This means that citizens will have to accept cell broadcast. The expectation that government creates amongst citizens in relation to the possibilities and limitations of cell broadcast will be very important in this respect. If citizens expect a system that works perfectly in a situation where it is not possible to activate mobile phones properly, messages are not displayed properly or do not work properly in other ways, citizen acceptance will quickly decrease. This will also cause a decrease in willingness to form part of the system, which will lead to a lower reach and, as such, to lower effectiveness. Therefore, the government must manage and monitor citizen expectations carefully.

In addition, the government will need to continually inform citizens via constant awareness programmes. A regular reminder via a cell-broadcast message, sent at the same time as the monthly siren-system test, for example, could contribute to awareness amongst citizens. Added to this, it would be useful for citizens to test whether their handsets are still set correctly at times convenient for them, via a *heartbeat* for example. The use of cell broadcast in crisis or disaster situations could contribute to this awareness. In this way, citizens will see that it can be useful to ‘take part’. Although this will give the use of cell broadcast added value, it must not become an objective in its own right.

The staged introduction of cell broadcast must include attention for *evaluation*. This must take place both during staged introduction and after completion. Evaluation will consistently provide information for decisions on later steps in the process. These decisions may lead to continuation, adjustments, repositioning or reconsideration of the use of cell broadcast as a citizen alert system.

Evaluation must include attention for the performance of all three of the subjects indicated: the transmission infrastructure, handsets and citizens. Attention must also be given to the

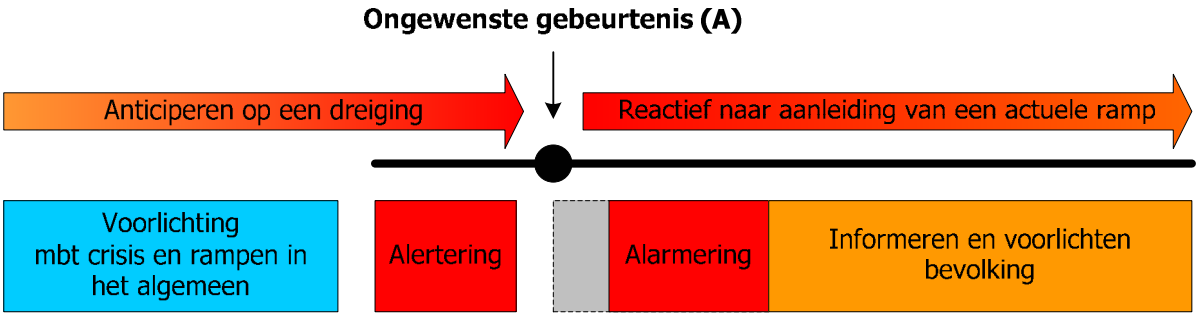
question of how effective the system was found to be in practice. This could be by means of an interim evaluation following each use of cell broadcast as a citizen alert system, for example. These evaluations can be used to ascertain how the system has performed from a technical point of view and which part of the population has been reached with cell broadcast. At this stage, it would be advisable to start to consider how these evaluations should be organised and under which conditions they will lead to an adjustment or reconsideration of the system.

During the tests, it was said that cell broadcast could replace the warning and alarm system in time. At a certain point, this possibility (in time, possibly) was even said to be one of the conditions for the introduction of cell broadcast as a citizen alert system. Replacement is currently not relevant.

The results of the tests performed in recent years do not give any cause to proceed to replace the present system. There are still too many uncertainties in relation to cell broadcast to raise the position of the WAS for discussion at the current time. A warning system in which cell broadcast is used would be very complex and could not be completely ‘managed’ by the government. This certainly applies for developments in relation to handsets, which must be left to the market to some extent. This applies even more for the willingness of citizens to feel responsible for alerting themselves, particularly in the long term. Time will tell how this will develop. Perhaps this question could be raised again several years after the introduction of cell broadcast. It should not be forgotten that requirements in relation to the deployability and reach of cell broadcast will be heavier when the system is regarded not as an additional system, but as a replacement system.

