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Automotive Telematics Services based on Cell Broadcast

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Automotive Telematics Services based on Cell Broadcast

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Title

Automotive Telematics Services based on Cell Broadcast

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Sammanfattning

Abstract

Cell Broadcast is a relatively old technique within the GSM-network which makes it possible to broadcast text messages to one or more cells in the network. As efforts in Sweden have been made to develop both traffic safety and information technology, the automotive telematics market is predicted to grow rapidly in the near future. The characteristics of Cell Broadcast make it especially suitable for automotive telematics services. The main purpose of this thesis is to investigate possible automotive telematics services based on Cell Broadcast and how these services can affect traffic safety.

The most important characteristics for Cell Broadcast in the automotive telematics market are close connection to the GSM/UMTS network, location-based information and information of push character. These characteristics allows the mobile operator to offer a number of automotive telematics services based on Cell Broadcast, some of them as service provider and some of them in joint ventures with car and mobile terminal manufacturers.

Nyckelord

Keyword

Automotive telematics, road telematics, in-vehicle telematics, traffic information, Cell Broadcast, GSM, UMTS, road informatics, traffic safety

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David Gundlegård

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Summary

Cell Broadcast is a relatively old technique within the GSM-network which makes it possible to broadcast text messages to one or more cells in the network. The technique is unused in Sweden today but lately the development of Cell Broadcast services has increased, mainly in central Europe. The main arguments against Cell Broadcast have been:

- No possibility to charge the end customer
- Lack of standardisation
- Energy consuming for the mobile terminal

Better standardisation, possibilities to charge the end customer and battery improvements in the mobile terminals have changed the conditions for the Cell Broadcast market. The breakthrough of SMS might also have affected the possible user-group of Cell Broadcast.

As efforts in Sweden have been made to develop both traffic safety and information technology, the automotive telematics market is predicted to grow rapidly in the near future. The characteristics of Cell Broadcast make it especially suitable for automotive telematics services. The main purpose of this thesis is to investigate possible automotive telematics services based on Cell Broadcast and how these services can affect traffic safety. The most important characteristics for Cell Broadcast in the automotive telematics market are:

- Close connection to the GSM/UMTS-network
- Location-based information
- Information of push-character

The close connection to the GSM/UMTS-network is important since most telematics services are in need of information from the vehicles to be developed. In order to make the users willing to pay for automotive telematics services the available traffic information has to be improved, which probably demands an uplink from the vehicles via GSM/UMTS. When the traffic information is improved (i.e. extended) the importance of location-based information increases and the small broadcasting area of a Cell Broadcast message becomes essential. Traffic information is the type of information that the user wants only when a deviation has occurred. The fact that the driver has difficulties in predicting when a deviation has occurred makes the push-character of the information important.

The operator will have a central role in the automotive telematics market since it controls an important uplink from the vehicle, road traffic data within the GSM-network and a suitable distribution media in Cell Broadcast. A number of automotive telematics services based on Cell Broadcast can be offered. Some of the services can be offered by the operator alone and some demand joint ventures with car and mobile terminal manufacturers.

Possible effects on the driver when an incident warning system based on Cell Broadcast is implemented are reduction in speed, higher attention and reduced workload. This might lead to accidents being prevented, such as congestion and rear end collisions, accidents involving animals and other local hazards.

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Terminology

<i>Abbreviation</i>	<i>Explanation</i>	<i>Description</i>
ASN.1	Abstract Syntax Notation one	Standard format for describing data types
BSC	Base Station Controller	Controls a number of BTSs in GSM
BSS	Base Station Subsystem	Includes BTSs and BSCs in GSM
BTS	Base Transceiver Station	Node B in UMTS.
CB	Cell Broadcast	See chapter 2
CBC	Cell Broadcast Centre	See section 2.3
CBCH	Cell Broadcast Channel	See section 2.8
CBE	Cell Broadcast Entity	See section 2.2
CN	Core Network	See section 1.1.2
CTCH	Common Traffic Channel	Logical channel used for broadcast/multicast services in UMTS
DRX	Discontinuous Reception	Technique to minimise the battery usage on mobile terminals when CB is used
ETSI	European Telecommunications Standards Institute	Europe's organisation for telecom standards
FCD	Floating Car Data	Cars with GPS and GSM equipment send their position for traffic information purposes
GSM-R	GSM-Railway	GSM network with coverage for the railway
HTTP	Hyper Text Transfer Protocol	Communication protocol for the web (at application level)
LPD	Link Protocol Discriminator	Determines which protocol that is used
MT	Mobile Terminal	Cf. mobile phone, cellular phone

<i>Abbreviation</i>	<i>Explanation</i>	<i>Description</i>
OTA-message	Over-The-Air message	Message which allows the operator to control functions in the MT
PDA	Personal Digital Assistant	Small handheld computer
RNC	Radio Network Controller	Controls a number BTS in UMTS
SDCCH	Standalone Dedicated Control Channel	Signalling Channel in GSM where Cell Broadcast messages are sent
TCH/F	Traffic Channel / Full rate	Bandwidth allocated for one phone call
TRISS	Trafikinformations-stödsystem	See section 4.1.5
UTRAN	UMTS Terrestrial Radio Access Network	Includes BTSs and RNCs in UMTS
RDS/TMC	Radio Data System / Traffic Message Channel	See section 1.1.1
SABP	Service Area Broadcast Protocol	Protocol used for broadcast services in UMTS
SMSCB	Short Message Service Cell Broadcast	Alternative designation of Cell Broadcast
TA	Timing Advance	See section 1.1.2
WAP	Wireless Application Protocol	Protocol used to collect content from Internet to mobile terminals

1 Introduction

The word *telematics* is a combination of the two words *telecommunication* and *informatics*. *Telematics* is a wide concept and involves everything that combines *telecommunication* and *information technology*. *Automotive telematics* can be described as services or functions that offer wireless communication to increase safety, mobility and convenience in the vehicle.

In Sweden the government has decided to dramatically reduce the number of people killed and severe injured in road traffic. One way to achieve this is to use automotive telematics to prepare the road-users for deviations in traffic situations that can cause accidents. How can automotive telematics services be designed with Cell Broadcast as distributing medium?

1.1 Background

1.1.1 Automotive telematics today

The Wireless communication in automotive telematics can be achieved using many different techniques. The most popular medium so far for distributing traffic information has been radio and RDS/TMCⁱ. As the use of mobile terminals has increased, the GSM network has evolved as a potential medium for distribution of traffic information to a large number of the road-users. The most commonly used media for traffic information and their characteristics are described in *Table 1* below.

Media	Distribution	Receive method	Scope	Uplink available
Radio	Point-to-multipoint	Push	Regional	No
RDS/TMC	Point-to-multipoint	Push	Regional	No
Telephone	Point-to-point	Pull	By road	Yes
WAP	Point-to-point	Pull	By road	Yes
HTTP	Point-to-point	Pull	By road	Yes
SMS	Point-to-point	Push	By road	Yes

Table 1. Overview of the most common traffic information medias.

The media described in *Table 1* are all used in automotive telematics today. The characteristics presented in the table affect how suitable a certain medium is for automotive telematics services. If the distribution is point-to-multipoint, the radio interface can be more effectively used, especially since vehicles in the same area often want the same information. The receive method determines whether the user has to collect the information when he/she thinks it is appropriate (pull) or if the information is pushed to the user when something has happened (push). The scope of the traffic information defines the area in which a certain message can be received. The available uplink tells us if the medium can be used for collection of traffic data.

ⁱ Radio Data System / Traffic Message Channel

Introduction

The characteristics of the medium are dependent on the implementation, but *Table 1* shows how the media are used today. It is important to note that specific applications can change how the user experiences the characteristics of a media. For example an application can pull information continuously without notifying the user, which makes it look like a push application to the user even though the underlying medium is a pull character. This type of development of a medium is dependent on application characteristics, but is very important to consider when the type of media for a specific type of service is analysed.

Most of the traffic information in Sweden is distributed via radio. The scope of the information varies from regional to national, depending on location. The traffic information via RDS/TMC is distributed regionally and Sweden is divided into five different areas that receive the same information¹. The coverage is about 98% and the service is free of charge, but requires a special receiver for RDS/TMC messages. In Sweden the TMC covers the European highways, national highways and trunk roads.

The mobile terminal has increased the number of ways to collect traffic information. The mobile terminal has also provided a possible uplink from the vehicle that has not been possible to establish with radio. This uplink can be important when it comes to developing the traffic information sources.

One way to retrieve traffic information is to call a traffic portal and indicate which road you are interested in. The information is the same as in the Swedish National Road Administration's (Sw. Vägverket) database TRISS (see section 4.1.5).

The information in TRISS can also be collected via WAP and HTTP. If the information is collected via WAP (wap.vv.se), a road or county is specified to filter the information. If the information is collected via HTTP (i.e. the web), a map can also be used to illustrate the traffic deviations (www.vv.se). For the larger cities in Sweden the web offers more detailed information about traffic flow and public transport (www.trafiken.nu).

There are a number of available services that offer traffic information via SMS^{2,3}. In order to use the services, the user starts some kind of subscription and defines which roads or counties he/she wants information from. The information sources are either based on national traffic information databases, e.g. TRISS, or on reports from the subscribers.

The services mentioned above could all be deployed with a radio, a RDS/TMC receiver or a mobile terminal. None of the services is dependent on integrated hardware in the vehicle. When the hardware is integrated in the vehicle, it is possible to increase the added value for the user. A good example of this is "Volvo on call", which has an automatic report of the vehicle's position to a call center when the air bag is deployed.

The automotive telematics services that are offered in Sweden today are quite few, but services that are introduced in, for example, USA can be introduced in Sweden within a short period of time.

1.1.2 GSM and UMTS basics

The GSM and UMTS networks consist of a core network (CN) and a base system. The core network includes nodes that handle e.g. authentication, subscriber information and switching. The base system, called Base Station Subsystem (BSS) in GSM and UMTS Terrestrial Radio Network (UTRAN) in UMTS, handles the distribution over the radio interface to the subscriber.

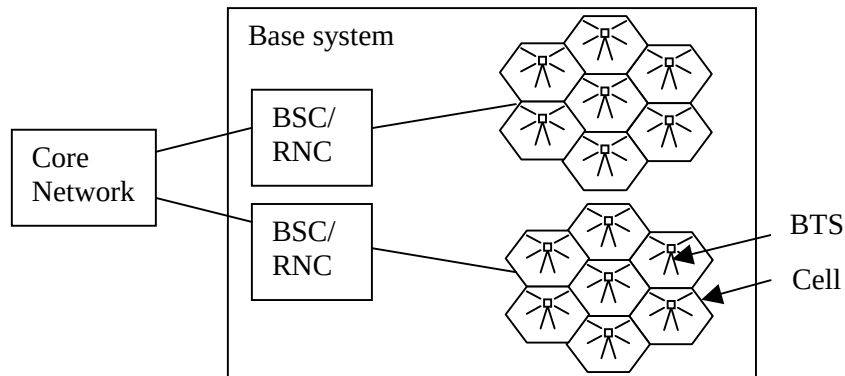
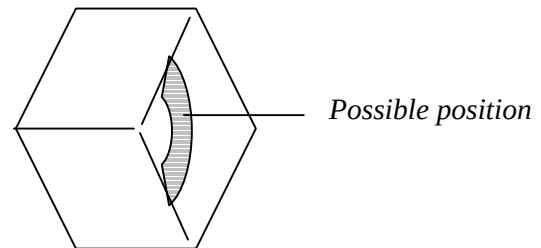


Figure 1. GSM and UMTS network overview.

The base system consists of Base Station Controllers (GSM) or Radio Network Controllers (UMTS) and Base Transceiver Stations. One BSC/RNC controls a number of BTSs. The coverage of one BTS is called a cell. The diameter of a cell can vary from a couple of hundred meters up to 70 km.

The information sent in the networks is divided into signaling traffic or data traffic. The data traffic is speech or data from subscribers. The signaling traffic is used to maintain a connection between the mobile terminal and the base station. Cell Broadcast is sent via the signaling channels.

Positioning in GSM is based on cell identification, Timing Advance (TA) value and possibly a direction. The TA value is used to determine how far from the BTS the mobile terminal is, which is needed by the terminal to send the data in the right time. This value can be used to determine an approximate range to the BTS when a terminal is positioned. Sometimes a cell is divided in different directions, which means that the position of a mobile terminal might be narrowed down to an area showed in the picture to the right. Hence is the position accuracy dependent on the cell size, which is different depending on location.



The positioning in UMTS builds on the same technique as in GSM; the positioning accuracy can though be improved due to smaller cells.