Appendix 1. Definitions, citizen alert and the alert cycle

This study concerns alerting citizens. This refers to two of the processes that are distinguished in disaster control. One process concerns an '(immediate) *population warning*". The object of this process is 'to warn the population as quickly as possible of an (immediate) threat or actual disaster situation that has arisen, with the object of bringing about a change in behaviour that is such that material and immaterial damage is limited wherever possible'. The other process is to '*inform'*. The object of this process is 'the deliberate provision of help through information, geared towards target groups at threat or who may be at threat of an imminent disaster or an actual disaster situation'. According to the Disasters and Major Accidents Act 1985, both processes fall under the primary responsibility of mayors. In practice, immediate warnings are provided by regional fire brigades. Information is usually provided by municipal communication advisers. The processes concerned have been depicted in relation to one specific unwanted incident in Figure 1. The axis in the middle of the figure represents the time axis starting from the time when incident A arises until the point at which it is no longer current. The figure shows that the alert function is the closest to the event in terms of time.



Ongewenste gebeurtenis (A)	Unwanted incident (A)
Anticiperen op een dreiging	Anticipation of a threat
Reactief naar aanleiding van een actuele ramp	Response to a current disaster
Voorlichting mbt crisis en rampen in het algemeen	Information on crisis situation and disasters in general
Alertering	Warning
Alarmering	Alerting
Informeren and voorlichten bevolking	Informing the population

Figure 1: Generic functions for alert, depicted in terms of time

In the figure, the provision of information is situated the furthest from unwanted incident A in terms of time. Following a disaster situation, the information provided will relate specifically to incident A. For example, the consequences, the current state of affairs and expectations about achieving a return to the normal situation in the area 'affected'. Information prior to an unwanted incident will focus on the provision of general information, which will prepare

citizens for disasters. For example, campaigns on how citizens should respond if the siren is sounded could be launched. The question of information provision is not considered in this study. Figure 1 is a generic figure that can be used for every type of disaster.

In the study, we distinguish three stages for a citizen alert: commencement of the emergency situation, activation of a warning system and response by the citizens alerted. In Figure 2, these stages are identified by means of the letters A, B and C. Numbers 0 to 4 break the stages down further and specify the use of cell broadcast as a warning system. These stages stand for:

A. Commencement of the emergency situation (this is always unknown)
    0. The emergency situation is identified and a decision is made about the need to send a text message alerting the population
    1. The decision on the type of message and content of the text message is made on the basis of the characteristics of the specific emergency situation
B. Activation of the warning system
    2. The warning message is sent to individual mobile phones via the GSM antenna system for the mobile network
    3. The population reads and understands the warning message
    4. Citizens decide whether or not to observe the instructions in the warning message
C. Citizen response to the warning message

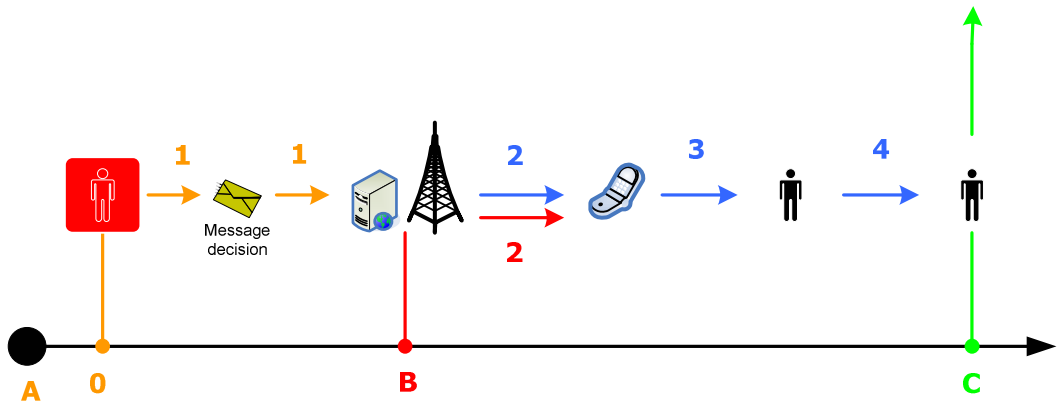


Figure 2: Alert cycle for a citizen alert using mobile technology

An alert in a life-threatening situation will have been effective after the event where *as many* of the individuals under threat have been reached *as possible*, with the individuals in question receiving *sufficient information* to be able to undertake the action required to ensure their safety.