1.1.3 Cell Broadcast

Cell Broadcast was introduced already in GSM phase 1 in the early 1990s. The technique has been poorly deployed world-wide. Recently the development of Cell Broadcast services has increased, mainly in central Europe. There are no Cell Broadcast services available in Sweden today. The only operator in Sweden that has a support system for Cell Broadcast is Banverket in their GSM-R network, but they do not use the technique commercially. Although the use of Cell Broadcast is supported in Telia's BSS, it is not used. To be able to maintain a Cell Broadcast service, a support system handling the messages is needed and this is lacking in Telia's network. The support system contains the Cell Broadcast Centre (CBC) and Cell Broadcast Entities (CBEs) for every sender of Cell Broadcast messages.

Cell Broadcast is a technique within GSM and UMTS to broadcast text messages to one or more cells in the network. A detailed description of the Cell Broadcast system and its functionality is presented in *chapter 2*.

1.2 Purpose

The purpose of this thesis is to investigate how Telia can exploit the characteristics of Cell Broadcast to offer value-adding mobile services. The focus of the thesis will be on investigating possible automotive telematics services based on Cell Broadcast and how these services can affect traffic safety.

1.3 Objectives

The main objective of this thesis is to answer the following questions:

- How can Telia exploit the characteristics of Cell Broadcast in combination with the GSM and UMTS network to offer value-adding automotive telematics services to the end customer?
- How do the services affect traffic safety?
- Is it technically possible to offer a good traffic information service with Cell Broadcast today?
- What other possibilities do the special properties of Cell Broadcast offer within mobile services and how can it generate revenues?

1.4 Scope

The thesis will define a system description of Cell Broadcast based on the ETSI standards for GSM and UMTS and various retailer documents. A general description of the services that can be offered with Cell Broadcast will be included. The focus of the report will be on describing the opportunities that Cell Broadcast in combination with a complete GSM or UMTS network will offer. Furthermore a detailed schematic description of how a traffic information service based on Cell Broadcast can be designed in Telia Mobiles network today is provided.

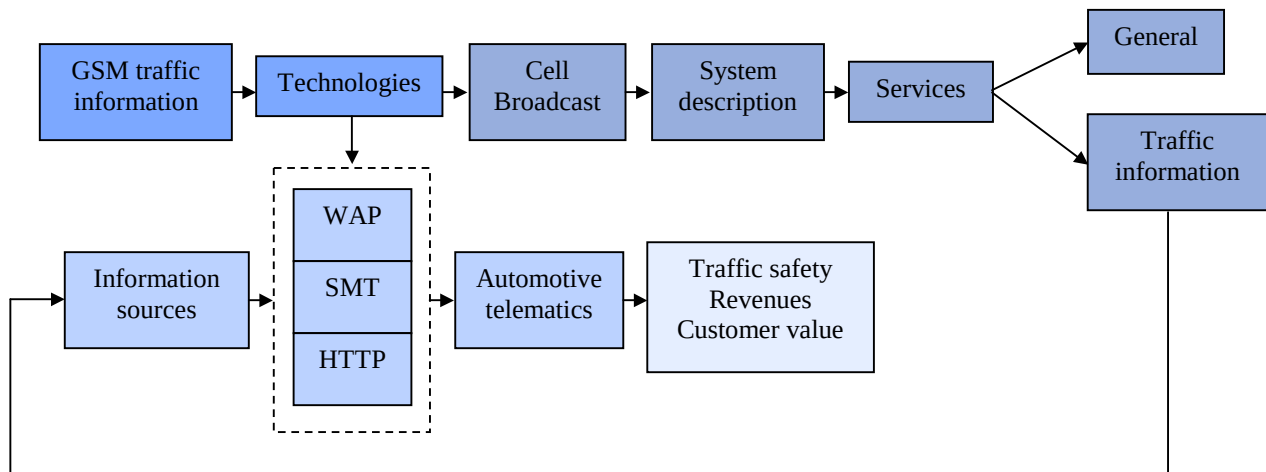
A detailed possible architecture of services beyond the scope of automotive telematics will not be included here. I will not put any of the services into practice. No detailed economic calculations will be included.

The possible effects on traffic safety that an incident warning system via Cell Broadcast can have are analysed. The potential number of prevented accidents is briefly described, but no research about exactly which actual accidents that could have been prevented is performed.

1.5 Method

To be able to reach the purpose with the thesis an extensive study of the current distribution media for traffic information has been performed. Most of the research has been made using the Internet where articles and reports on the subject have been found. For the comprehension of Telia Mobile's current position in the automotive telematics market the visit at *Telia Mobile – Telematics department* in Gothenburg (May 2002) was important, where current projects within the area were discussed. A flowchart of the working methodology is shown in *figure 2*.

Introduction

*Figure 2. Method description.*

When deciding that Cell Broadcast is an interesting way of distributing traffic information, the research is focused on the technical functionality of Cell Broadcast. A system description has been made and used to analyse the possibilities of automotive telematics based on Cell Broadcast. The most important information-sources in this research are the ETSI-standards for GSM and UMTS. The Cell Broadcast Forum has been used as a portal to receive general information. Information from the Cell Broadcast-retailer CMG in the Netherlands has been important first of all to see a specific solution in contrast to the general information in the standards. Furthermore this information has been helpful since parts of the Cell Broadcast system have not been standardised by ETSI.

Based on the technical description, possible Cell Broadcast services are described. The services outside the automotive telematics market are conceived with inspiration from co-workers at Telia Mobile Services Design, CMGs Robert Evers and friends. These services are briefly described.

The currently available and in the future possible information sources of the traffic information service are analysed. A traffic information service that can be offered with Cell Broadcast today is described. The information from the Swedish National Road Administration was important in determining the possible architecture of this traffic information service based on Cell Broadcast and their database, TRISS.

How the different technologies available via a mobile terminal can be combined to offer automotive telematics with Cell Broadcast as distributing media is examined. The telematics services based on Cell Broadcast are compared to services based on other media and the characteristics are evaluated.

Moreover Banverket, the only user of Cell Broadcast in Sweden, has been contacted regarding their use of Cell Broadcast.

In order to analyse the effects of an incident warning system based on Cell Broadcast a study of relevant tests and literature within incident warning systems and in-car behaviour has been made. The result from this study have been applied to an incident warning system based on Cell Broadcast and possible effects and demands on the system are suggested.

1.6 Outline

Chapter two describes the parts that constitute a Cell Broadcast system and their functionality. How messages are sent from the content provider to the end customer is described and exemplified with a traffic case description.

Chapter three also describes general characteristics of Cell Broadcast. This chapter is, however, focused on economic aspects. The actors on the Cell Broadcast market and the possible users are analysed.

Chapter four contain suggestions of automotive telematics services based on Cell Broadcast. A basic service and the possible developments of this service regarding user interface and sources of traffic information are included.

Chapter five describes the possible effects that the automotive telematics services can have on traffic safety, both positive and negative. An analysis of the possible effects that the system can have on the users and a short analysis of the potential effects in number of persons killed and severe injured are made.

Chapter six contains a short description of the services outside automotive telematics that can be offered with Cell Broadcast.

Chapter seven discusses what characteristics that differentiate Cell Broadcast from similar distributing media and what effects this can have on the services offered. The focus is on automotive telematics and what advantages Cell Broadcast can offer to the operator if it is deployed. Moreover general safety aspects regarding wireless communication are discussed.

Chapter eight is a description of how the author thinks Cell Broadcast should be deployed by Telia and how the knowledge within the area can be extended.

2 Cell Broadcast system description

Cell Broadcast is supported in both GSM and UMTS and the functionality is very similar in the different standards. When motivated, the descriptions are separate for GSM and UMTS. This chapter provides an overview of how Cell Broadcast works and what the functionality of the different nodes in the system are. Furthermore the Cell Broadcast message and the radio interface are separately described. The functionality is then exemplified with a traffic case description that describes the traffic in the network when a Cell Broadcast message is sent.

2.1 Overview

You can choose to send a Cell Broadcast message to the whole network or specify the cells you want to send it to. The message is sent to all mobile terminals in idle mode in the specified area. The repetition time of the message can be specified or it can be sent continuously until it is aborted via the CBC.

The subscriber can choose in the terminal if he wants to listen to a Cell Broadcast channel or not. If the subscriber has activated Cell Broadcast on the terminal he/she also has to specify which channels to receive information from. The terminal ignores messages that are of no interest to the subscriber, i.e. not in the list of channels, in the wrong language or repeated messages. The nodes used in the Cell Broadcast system when the content provider wants to distribute information to the end customer are described in *Figure 3*. The content provider has an interface to the Cell Broadcast Entity (CBE) that varies depending on application.

The CBE initiates the message and sends it to the CBC. The CBC adds the serial number, which contains information about where the message comes from, where it is going and the duration in time. The Base Station Controller (BSC) in GSM and the Radio Network Controller (RNC) in UMTS stores the message and routes it to the right Base Transceiver Station (BTS). The BTS sends the message over the radio interface. The mobile terminal (MT) chooses which messages to display with respect to serial number.

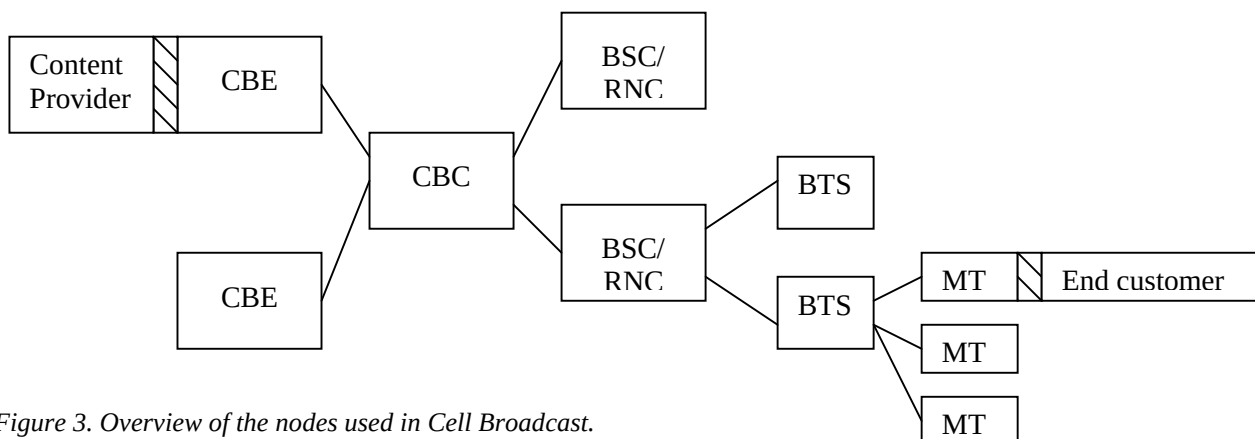


Figure 3. Overview of the nodes used in Cell Broadcast.

2.2 Cell Broadcast Entity

The CBE is where the Cell Broadcast messages originates and is intended to do the formatting of the Cell Broadcast message, including splitting the whole message into a number of messages that fit within the 82 octets of information in each Cell Broadcast message. The CBE and the interface to the CBC are outside the scope of ETSI specifications, but retailers often use open standards in order for the operators and content providers to have the possibility to develop applications.

The CBE is a client from where it is possible to send Cell Broadcast messages. The client is usually implemented in a PC and connected to the CBC via Internet. The appearance of the CBE interface is fully dependent on the application. Some applications will demand a specially developed interface to be implemented. Many applications can, however, be handled with a map interface where the broadcasting area can be defined and inputs for duration, frequency and message are available.⁴

2.3 Cell Broadcast Centre

The CBC is the core of a Cell Broadcast system. The CBC is responsible for initiating broadcast of the message and allocation of the serial number, i.e. defining where the message comes from, where it is supposed to go and what kind of information it contains. It is also responsible for determining the duration in time for the message, the sending frequency and in what language(s) the message should be sent.⁵

In GSM the CBC is considered outside the Public Land Mobile Network (PLMN), which means that a special network has to be used to connect the CBC with the BSCs. Moreover the interface between CBC and BSC is not standardised; the protocol can vary depending on vendor and operator. ETSI has, however, specified requirements on the interface. The network structure for Cell Broadcast in GSM is described in *Figure 4* below.⁵

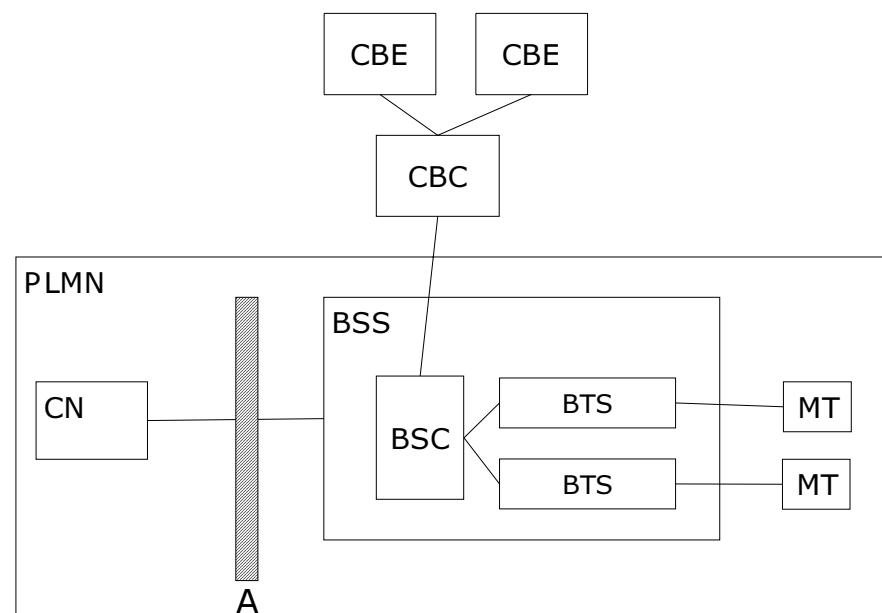


Figure 4. Cell Broadcast network structure in GSM.

Cell Broadcast system description

In UMTS the CBC is a node in the core network. This means that in UMTS the CBC is connected via the Iu-interface that connects the core network with UTRAN (see *Figure 5. Cell Broadcast network structure in UMTS.*). This implies that it is not necessary to have an additional network to connect the CBC to the RNCs in UMTS since the CBC uses the same connection interface (and network) as the other core network nodes (e.g. MSC/VLR, HLR, SGSN).⁵

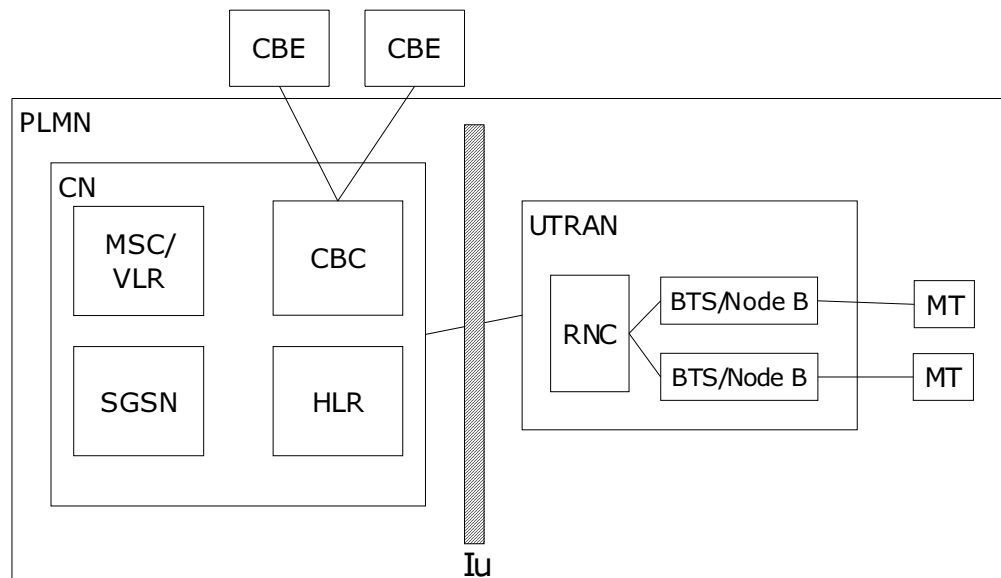


Figure 5. Cell Broadcast network structure in UMTS.

The interface between CBC and RNC is standardised with a mandatory protocol (SABP) and uses the IuBC-interface.⁵

2.4 Base Station Controller / Radio Network Controller

The BSC (GSM) and RNC (UMTS) interpret commands from the CBC. The BSC/RNC is responsible for storing messages and routing them to the right BTS. It is also responsible for scheduling the messages on the Cell Broadcast Channel (CBCH) and giving feedback to the CBC about successful or unsuccessful commands. The BSC can optionally change the schedule of messages depending on the load indication from BTS.⁵

2.5 Base Transceiver Station

The BTS in GSM conveys information from the BSC over the radio path to the MT and can optionally send load indication to the BSC⁶. The BTS in UMTS (Node B) has no special functionality in sending Cell Broadcast messages.⁵

2.6 Mobile terminal

How the mobile terminal handles the Cell Broadcast messages is outside of the GSM specifications. The mobile terminal is intended to discard messages out of interest for the mobile terminal, ignore repeated Cell Broadcast messages and let the user activate and deactivate Cell Broadcast. The mobile terminal is also supposed to let the user choose which ones of the 1000 lowest channelsⁱ to listen to and concatenating up to 15 messages.

ⁱ Here “channel” refers to a logical channel. One “channel” is a certain topic, which is defined by a range of serial numbers.

The first 1,000 (0-999) channels can be activated from the terminal; above those there are reserved channels that can be activated by the operatorⁱ. There are totally more than 65,000 channels available.

Principally all new mobile terminals support Cell Broadcast today; the problem is that it is supported in different ways. To overcome this problem the Cell Broadcast Forum has specified how the mobile terminal is recommended to handle Cell Broadcast messages in their report *Handset requirements specification*⁷. A non-scientific examination by the author, including approximately 20 relatively new mobile terminals, shows that most terminals support turning Cell Broadcast on and off and have an editable list of channels from 0-999. Every terminal in the examination had these features.

A problem with Cell Broadcast has been that it takes energy from the battery of the mobile terminal to listen to the Cell Broadcast channel. The first thing that is applied to minimise the usage of the batteries is that the terminal only reads the header of the Cell Broadcast message. If the message is of no interest for the terminal, it ignores the rest of the message. To reduce the battery usage further, scheduling messages are used. With certain intervals scheduling messages are sent on the Cell Broadcast channel that informs the mobile terminal about what messages that are to be broadcasted in the near future. In this way the terminal only has to listen to the broadcast channel when it knows that there will be a message of interest for it. In GSM the technique (DRX-mode) is optionally supported both by the terminal and the network but in UMTS the technique has been developed and is mandatory.^{8,9} See more about the scheduling messages in section 2.7.

2.7 Cell Broadcast message

2.7.1 GSM

There are two different kinds of messages: scheduling messages and Cell Broadcast messages. The scheduling messages support Discontinuous Reception mode (DRX) for the mobile stations (see also section 2.6). The Cell Broadcast messages contain the user information. The Cell Broadcast message is described in *Table 2* below.

Octet(s)	Field
1-2	Serial number
3-4	Message identifier
5	Data coding scheme
6	Page parameter
7-88	User information

Table 2. Cell Broadcast message format in GSM⁵.

The message Identifier defines the source (e.g. “Restaurant Jade Garden”) and the type (e.g. “lunch offers”). The serial number identifies a particular Cell Broadcast message with the same message identifier, the geographical scope of the message (cell wide, location area wide or PLMN wide) and the display mode. The data coding scheme defines the alphabet and language used. The page parameter contains information about how many messages that should be concatenated and the sequence number for the message. A Cell Broadcast message can contain of up to 82 octets of user information, which provides a maximum of 93 characters in one message. The number of characters depends on the coding used. Up to

ⁱ Some terminals might support activation of channels above 999.

Cell Broadcast system description

15 messages can be concatenated to one, which means that it is possible to send up to 1,395 characters in one (concatenated) message.

The time covered by a scheduling message is called the schedule period. A schedule period consists of a number of slots; one slot can contain one Cell Broadcast message. When no scheduling message has been received concerning a specific message, to see if it is of interest, at least the header should be read by the mobile terminal.

The schedule message has the following structure:

- Octets 1-2: define begin and end slot number for the schedule message.
- Octets 3-8: describe which slots that have new messages.
- Octets 9-88: contain message descriptions of all new messages.

The separation of new and old messages is implemented with a bitmap. The field of one message slot in the bitmap is set to one if the message is new and zero otherwise. A message is regarded as new if it has not been sent in the previous scheduling period or if it is a reading advised message without *message identifier*. The message bitmap is used to tell the mobile terminal what message slots to listen to.

The message description consists of *message description type* and possibly *message identifier*. If no *message identifier* is included in the message description, the *media description type* defines if the message is optional or advised to read by the MT. Messages with no message description but advised reading can be used for high-priority messages.¹⁰

2.7.2 UMTS

As well as in GSM, both Cell Broadcast messages and Scheduling messages are defined. Which of the two types a message belongs to is defined in the message type.

For a Cell Broadcast message *Message ID*, *Serial number* and *Data coding scheme* are the same as in GSM (see section 2.7.1). *CB data* is the content of the Cell Broadcast message.

Octet(s)	Field
1	Message type
2-3	Message ID
4-5	Serial number
6	Data coding scheme
7-1252	CB data

Table 3. Cell Broadcast message format in UMTS.⁵

The only difference between GSM and UMTS regarding the Cell Broadcast message format is that one message in UMTS can be much longer instead of concatenating different messages into one. This decreases the amount of information sent over the radio interface.

The scheduling in UMTS is divided into two parts: level 1- and level 2-scheduling. Level 1 scheduling schedules the CTCH on the FACH and hence on the physical channel (S-CCPCH), i.e. it describes when you can find Cell Broadcast information on the FACH. This information can be received with the common system information sent on the Broadcast Control Channel (BCCH). See section 2.8.2 for descriptions of CTCH, FACH and S-CCPCH.

Level 2 scheduling concerns the scheduling within the CTCH and is very similar to the scheduling in GSM. The scheduling period in UMTS consists of a number of block sets.

The scheduling message for one period has the following structure:

- Octet 1: Message type
- Octet 2: defines when the next scheduling period starts
- Octet 3: defines the length of a scheduling period
- Octet 3-m: describe in which block sets there are newⁱ messages
- Octet m-n: Message descriptions

The numbers m and n are dependent on the length of the scheduling period. The message description has the same format as in GSM.⁹

2.8 Cell Broadcast on the radio interface

2.8.1 GSM

The Cell Broadcast messages are sent on the logical Cell Broadcast Channel (CBCH). The CBCH uses one of the sub-channels to the Standalone Dedicated Control Channel (SDCCH). SDCCH is a logical signalling channel where, for example, call set-up is handled and SMS is sent. SDCCH has four or eight sub-channels depending on configuration of the logical channels in a cell, one sub-channel for every mobile terminal. A SDCCH with eight sub-channels uses one physical channel, i.e. one time-slot.^{11, 12}

Due to the capacity of the CBCH, the highest frequency to send out Cell Broadcast messages is approximately once every other second (1.833 s). When Cell Broadcast is used, this is indicated within the Broadcast Control Channel (BCCH).⁵

Cell Broadcast messages can be sent on basic or extended CBCH. The extended CBCH is only optional supported, both by the mobile terminal and the network. Using the extended CBCH makes it possible to allocate more bandwidth to Cell Broadcast in a network. The extended CBCH can, however, interfere with idle mode procedures of the mobile terminal. If the terminal is GPRS-attached the basic CBCH can also be disturbed by the terminal's idle mode procedures.¹¹

2.8.2 UMTS

In UMTS the Cell Broadcast messages are sent on the logical Common Transport Channel (CTCH) on the radio interface. A CTCH is mapped onto one of the transport channels called Forward Access Channel (FACH), which is mapped onto the Secondary Common Control Physical Channel (SCCPCH). FACH is primarily used for control information, but can also be used for packet data. There can be more than one FACH in a cell. FACH uses one SCCPCH together with one Paging Channel (PCH).⁵

General information about Cell Broadcast (e.g. which transport channel is used) is sent on the Broadcasting Channel (BCH), which uses the Primary Common Control Physical Channel (PCCPCH).

ⁱ New message = not sent in the previous scheduling period or a reading advised message without message description.

The highest frequency to send out Cell Broadcast messages is the same as in GSM (once every 1.883 seconds). The difference in UMTS is that the capacity in UTRAN is higher, which means that more than one message can be sent out with that frequency at the same time.⁵

2.9 Bandwidth demand – competition with other services

The Cell Broadcast channel (CBCH) allocates one of eight sub-channels of the SDCCH, which uses one physical channel (TCH/F) on the radio interface in GSM. This means in practice that one less phone call can be connected simultaneously in a cell when Cell Broadcast is used.

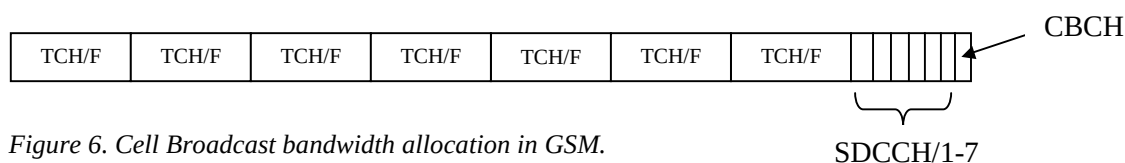


Figure 6. Cell Broadcast bandwidth allocation in GSM.