Appendix 2. Generalisation: significance of the results for citizen alerts with regard to the population of the Netherlands as a whole

What significance do the results of the tests have as they are applied to the population of the Netherlands as a whole? This question cannot be answered automatically. The design of the tests prevents the establishment of the exact percentage of the Dutch population that will be reached by a cell-broadcast message sent in an actual crisis or disaster. Various factors will play a role in this translation. These factors can have either a positive or negative effect on the reach of cell broadcast.

The translation of the results obtained from the various practical tests to the Dutch population as a whole will depend on the question to what extent the participant groups are representative, the extent to which the technical resources used are a realistic reflection of the technologies available on the market and on the sort of questions that can be answered with the test design used.

The practical tests generate information about the citizen group that participated in the tests. In principle, the results obtained are only a reflection of the participant group for each separate test. The translation of these results to the population as a whole in a test area and to the Dutch population will depend upon how representative the participant groups are. The study looked at the gender and age of participants and at their attitude towards technological innovation.

In the practical tests, men were overrepresented in comparison to women. During ‘best effort’ implementation, the 40-65 age category was overrepresented and older people (65+) were underrepresented.

As regards participant reach, the results of the tests do not show any differences between men and women. By contrast, older people were found to respond less during the tests involving participants’ use of their own mobile phones. Because of the underrepresentation of older people in relation to test participation, the result of the tests may provide a picture that is too positive.

Test participation was limited to people with mobile phones (whether or not provided specifically for the test). As such, 100% of the participants had a mobile phone at their disposal. This is not the case for the entire Dutch population. There will always be part of the population that does not have a mobile phone. It will never be possible to reach these people directly via a cell-broadcast message.

On the other hand, it is possible for a cell-broadcast message received on a single handset to reach a number of people. In principle, where people are part of a larger group, it will be sufficient for one message to be received on one or several handsets. It will not be necessary for everyone to receive a message, because people can inform each other. In this way, a whole group of people can be reached with just several handsets. This is referred to as the *buddy system*. This is regarded as one of the strengths of cell broadcast. The study did not address the question of how not possessing a mobile phone on the one hand and the provision of information to people through one mobile phone on the other hand influences reach.

A user test in which a technical innovation is tested will particularly involve participation by people with a positive orientation towards technology in general. Participants will be curious about the new application and will have a relatively higher acceptance than the population in general.

In the test with increased vigilance at Walcheren and Zuid-Beveland, a special handset was issued on which cell broadcast had already been activated. As a result, all of the citizens participating had the same type of mobile phone. A uniform implementation of this nature will never happen in practice. The great diversity of mobile phones used by participants in the earlier tests (‘best effort’) provides a more realistic reflection of the handsets used by the Dutch population. This diversity will continue to exist after the introduction of cell broadcast. Amongst other things, this means that telephones will certainly need to be set up in the first several years after being bought. This will apply both for existing handsets owned by citizens at the time the system is introduced and handsets that are bought after the system is introduced.

The results of the tests were all obtained as a result of cell-broadcast messages sent under normal conditions. These results will not automatically apply to a crisis or disaster situation. The expectation on the one hand is that citizens will be more motivated to read a cell-broadcast message if received in a threat situation, provided the receipt of a message is observed. This requires clear recognisability when messages are received, unique to the use of a citizen alert. Where the same recognition (a tone, for example) is used for other applications, this effect will be lost. On the other hand, the stress of a crisis situation will increase the chance of people making mistakes. Uncertainties resulting from a poor implementation of the technology will lead more frequently to the inability to read a message in a crisis or disaster situation. This effect will be reinforced where the application is not used often, as a result of which citizens are not sufficiently familiar with the system.

The practical tests had a short turnaround time for each participant group. This meant that it was not possible to get used to the system, nor were learning effects or long-

term effects possible. It is not possible to estimate whether effects of this nature have a positive or negative effect on the effectiveness of cell broadcast.

During the tests in Zoetermeer, Zeeland and Amsterdam, ‘best effort’ implementation was used. This meant that it was possible to send cell-broadcast messages via the networks offered by three providers. Cell broadcast did not form part of the monitoring systems used by the providers, which meant that checks to ascertain whether the cell broadcast functionality was still working did not form part of network maintenance or network extensions. Problems like this influenced the results of the tests carried out on a ‘best effort’ basis. The results from the test based on ‘increased vigilance’ show that the inclusion of cell broadcast in standard provider processes greatly reduces the number of errors in the network.