Figure 6 shows the Cell Broadcast bandwidth allocation for one cell in GSM. The figure shows one of the available frequency spectrums in a cell. The bandwidth allocation for Cell Broadcast in UMTS is higher, how much higher is, however, not determined in the ETSI standards.

The moderate bandwidth may limit the possible number of services, but takes on the other hand less space from other GSM or UMTS services.

2.10 Charging

2.10.1 Charging of content providers

The charging of content providers is based on records maintained by the CBC. The CBC produces billing files containing information on which content provider has sent what and when. These files can be used differently depending on tariffs and billing strategy.

2.10.2 Charging of end customer

Charging the end customer has been a key question for Cell Broadcast since the beginning. The challenge lies in the message type. Broadcast messages have the characteristic that it is sent out to a certain area and the users who are interested 'tune in' the right channel and no acknowledgement is sent back to the network that someone has received a message. It is a one-to-many one-way communication media and the lack of acknowledgement makes it difficult to charge a specific user.

Today there is no standardised technique for charging the end customer, but techniques for this are being developed (see section 7.2.1).

2.11 Traffic case description

The initiation of the Cell Broadcast message is performed in the Cell Broadcast Entity (CBE), where a content provider decides that a message should be sent to a certain area, with a certain frequency during a certain time. How the information is sent between the CBE and CBC varies depending on CB-vendor and is not regarded in this traffic case description.

When the content provider via the CBE has specified where, when and how often a Cell Broadcast message should be sent, the CBC is responsible for making sure that the request is fulfilled. To do this the CBC communicates with the BSCs/RNCs via specified commands. It should be noted that the protocol between the CBC and BSC is not specified in GSM, the choice of protocol is up to the operator and the Cell Broadcast vendor to decide. The protocol in UMTS is on the other hand standardised.

The commands to the BSCs/RNCs are *Write-replace*, *Kill*, *Status-load-query*, *Status-message-query*, *Reset* and *Set-DRX*. Write-replace is a command used for initiating a new Cell Broadcast message or replacing an old message and the traffic case study will be based on this command. The other commands are described in *Table 4*.

Command	Function	BSC/RNC respons
Kill	End broadcasting of a certain message in defined cells	Confirm
Status-load-query	Obtain current loading of CBCH/UTRAN Radio Resource	Loading-list
Status-message-query	Obtain current status of a certain message for defined cells.	No. of broadcasts completed-list
Reset	End broadcast in defined cells	Confirm
Set-DRX	Start/change DRX-function (only GSM, mandatory in UMTS)	Confirm

Table 4. Commands from CBC to BSC/RNC.^{13, 5}

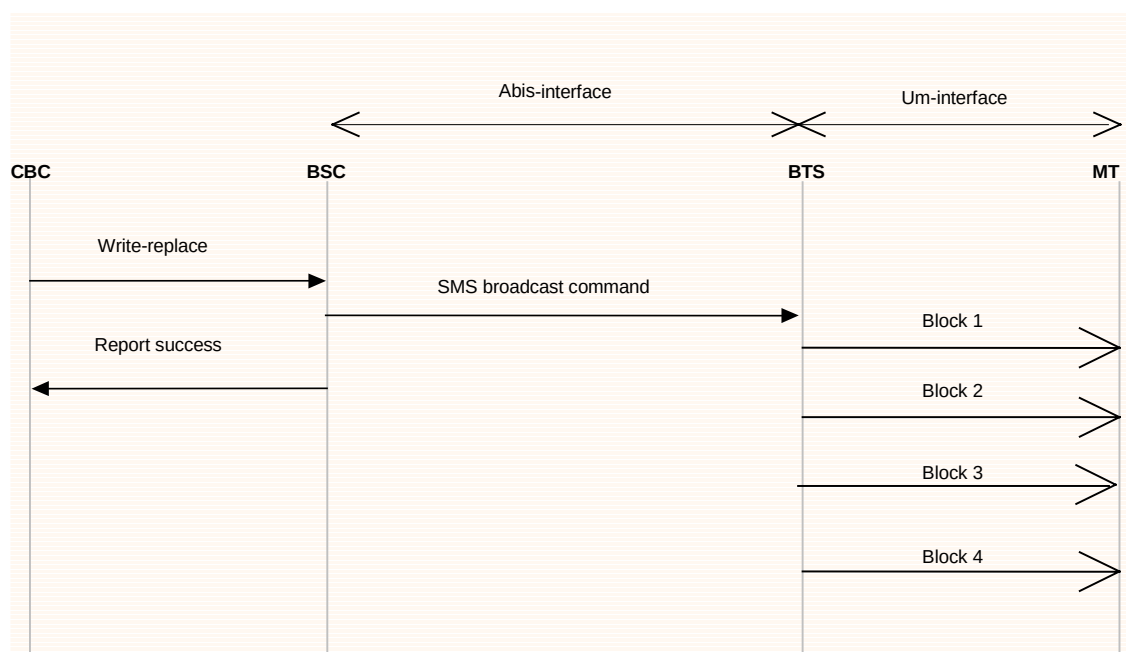
The communication from the BSC/RNC to the CBC mostly consists of acknowledgements and responses, but the BSC/RNC also sends messages to the CBC when a new cell is usable for CB or when CB-related problems occur in a cell. In UMTS the RNC can also send information about changes in available broadcast capacity per cell.

In GSM the BSC sends Cell Broadcast messages to the BTS with the commands *SMS broadcast request* or *SMS broadcast command*. When *SMS broadcast request* is used, the segmentation of the messages to fit on the radio path is done in the BSC, otherwise the segmentation is done in the BTS. The BSC is responsible for queuing, repetition and transmission of the messages, but the BTS can indicate overflow or underflow on the Cell Broadcast channel. The over- or underflow is indicated with the command *CBCH load indication*. In the BTS the message is segmented (*SMS broadcast command*) into four blocks of 22 octets. To send it on the radio-path an L2-header of one octet is added (see *Table 7*).

2.11.1 GSM traffic case for *Write-replace command*

When a Cell Broadcast message is initiated a *Write-replace command* is sent from the CBC to the BSC. The information flow in the Cell Broadcast system when this command is executed is described in *figure 7*.

Cell Broadcast system description

Figure 7. Information flow for Write-replace command in GSM Cell Broadcast system.⁵

The message format on the interface between CBC and BSC is shown in Table 5.

Parameter	Description
Message-Identifier	Source, type
Old-Serial-Number	Cell Broadcast message to replace
New-Serial-Number	New message serial number
Cell-List	Cells for the message to be broadcasted in
Channel Indicator	Basic or extended CB-channel
Category	High, normal or background priority
Repetition-Period	How often to send the message
No-of-Broadcasts-Requested	How many times to send the message
Number-of-Pages	Number of concatenated messages (pages)
Data Coding Scheme	Type of coding and language
CBS-Message-Information-Page 1	Content of message page 1
CBS-Message-Information-Length 1	Length of user information without padding (page 1)
CBS-Message-Information-Page 2	
CBS-Message-Information-Length 2	
:	
CBS-Message-Information-Page n	Content of message page N
CBS-Message-Information-Length n	Length of user information without padding (page N)

Table 5. Message format on CBC-BSC interface for Write-replace command.⁵

The parameter *Old serial number* is used to replace an existing message; if the field is empty a new message is initiated.

Cell Broadcast system description

In the BSC the Write-replace command is deployed and a *SMS broadcast command* (or four *SMS broadcast requests*) is sent to the BTS on the Abis-interface. The protocol used is LAPD. The format of this message is shown in *Table 6* below.

Octet(s)	Information element	Description
1	Message discriminator	Message-group (Common channel management)
1	Message type	Message-type in the message-group (SMSCB-message)
2	Channel number	Specifies the physical channel to be used
2	CB Command type	Specifies type of Cell Broadcast message (e.g. normal or schedule)
2-90	SMSCB message	Length of message and the user information.
2	SMSCB Channel Indicator	Basic or extended channel

Table 6. Message format on BSC-BTS interface for Write-replace command.⁵

On the Um-interface between BTS and mobile terminal the Cell Broadcast messages are sent in four blocks of 22 octets each. The BTS adds one octet (L2-header) that defines the Link Protocol Discriminator (LPD) and the sequence number of the block (see *Table 7*). The LPD is set to "01" for Cell Broadcast messages, i.e. SMSCB link protocol is used instead of the LAPDm protocol.

Information element	Description
L2-header	LPD and block sequence number
SMSCB message	User information

Table 7. Message format on BTS-MT interface for Write-replace command.¹²

The SMSCB message that the MT receives has the following structure:

Octet(s)	Field
1-2	Serial Number
3-4	Message Identifier
5	Data Coding Scheme
6	Page Parameter
7-88	Content of Message

Table 8. Structure of SMSCB message received by the MT.⁵

A more detailed description of the Cell Broadcast message is made in *section 2.7*.

2.11.2 UMTS traffic case for *Write-replace* command

The information flow within the Cell Broadcast system in UMTS is very similar the one in GSM when a Cell Broadcast message is sent (see *figure 8*). A difference is that the messages in UMTS are sent transparent through the BTS.

Cell Broadcast system description

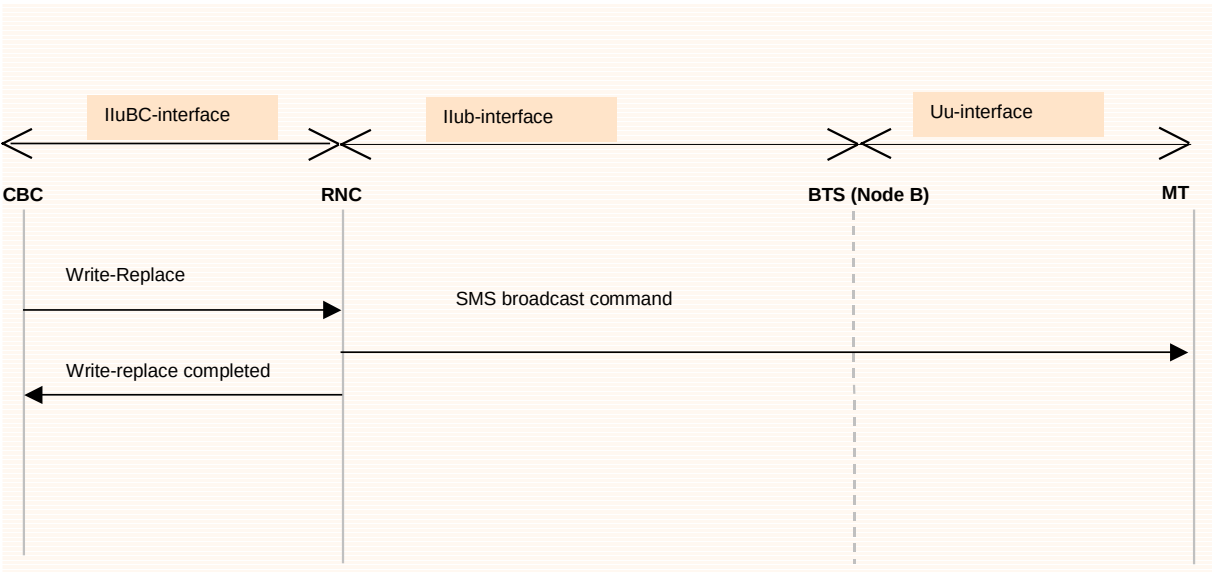


Figure 8. Information flow for Write-replace command in UMTS Cell Broadcast system.⁵

A more detailed description of the protocols used in UMTS for Cell Broadcast is shown in Figure 9.

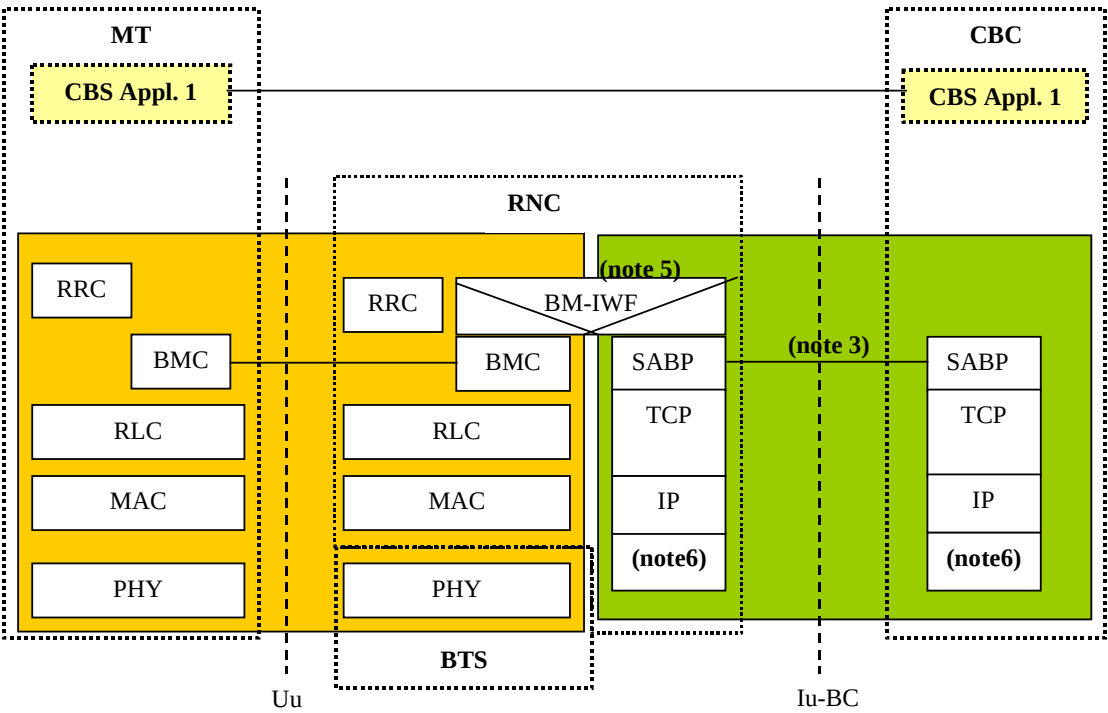


Figure 9. Description of protocols used in UMTS Cell Broadcast system.⁹

The CBC communicates with the RNC via the IuBC-interface. The protocol used for this communication is Service Area Broadcast Protocol (SABP). The message format on this interface is the same as in Table 5, except that the *channel indicator* field is not used.

Within the RNC the Broadcast/Multicast Interworking Function (BM-IWF) distributes the information to the relevant Broadcast/Multicast Control-entities (BMC). One BMC-entity is

Cell Broadcast system description

defined for every cell (service area). The BMC-entity is responsible for storage and repetition of Cell Broadcast messages in one cell. The BMC entity in the RNC sends the Cell Broadcast message over the Iub- and Uu-interface to the BMC entity in the MT (transparent to the BTS). The message format in this interface is shown in *Table 9*.

Octet(s)	Parameter
1	Message Type
2 – 3	Message ID
4 – 5	Serial Number
6	Data Coding Scheme
7 – n	CB Data

Table 9. Message format between RNC and MT.⁵

A more detailed description of the Cell Broadcast message is provided in *section 2.7*.

3 Business opportunities

Cell Broadcast is a broadcasting medium so far not commercially utilized in Sweden. The medium has similarities with the service teletext and also with other broadcasting medias like radio and television. The main characteristic that differentiates Cell Broadcast from these services is the mobility and the possibility to distribute information to small geographical areas. Other differences are bandwidth, receiving gear and information type.

To determine the possibilities of a new medium, it can be of interest to confer with similar medias and their development. Since the medium has the same receiving gear and information type as SMS and WAP, the user group of Cell Broadcast services can be connected to these media. This is discussed in section 3.1 below.

Due to the fact that Cell Broadcast is a broadcasting medium, the business models are similar to the ones used within television. The business models are examined in section 3.2 below. The last section in this chapter describes the actors in the Cell Broadcast market that are developing Cell Broadcast and their roles.

3.1 User group

As for any unexploited technology it is very hard to forecast the user group. Good examples are the user groups of SMS and WAP. These specific cases are of interest to compare with since Cell Broadcast has similarities with both of them. The user group of SMS was forecasted to be much smaller than it is now. The opposite effect has occurred with WAP.

It is important to note that it took a quite long time before SMS became popular and the user group started to expand enormously. Relative to SMS, WAP is a new technology and can expand within a few years. The problem is that other technologies may take over the functions of WAP before it has had the time to grow large (e.g. HTTP). Perhaps Cell Broadcast also will need time to establish a market, or it will be seen as a branch of SMS and acquire a lot of users in a short time.

The user group of a technology is, of course, dependent on the services that can be offered with it. One positive feature with Cell Broadcast is that it is easy to get started if you want to try a service. The free of charge services can be used by a large part of the subscribers. Only a number that defines the channel you want to listen to has to be specified in the terminal. No further adjustments or subscriptions have to be made.

Even if it is easy for the subscribers to start using Cell Broadcast, it is important that they see a value in receiving the information this way. Otherwise the user group will be very small. The value added by the medium is very dependent on how the services use the specific characteristics of the medium. Cell Broadcast is characterised by local push-information to a mobile terminal.

One important section of the user group for Cell Broadcast is companies. A company can have services implemented to fit only their needs. Both services developed by the operator, the company itself or even a third part can be realised with an operator's Cell Broadcast system. A company could, for example, need its own Cell Broadcast channel to distribute information. Often coding is brought up in these applications, but the company can need a channel that all the employees can hear regardless of whether other persons also can listen to it. Coded channels can be used to create other services to companies.

Another part of the user group is machines. Often the machine has an interface to a user, but some applications can consist of sending local instructions to isolated machines. These applications are suitable when there are a lot of machines that should have the same information.

3.2 Business models

The business models are closely connected to the possibilities of billing, i.e. which actors that can be charged. This is why the business models are similar to the ones used within television.

3.2.1 The content provider pays

The business case where the content provider pays for the ability to use Cell Broadcast as an advertising channel is probably the most obvious. The content provider is offered an advertising channel where he can have location-based and directed mass distribution to mobile terminals. The operator maintains the channel and gains revenues from the content providers.

The billing for this business case should not be so complex. For example in CMGs Cell Broadcast system actions are logged for every CBE and this information should be possible to combine with a price list and be implemented in Telia's own billing system.

The challenge with this business case is to convince the content provider that the end customers receive the distributed information. There is no possibility to verify this within the Cell Broadcast system since there is no acknowledgement from the mobile terminal that it has received a message. The Cell Broadcast channel is one-way only, and the business cases for Cell Broadcast are similar to other broadcast media like radio and television. One way of checking this is to send special offers only usable for the ones who have received the Cell Broadcast message.

This business case also contains services where the government pays to maintain the service due to commonweal (e.g. local warnings, see section 6.5).

3.2.2 The operator pays

There is a business case where the operator pays for Cell Broadcast and a third party can be involved, but does not stand for any significant costs in that case. One possibility here is to increase the traffic in the network by sending out triggers to WAP and SMS via Cell Broadcast and in this way generate revenue by the increased traffic. The triggers for WAP and SMS could be implemented in many different ways (see section 6.4).

The operator can also offer free of charge services that provides added value to subscriptions with the operator. This can both generate more subscribers and help keep the ones already connected.

3.2.3 The end customer pays

One of the main challenges of Cell Broadcast is how to get the end customer to pay for the services he uses. Only when it is possible to charge the end customer can the operator offer third parties to handle services other than commercial broadcast and Cell Broadcast can start to generate bigger revenues. Today there are different methods for letting the end customer pay. Two main ideas have been developed: encoding and over-the-air (OTA) activation of channels above 999 (see section 7.2.1).

When it is possible to let the end customer pay for the services he uses, it will also become easier to generate revenue from the services that the operator develops. The operator is no

longer dependent only on revenues via increased traffic. In this business model the operator works as a service provider and stands for charging of, distribution and interface to the end customer.

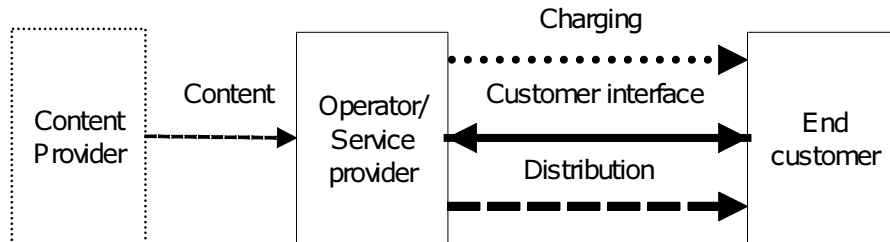


Figure 10. Business case where the operator's role is a service provider.

Charging of end customers also creates a business case where the third party is the service provider and Telia only works as a distributor of information between the third party and the end customer. In this case Telia will only charge the third party for using their network and the third party will take the revenues from the end customers.

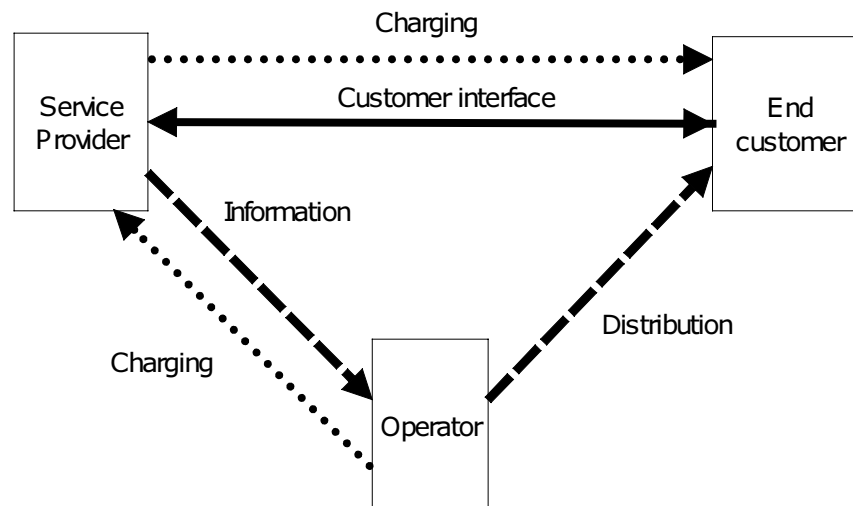


Figure 11. Business case where the operator's role is a distributor.

3.3 Cell Broadcast development actors

The most important actors when it comes to development of Cell Broadcast functions and technology are the MT manufacturers, the Cell Broadcast system vendors, the operators and the Cell Broadcast Forum. The development of services is perhaps mostly made of service or content providers, but they need the technology behind, for example, charging to work. It is also likely that the operators will have to develop their own services in the beginning before the market has grown enough for the external service providers to enter.

3.3.1 Mobile terminal manufacturers

The mobile terminal manufacturers have a central role in the development of Cell Broadcast since a lot of the functionality in Cell Broadcast is placed in the mobile terminal. Important functions in the terminal are to ignore messages of no interest to the users, activate Cell Broadcast channels and display the messages. How this is done is determined by the mobile terminal manufacturer.

The mobile terminal manufacturers interest is to see that their mobile terminals support Cell Broadcast sufficiently. But since almost all terminals on the market support Cell Broadcast,

there are small possibilities for a manufacturer to gain market shares with the help of Cell Broadcast in Sweden today. If Cell Broadcast turns out to be a technique widely used in Sweden, the situation is rather different. We can compare with the technique for text input in SMS and see that it can be a factor when choosing a mobile terminal. If an MT manufacturer has a certain technique that makes this brand more attracting when it comes to Cell Broadcast functions, it can have impact on the users. The probably most straightforward thing for the MT manufacturers to do is to follow the recommendations on the terminals made by the Cell Broadcast Forum (see section 5.3.3).

3.3.2 Cell Broadcast system vendors

There are a number of different vendors of Cell Broadcast support systems. Large vendors are CMG, Logica, Sema and Swapcom. The vendors have an important role in the development of Cell Broadcast, since their support systems are the core in a Cell Broadcast system. The vendors compete with functionality and of course price. Current developments are charging of end customer and the possibility to broadcast EMS.

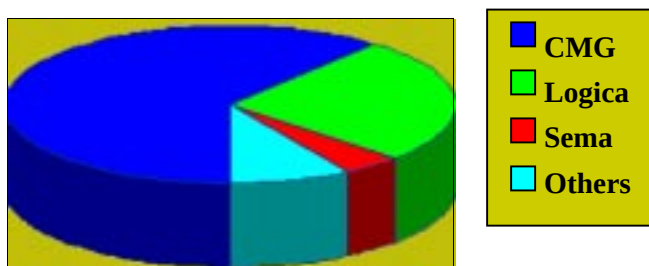


Figure 12. Market shares of different vendors. Source: CMG, 2001.

The vendors all offer complete solutions for Cell Broadcast. How much functionality Telia Mobile should buy of the vendor is outside the scope of this thesis.

3.3.3 Cell Broadcast Forum

The Cell Broadcast Forum (CBF) is a non-profit Industry Association that supports the Cell Broadcast standard by bringing together different players on the Cell Broadcast market and specifies recommendations outside the scope of the ETSI standards. The main objectives of CBF are to contribute to the development of Cell Broadcast and stimulate the Cell Broadcast market, establish contacts with involved parties, execute surveys and develop visions. CBF was founded in November 2001 and the founding members are CMG, Orange, Swapcom and Logica. Currently there are nine members of CBF.

A problem with Cell Broadcast has been the different ways that the mobile terminals handle Cell Broadcast messages. CBF has now tried to solve this problem by defining how the terminals should handle Cell Broadcast in the report "Handset Requirements". Even though the terminals handle Cell Broadcast differently and it is named differently, the terminals seem to support Cell Broadcast better in general. This is natural when the use of the technique increases and the question is how the manufacturers adjust to the recommendations. CBF will probably have an important role within the work of standardisation in Cell Broadcast also in the future.

4 Automotive telematics services

This chapter describes automotive telematics services based on Cell Broadcast. All the services described in this chapter are based on a basic service which distributes information from the database TRISS via Cell Broadcast. This service is relatively easy to implement and has a lot of potential users. This service is described in section 4.1. In section 4.2 the possible developments of the basic service in terms of information from the vehicles and interface to the driver are described. These developments can require more work to be implemented but increase the added value to the customer

4.1 Basic service

The purpose of the service is to supply drivers with location-based traffic information from the Swedish National Road Administration's database TRISS. The traffic information should be sent to the cells that are influenced by a traffic deviation via a Cell Broadcast message. The message should be displayed instantly on the display of the terminal. Exactly how the message is shown on the display differs between brands of the mobile terminal. A sound will alert the subscriber of the message. The message could be of general kind or more specific, as described in more detail in section 4.6.2.

4.1.1 Customer value

The purpose with the Cell Broadcast messages is to increase the driver's attention to traffic deviations. The increased attention to traffic deviations can prevent accidents, which has a good customer value. The question is how effective the service is in the prevention of accidents (see section 5) and how it differs from other existing traffic information services (see section 7.3).

Another area of usage for the service is to guide the users around areas of traffic congestion and this helps drivers to choose a more efficient route to a certain destination. This type of message can be distributed before known bottlenecks in primarily large entrance roads to the big cities. For people that use the car to travel into big cities with a lot of traffic, this kind of service can have a good customer value.

The service is also intended to decrease the time from when an accident takes place to reporting the information to the driver compared to other similar services. The service can also provide more relevant information than most of the systems available today due to the delimitation of the broadcast area of the message. Since the broadcast area is relatively small, much more detailed information can be distributed. The system gives the driver a possibility to be prepared even for small deviations in traffic.

4.1.2 Pricing and business case

Since there are no third parties that want traffic information distributed today (except the Swedish National Road Administration and non-profit organisations) only two business cases are possible: the operator pays or the end customer pays. If the interest from the users is high and the willingness to pay for these services increases, the number of third party companies that are interested in offering these services will also increase. If third party companies join the market, the operator can use a different approach and offer a good platform to build automotive telematics services on.

If the operator pays, the business will be in enticing people to choose them as their operator due to the added value of the service. Because of the benefit for the society if the service prevents car accidents, the service can also generate obvious goodwill and good commerce for Telia.

If instead the end customer pays, the business is more obvious and the service can generate more revenue faster. This is why much of effort is put into designing Cell Broadcast systems for end customer billing. The fact that it is not technically possible to see how many messages a user receives makes a monthly fee the natural pricing method. If OTA activation is used, a starting fee can be applied to decrease the number of OTA messages sent.

Due to considerations regarding traffic safety a module for attaching the phone to the dashboard can be included in the price.

4.1.3 Sales channels

Depending on activation method, different approaches can be used. Independent of activation method the following sales channels should be used:

- www.teliamobile.se (www.telia.se)
- Brochures and/or references to www.teliamobile.se of petrol stations and restaurants along major roads
- Telia shops
- Telia subscription retailers

Any place where traffic information is collected today is a good place for information about this service.

4.1.4 System description in Telia Mobile's network

This service architecture is possible if CMG's cell broadcast centre is used. The service will use traffic information from the Swedish National Road Administration's database TRISS (see section 4.1.5). This information will be formatted in the CBE to fit as a Cell Broadcast message. In the CBE the coordinates will be mapped to the right BTSs, the duration time will be extracted from the TRISS message and parts of the message will be sent to the CBC for broadcast to all idle mobile terminals in the specified cells (see *Figure 13*).

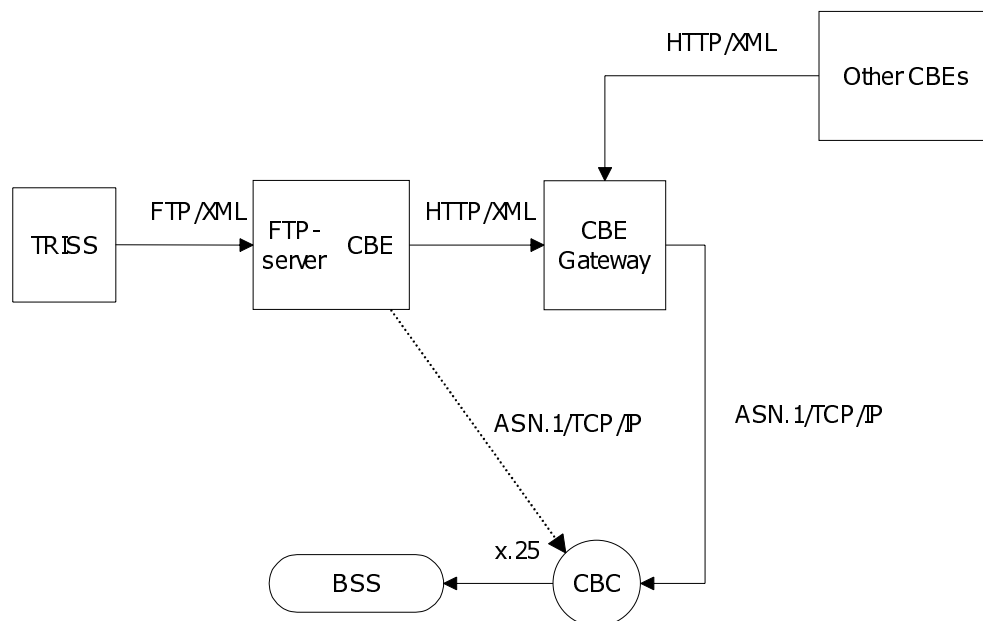


Figure 13. System overview with specified protocols

The information from TRISS is sent to an FTP server in XML format. In the CBE the information from TRISS is filtered and sent to the CBE gateway via HTTP, still formatted with XML. An alternative in this case is to have the software for the CBE gateway in the same place as the CBE and the information will then be changed to ASN.1 format directly and sent via the TCP/IP protocol to the CBC. Otherwise the CBE gateway is a separate node that other CBEs can also use to access the CBC via ASN.1/TCP/IP. The CBC communicates with the BSCs via an X.25-network.⁴

4.1.5 Information source TRISS

TRISS is a database maintained by the Swedish National Road Administration. The information is collected for example from traffic call centres around the country, cameras and from the Swedish National Emergency Unit (SOS Alarm). The database contains general traffic information like accidents and traffic congestions but it is also possible to receive information about temperatures via the Swedish National Road Administration's road weather information system (VViS), which is connected to TRISS.

There are different types of information in the database and the headlines among others are:

- Road conditions
- Accidents/Traffic information
- Road constructions
- Lay-bys
- Air and road surface temperature

The topics that are of most interest for the Cell Broadcast traffic information service are *Accidents/Traffic information* and *Air and road-surface temperature*. The events within the different topics are divided into different classes, for example the Accidents/traffic information topic is divided into accidents, traffic jams, traffic messages and closed roads.

 Accident.
Destination: Rv 9 between Hammenhög and Järrestad in Skåne county. Both directions.
Description: Car on fire at Rv 9 just east of Hammenhög.
Start time: 2002-07-18 13:27
End time: 2002-07-18 14:27

Figure 14. Example of accident information from TRISS.

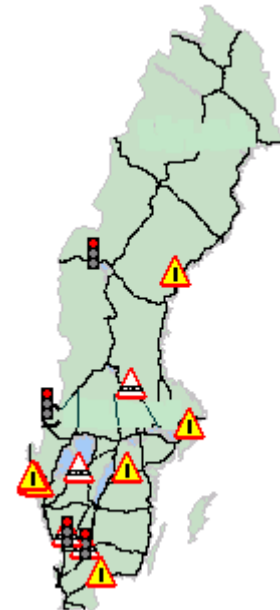
 Traffic message.
Destination: E 6 at Kungälvleden, Kungälv -> Göteborg between Backadalsmotet (Göteborg) and Tingstadstunneln in Västra Götalands county.
Meddelande: Slow traffic
Description: Due to heavy traffic queues with slow traffic are building up on E6 direction south in conjunction to Tingstadstunneln. Watch out for hard braking!
Start time: 2002-07-18 12:24
End time: 2002-07-18 18:00

Figure 15. Example of traffic congestion information from TRISS.

The Swedish National Road Administration sends out information from TRISS for free. They do this because they want the information to be distributed to as many and as efficiently as possible. The information distributor sets up an agreement with the Swedish National Road Administration and the information is sent from TRISS to an FTP server in XML format. When the database is updated, information is automatically sent to the FTP server.

For traffic information a standard called DATEX is used. Within this standard the protocol TRAVIN is used to specify the traffic messages. Later a protocol within DATEX called TRAILS will also be used to send weather information. How to interpret the messages is defined in two documents that can be ordered from the Swedish Standards Institute.ⁱ

It is possible for the Swedish National Road Administration to filter the information before it is sent to the FTP server, which could be useful for this traffic information service since not all information in TRISS is relevant to broadcast.



4.2 Basic service developments

There are a number of possible ways to offer automotive telematics services with the operator as service provider, and these will be described in *section 4.2.1*. These services are characterised by it being possible to introduce them without major hard- or software developments. It is important to note that the services can be maintained by a third party in the future if companies are interested.

Perhaps the best solutions are made in joint ventures between the operator and manufacturers of mobile equipment and vehicles, e.g. Wireless car, and these will be described in *section 4.2.2*. These services are characterised by having integrated hard- and software for telematics services in the vehicle, which provides more possibilities to deploy the human machine interface and the machine-to-machine communication in the vehicle.

The services and functions described in the following sections will be connected to the basic service described in the previous section.

4.2.1 The operator as service provider

The value added by the basic service described in the previous section will increase with better traffic information. The developments of the service with the operator as service provider are focused on improving traffic information by collecting traffic information from the vehicles.

The first development of the service regards traffic information available in the GSM-network. There are possibilities to gain average speeds on certain roads via the information available in the GSM network¹⁴. The method is based on comparing the timing advance (TA) value for every mobile terminal with a digital map. The TA value is used by the GSM-network to compensate for the mobile terminals different range to the BTS in order to synchronise the mobile terminal with the BTS. By analysing the how the TA value changes over time and comparing it with the digital map, average speeds can be determined on

ⁱ 'Road transport and traffic telematics - DATEX specifications for data exchange between traffic and travel information centres' and 'Road transport and traffic telematics - DATEX traffic and travel data dictionary'

certain links in a road network. Since there are a lot of mobile terminals, there is a lot of information to analyse. It is important to filter mobile terminals that are of no interest when the average speeds are gained, e.g. users that go by bike, train or walk.

The average speeds on links can be used to detect deviations and congestions in the network or be used to calculate travel times for different routes in the network. Detected deviations can be distributed with Cell Broadcast and complement the information from TRISS. To detect congestions this way can also be useful when it comes to route guidance in city networks. The routing function in the basic service can be equipped with real-time congestion information from the GSM-system.

Furthermore can the information from TRISS and the GSM-network be completed with manual reports of traffic deviations from drivers. This information should be broadcast to the surrounding cells of where the deviation was detected. The manual driver report assumes that the message is sent directly when a deviation is spotted, and demands a suitable system for input of information. The Cell-ID can be used to locate the person who is reporting the deviation.

One way of collecting this information is via a voice portal, where standard types of traffic deviations like "accident" or "obstacles on the road" can be reported. The call should be free of charge and it should be possible to report the type of accident via voice.

An alternative to a voice portal is to use a SIM application toolkit in order to make a new menu on the terminal that makes it easy to send information about standard traffic deviations via SMS. Another alternative is to use a JAVA application in the terminal to make the SMS interface.

4.2.2 Joint ventures

It is quite easy to implement a Cell Broadcast service where the information is sent to a mobile terminal that the driver brings to the car. Sending the traffic information to this kind of terminal give the opportunity to reach a lot of users, but can also have negative attributes and restrictions. One such negative attribute is, for example, the fact that the terminal can be placed anywhere in the car depending on where the driver has placed it. Another is the limited display and, so far, the lack of voice messages. Communication between the systems in the car and the terminal is also hard to establish when the terminal is not integrated in the vehicle. These limitations can be avoided with an integrated telematics system equipped with a GSM or UMTS module. This system will have a completely different user group and it will require extensive co-operation with other companies. The advantages will instead come in better functionality and possibly larger marginal revenues. These services will also include the functions described above.

Possible extended functions with an integrated telematics system are:

- Airbag deployment detection, friction assessment detection, temperature warnings
- Voice messages, voice control
- Enhanced graphics optimised for traffic information
- Assisted GPS
- Dynamic link costs in route guidance

When the airbag is deployed a message can be sent to the Cell Broadcast system. The Cell Broadcast system can distribute the information to the surrounding cells. This information can be useful for the surrounding vehicles to have and for the persons involved in the crash to distribute. When a Cell Broadcast message is received, the text message can be

transformed to speech, at least for standardised traffic incidents. A navigation system can be deployed with dynamic link costs of the surrounding links, which can be helpful in calculating the best route to a predefined destination. The GPS positioning in the vehicle can be enhanced with assisting information via Cell Broadcast. The enhanced position can be useful if road tolls based on GPS are considered. A developed automotive telematics system based on Cell Broadcast can have an information flow as shown in Figure 16.

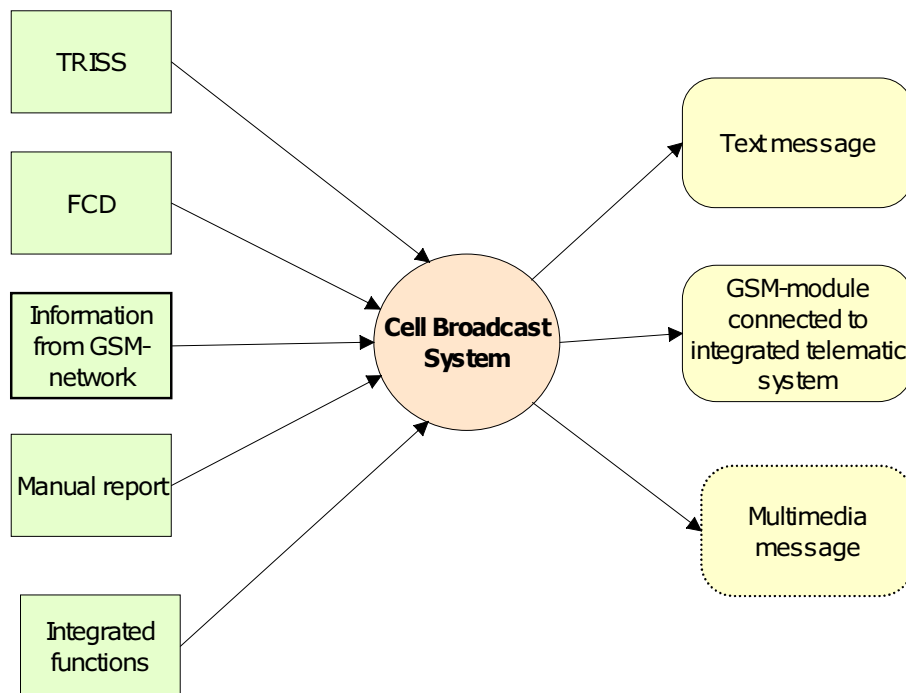


Figure 16. Information flow in future traffic information systems with Cell Broadcast.

It is also possible to provide solutions where the integrated functions not are combined with a GPS navigation system. A complete automotive telematics service based only on a GSM-module can be implemented. Functions as detection of airbag inflation, location-based traffic information and external vehicle positioning can also be achieved in cars that have a price such as that a GPS navigation system is too expensive to implement in the car.

If the GSM module is integrated in the car, even without GPS and digital maps, airbag deployment can be detected and information sent to an emergency central (cf. "Volvo on Call") and this information can be distributed to the surrounding cells. Cell Broadcast messages can be transformed into voice messages. The vehicle can be approximately positioned, which can be used for basic purposes such as just finding out where the car is now. The main advantage with this function is if the car is stolen, the searching area of the vehicle decreases radically with the help of GSM positioning. This function involves, as any positioning function, important personal integrity issues.

5 Traffic safety

Since most of the customer value in the incident warning system comes from increased safety in the vehicle, it is important that the possible effects are analysed. What positive effects can be expected from the system regarding traffic safety and are there any negative effects? It may be of interest to estimate the possible number of prevented accidents if the service is subsidized.

5.1 Accident causes and safety measures

In this chapter some possible effects of an incident warning system via Cell Broadcast are estimated. Hence it is natural to consider only accidents that can be prevented with an incident warning message. The selection will be based on causes of the accident. It is, however, important to note that an accident seldom or never has one cause, but instead is a result of a series of contributing factors¹⁵. The analysis in the next section will hence only refer to *possible* effects of the warning system. This distinction differentiates the accidents where an incident warning system could have helped prevent the accident. Accident factors can be categorised as necessary and sufficient for an injurious sequence of events¹⁶ and the ones prevented by the incident warning system are mostly classified as sufficient, which also determines that not all accidents will be prevented as a result of increased information to the driver.

It is also important to note that even if the causes of accidents are obvious and quite isolated, the countermeasures are not automatically determined¹⁵. Some accident factors may be hard, i.e. technically difficult, expensive or unwanted, to impact while others provide a better result for the same effort. Communication between vehicles is one way to achieve higher awareness of the traffic situation for the driver but due to the complexity in accident factors it might have other effects as well, both positive and negative.

5.2 Possible effects of an incident warning system via Cell Broadcast

Naturally one of the most important issues regarding traffic safety is what the effects of the incident warning system can be. To get an idea of what effects the system can have, it is important to know how a driver reacts to warning messages.

A recent study have analysed how drivers are affected by incident warning messages in a simulated environment¹⁷. A general conclusion from this study was that responses to the incident that a warning had been issued for was speeded up, which is positive for traffic safety. For most incidents the natural response is to reduce speed and the warning messages made the drivers reduce speed earlier than without warning messages. Often an early reduction in speed can lead to better control of the situation for the driver and this can be the difference that makes the driver avoid an accident triggered by a deviation in the traffic situation.

Another positive effect of the warning systems was that the drivers' workload tended to be lower. Reducing workload for drivers in the sometimes stressed situations that occur while driving, especially around traffic deviations, can be a way to reduce the number of wrong decisions compelled by stress.

The traffic messages will not only affect the driver that received the message; the surrounding traffic will be affected by this driver's reaction to the message. The possible positive effect on surrounding drivers is that they will be forced to reduce speed if they are

behind the driver who received the message. The reduced speed leads to more time to react to potential risks, which can lead to prevention of accidents. The possible negative effect is that the surrounding motorists will be irritated by the apparently unmotivated reduction in speed and this can lead to dangerous overtaking. This effect may be negligible and perhaps the most important effect is that the driver who received the message can avoid making sudden manoeuvres and has more time to inform the drivers behind that a deviation in the traffic situation has occurred.

Inattention is often claimed to be a cause of traffic accidents. Whether or not it is a common decisive factor, attention should be increased if you receive a warning message. This means that accidents could be avoided by increasing the attention of drivers around traffic deviations. It is essential that the information comes at the right time and that it is presented in a suitable way to prevent distraction from the most safety-relevant information.

The information on road surface slipperiness, when the humidity and temperature lead to icy roads probably has the same effect on drivers as the general warning message, i.e. reduced speed. This information is probably most important when the first cold mornings come in autumn, when many traffic accidents occur most years.

There are approximately 700 weather stations in Sweden today, which can report quite large variations in conditions within the area of one weather station. The information can, however, warn the drivers that there is a risk for ice in extreme areas. There is also a possibility to have warnings sent out when the temperature drops so much that the road salt does not keep the roadway free from ice (where road salt is used).

Many cars are equipped with a thermometer today, and these will probably show a more exact value of the air temperature for the current position of the vehicle. The advantage of distributing measurements from the weather stations via the Cell Broadcast system compared to thermometers placed on vehicles is that the weather stations are placed where the temperature can be extreme. The vehicle thermometer will show this extreme temperature when it occurs and at this time it can be too late. Another advantage is that not only air temperature, but also temperature gradient, road surface temperature and humidity are measured in the weather stations, which provides more information about the slipperiness on the road than just the air temperature.

5.3 Vehicle crash and incident information

In order to evaluate what the effects described in section 5.2 can have in terms of actual prevented accidents, detailed information about the course of events in the accidents has to be analysed. This information is not always available and can make it difficult to estimate the potential effects of an incident warning system via Cell Broadcast.

As described in section 5.2 the positive effects of a warning message are reduced speed, increased attention and decreased mental workload. These effects may prevent a number of accidents. Available information in the suggested incident warning system may prevent rear-end collisions in congested traffic, accidents caused by sudden slipperiness and accidents involving animals. Single vehicle accidents may be prevented by increased attention and reduced speed around traffic deviations.

Traffic safety

Accident type	Accidents	Killed persons	Severely injured persons	Lightly injured persons
Involving animals	604	16	-	-
Rear end collisions	1807	9	274	2917
Single vehicle accidents	3997	187	1203	5387

Table 10. Number of police reported accidents with injuries in the year of 2001¹⁸.

In 2001 there were 2411 accidents reported that involved animals or rear end collisions and they resulted in 25 killed and a large number of injured persons. These are the type of accidents that have the largest potential to be prevented by an incident warning system. Of course not all of these accident will be prevented, but the statistics show that there are a lot of accidents within this area that could be affected. In addition a great number of crashes are not reported to the police, particularly single vehicle accidents and those with wild animals involved.

As described above an incident warning system can also possibly prevent accidents involving only one vehicle by reduced speed and increased attention to traffic deviations. The effects of this type of accident may not be as straightforward as in the accident types above, but on the other hand the number accidents of this type is much higher. There were almost 4000 single-vehicle accidents in 2001 and they resulted in 187 deaths.

Even if an accident cannot always be avoided, early braking and reduction in crash speed will have an effect on the consequences of the accident. The risk of a driver getting killed in a crash does not only increase proportionally with the change of speed, but rather to something like the fourth power¹⁹. This means that a reduction in speed is very important for the outcome of an accident.

A more detailed investigation about the estimated effects of an incident warning system via Cell Broadcast can be realised by analysing traffic accident databases such as STRADA²⁰ and FARS²¹. By analysing the course of events in actual accidents, some effects of an incident warning system via Cell Broadcast may be estimated.

5.4 Distraction and its avoidance

The mobile terminal is becoming more and more frequent in vehicles today and Sweden has a very high proportion of drivers with mobile terminals. The distraction caused by the mobile terminal has been a subject of discussion for some time. Regulations on the use of cellular phones in the vehicle or hands-free functions have also been proposed in Sweden.

Distraction is inattention triggered by an event and can be defined as “when a driver is delayed in the recognition of information needed to safely accomplish the driving task because some event, activity, object or person within or outside the vehicle compels or induces the driver’s shifting attention away from the driving task”²². The incident warning system may cause some kind of distraction to the driver, the question is how much and will it affect traffic safety?

The answers to the questions above are very dependent on system design. Important distraction factors are where the mobile terminal is located and appearance of the message.

Studies have shown that talking in the phone while driving affects the situation awareness²³,²⁴, which can lead to increased reaction times (also with hands-free function). It is important to point out that the kind of distraction caused by the incident warning system is very different from the one caused by talking in a mobile terminal. In best case, that is if the terminal is fixed to the dashboard and placed in a correct angle for the driver, the distraction will only consist of a second of increased visual workload when the alert is received. For this to be true the type of warning message has to be of general kind (i.e. “warning, accident”) and be displayed instantly (cf. flash-SMS).

If the terminal is located elsewhere than fixed on the dashboard, the distraction can be much higher. If the driver has to look for the terminal or reach out to get it, the distraction can be compared with distractions like incoming phone calls or changing radio channel, which is a possible cause of accidents²². The worst case is if the driver is distracted by looking for his terminal and collides with the object that he has been warned about. Studies have shown, however, that the driver has a tendency to be distracted only when the situation allows it and, if the driver suspects that the message is a warning message, it is possible that he does not let himself be distracted.

The presentation and formulation of the text-message is also important for how much distraction the message will cause. Most terminals support showing the first words of the message instantly and then a button has to be pressed to read the rest of the message. This can be used to have a general warning message displayed instantly to inform the driver that something (e.g. congestion) has occurred nearby. Reading the general message can increase the driver's attention, and the information about what exactly happened and where the accident is located can be read when the traffic situation allows it.

Considering the distraction it would be preferable to have a voice message together with the text message. This is not possible today if the terminal is not integrated in the vehicle and a special application is developed for this. Some future possibilities regarding multimedia messages via Cell Broadcast are discussed in section 7.2.2.

According to the results above, some conditions have to be fulfilled by the equipment and the service to prevent unnecessary driver distraction:

- The terminal should be placed on the dashboard, as close to the driver's normal viewing angle as possible.
- A general warning should be displayed instantly on the display; more precise details can be accessed by pressing a button on the terminal.
- The general message should be so short that the whole message can be viewed instantly in most terminals. It might be recommendable to have a space between the general message and the more specific one, in order to keep them apart.
- If manual reporting is implemented, it is essential that the reporting procedure can be performed simply while driving.

When it is possible to connect the Cell Broadcast messages to integrated equipment in the vehicle or when it is possible to send multimedia messages, it may be better to combine the text message with a voice message.

Due to the distraction issue, it is important that no unnecessary information is distributed within the service. Apart from distraction, unnecessary information will cause irritation that is negative, both for the service and traffic safety.

6 Services outside automotive telematics

The characteristic that can make Cell Broadcast a popular channel for information distribution is that it is location-based push-information. Another interesting fact is that commercial to mobile terminals has become attractive both for content providers and mobile users. There has been a discussion about not allowing spam to be broadcast to mobile terminals; this is not an issue in Cell Broadcast since users have to actively choose which channels to listen to.

6.1 Local service

One group of possible advertisers are the ones who run local service businesses. Examples here could be:

- Taxi
- Car mechanics
- Hotels

These services can be implemented with Cell Broadcast, but these are the kind of services that perhaps are of pull type. This is due to the fact that they are not used often and when you use them you could make the effort to send an SMS to get a response. Cell Broadcast is push information and the advantages of this should be used, so perhaps the services mentioned above could also be implemented with SMS.

6.2 Travelling

Since Cell Broadcast is location-based many services offer the best customer value when the customer is travelling. There are some applications that suit motorists. Gas stations can be interested in telling their customers that they have entered a zone where they can buy gas from them. Fast-food chains may also be interested in sending out a message when you come into a specific area. Other possibilities are tourist information and information about local events.

Today Telia offers a service where you can send an SMS and see if there are any available houses or apartments in the area. This service could be improved if the information was of push type instead of pull, i.e. using Cell Broadcast. If you listen to a specific channel for available houses you could get a message when there is a house for sale in the area you are in. Different channels could be implemented to differentiate, for example, the type of house and price. Information about visiting hours and estate agent can be included in the message.

6.3 Offers and events

Shopping malls are another possible user of Cell Broadcast. The shopping mall could have its own channel with special offers from the stores. This kind of advertising is also applicable in a city, where stores can have their own channel or share it with other stores to make special offers to entice people into the store.

Cell Broadcast could also be of interest during major events like soccer games, etc. In these situations companies can have special offers just to those who go to a certain game. In exhibitions you could, for example, send out every hour which lectures are being given and where. The same goes for festivals, which band is playing now and where? Ten minutes before every band starts playing a message can be sent. The different stages can use different channels if necessary.

Another simple application is lunch offers. In cities, industrial centres and malls there could be a demand for lunch restaurants to broadcast an offer of today's lunch specials. This broadcast could be done just once a day at a certain time or during a period of time.

6.4 WAP and SMS triggers

One way to exploit Cell Broadcast is to send out different local offers on mobile services or having location-based contests or games.

A possibility is to have offers broadcast around Telia stores. An example could be: "Sign up for mobile data today and have one month free trial. Your closest Telia store is on the High Street. Come!" This message will probably feel personal and perhaps entice people to the Telia store and sign up for mobile data.

An example of a contest could be: "Welcome to Sundsvall City! Send an SMS with the text "Sundsvall" to 1234 and win tickets to the summer festival!"

A game or competition could be for example "SMS-SM". A Cell Broadcast message is sent to different areas in Sweden at different times and the message contains a text string that the contestants should SMS to a certain number as fast as possible. The fastest subscribers within an area get points and get a response: "Congratulations, you got 5 points!" Scoreboards could be available on the Internet. The contest could be delimited in time or be continuous. The game could also be modified to SMS Jeopardy or any other game with questions in it.

A trigger for both WAP and SMS is news' flashes that come regularly to your terminal. These messages should be on the terminal in principle constantly and consist of news headers. The message should also contain links to WAP pages or reply paths for SMS messages so that the user can read more from a special news header. There are a number of advantages with this sort of information. The first is that the user only has to pay for things that he is interested in. This means that he does not have to pay for searching the news he is interested in, which provides added value for the user. The user also gains access to push-information, which means that he knows that he will be informed if something extraordinary happens. For the operator the revenues come from the increased traffic generated by the triggers. A service like this can increase the number of WAP users and the amount of data they collect via WAP. Since WAP is an important gateway to UMTS services these kinds of services can have effects even on future demands of doing other things than just talk in your mobile terminal. When MMS is available, you could perhaps trigger, for example, trailers for new films with this service.

6.5 Local warnings

Cell Broadcast is also well suited for local warnings outside the scope of road traffic. People who are suffering from a hearing impairment have trouble hearing the warning sirens, and sometimes it is hard to hear the siren when you are indoors or in a noisy environment. In these cases a Cell Broadcast message with a vibrating alert could make a difference.

Another problem with sirens is that people do not know what to do when they hear it. With Cell Broadcast messages the kind of danger can be specified immediately as well as a description of the proper actions. The fact that messages can be sent to the whole country or just to one cell is also important for these kinds of warnings.

This service has a large customer value, but does not have an obvious business case. The service could, however, create goodwill for Telia and perhaps increase the number of

subscribers in groups of people who suffer from hearing impairment and work in noisy places. It is important not to forget that the service is also suitable for people who hear perfectly well and do not work in noisy places since there is more information in a text message than in a siren. The subject is of special interest in these days of terror threats.

Cell Broadcast could be used for reminding people to shut their terminals off. The obvious applications are airports and hospitals, but perhaps this function could be used in other places.

6.6 Weather forecasts and warnings

Usually there is no need for weather warnings in Sweden except for slipperiness warnings to road users. However, along the seaboard and in the mountains warnings about hard weather could have a market. Weather forecast in general is a possible application for Cell Broadcast. The advantages of Cell Broadcast in this context are that the user is mobile, the forecasts can be very local and the information is pushed to the user if the forecast is changed.

If the same message is sent until the forecast changes, the user can always be updated with the latest forecast. Even if it the weather is not severe this information could be valuable in the mountains and along the seaboard. In these cases push information is preferable.

6.7 Local chat

It is possible to offer a local SMS chat with Cell Broadcast. This service can be achieved by distributing the chat messages that are sent to a special chat number via Cell Broadcast. The operator can choose which cells in the vicinity of the chatter the message should be broadcast to. The differentiating characteristic of this service compared to an ordinary SMS chat is that you will always chat with persons in the neighbourhood of where you are.

6.8 Differentiated GPS

Cell Broadcast can be used to send out differentiated GPS information. This means that a stationary GPS receiver knows its position exactly and can hence calculate the error in the GPS signal. The current error in the signal is distributed to the surrounding GPS receivers via Cell Broadcast, where the position can be calculated more exactly.²⁵

7 Discussion

This chapter begins with a discussion of why the author thinks Cell Broadcast is unused at present and also future functions within the technique. Moreover automotive telematics services and their information sources are discussed from the operator's and the customer's point of view. The chapter concludes with a general discussion of safety communication between vehicles.

7.1 Why is Cell Broadcast unused in Sweden?

Cell Broadcast has been available as a function in GSM for a long time; the question is why the function is unused in Sweden. One reason is probably the lack of standardisation. Both the mobile terminals and the interfaces to the Cell Broadcast Centre (CBC) have been poorly standardised. The effects of this are difficulties in developing services and getting the users to understand how to activate them. Today the mobile terminals have a much better interface to handle Cell Broadcast services and the users have more experience in handling their terminals.

Even if the standardisation has been a problem, the most important reason that has led to Cell Broadcast being unused is that it has been difficult to charge the end customer for using the services. This has made the operators unwilling to invest in Cell Broadcast service development. When the possibilities of controlling the mobile terminals via OTA messages came, the charging obstacle was reduced. If it is possible to charge the end customer in an appropriate way, Cell Broadcast will be much more of interest for the operator.

Another problem with Cell Broadcast is that it has taken energy from the battery of the mobile terminal to listen to the Cell Broadcast Channel (CBCH). The use of energy has been decreased by DRX reception (see section 2.6) and the question has become less important since the batteries in the mobile terminals have become greatly improved in recent years.

As mentioned above, Cell Broadcast is quite an old technique. The standard for Cell Broadcast came approximately at the same time as for SMS. Who thought that there were going to be 10^9 SMSs sent in 2002²⁶? It is important to note that the users' attitude to mobile services has changed since the breakthrough of SMS and that this will affect the possible Cell Broadcast market.

7.2 Future functions in Cell Broadcast

7.2.1 Charging

Within the television business the charging of end customer is solved by coding the information and the subscriber pays for the decoding. This procedure is also possible in Cell Broadcast and is one of two possible solutions to the billing problem. The other possible solution is over-the-air activation of the subscriber's terminal controlled by the operator.

If coding is used an algorithm that can decode the messages has to be stored on the SIM card. If this algorithm can be stored over-the-air, it is a highly interesting alternative. The billing can in this case be connected to the activation procedure. If the subscriber wants to stop using the service, perhaps the algorithm could be deleted (or deactivated) over-the-air as well. This procedure is only possible if the subscriber cannot reject the deactivation

message. The algorithm can be activated via for example customer support, but the main activation interface should be the web. The alternative to OTA messages is that the user goes to a Telia shop to activate the algorithm on the SIM card.

Activation of the terminal controlled by the operator is also dependent on over-the-air messages. In most terminals only Cell Broadcast channels from 0-999 can be activated (recommendations from ETSI), which can be used to charge the subscriber. If channels above 999 are used for a service, the operator can control which subscribers that can receive the information. The activation can be carried out via a web interface and the billing can be connected to the web interface. This procedure also has the advantage that the user can get a better overview of the different channels on the web page and does not have to learn how to activate channels on the terminal. This alternative also allows charging the user in different ways depending on which channels he activates without having to deal with different codings for different Cell Broadcast channels. Generally it is easier to activate a channel in the mobile terminal than to get involved in coding and decoding of the Cell Broadcast content. In this case too, the alternative is to let the users come to a Telia shop to activate the channels instead of OTA activation.

7.2.2 EMS and MMS

Today some vendors offer EMS via Cell Broadcast. This allows sending melodies, pictures and animations via Cell Broadcast. MMS on the other hand cannot be sent via Cell Broadcast today and this will probably not be possible in the near future. The problem with MMS is that it is intended to be sent via the data channels and requires much more bandwidth than what is available within Cell Broadcast today. An alternative regarding bandwidth-demanding content via Cell Broadcast is to send a shortcut to the mobile terminal where specific multimedia content can be found. The message can be like this:

“Madonna has released a new video, download?” and the video can be downloaded via the link.

Another alternative is to send a Cell Broadcast message that orders the mobile terminal to collect multimedia content. In this way the user will feel that he has received a multimedia message via Cell Broadcast. The question is how many customers want the operators to be able to control their terminals this way? Perhaps they are willing to have this function if the messages are important, e.g. relevant traffic messages. In this case, the revenues of the service can be collected via data traffic or via a monthly fee if the message can be collected for free. This would let the user believe that he receiving traffic information voice messages via Cell Broadcast, although this is not the case.

7.3 Telia and automotive telematics

Cell Broadcast is an efficient distributing media for traffic information services. It is clear that the Swedish National Road Administration is positively inclined to implementing new techniques for distributing traffic information. If commercial efforts are to be made, there has to be a business case in distributing traffic information. In order to have a business case, someone has to be interested to pay for the information. If someone is going to be interested in paying for the information, it has to be of high quality. This is where the operators can get the wheel rolling and hopefully collect the revenues within a relatively short period of time.

7.3.1 Differentiation from traffic information distribution via radio

The main obstacle for commercial actors today is that traffic information is distributed for free via radio channels. If the customer is going to be interested in paying for traffic information, there has to be a significant difference compared to the information provided via radio. The challenge lies in offering traffic information that the customer is willing to pay for. Traffic information of high quality is distinguished by **relevance**, **timing** and **visualisation**.

The relevance and the timing are the primarily characteristics that can differentiate the information sent via Cell Broadcast from the information provided by radio stations. First of all the smallest broadcasting area regarding a specific deviation is much smaller for Cell Broadcast than regular radio. This means that only the users who are affected by the deviation will receive a warning message. It also allows sending more detailed information without having users continuously receiving traffic messages. This characteristic will become increasingly important when the information about the current traffic situation improves and is more detailed.

Relevant information is also characterised by only being sent to the user when he/she is traveling in the car. People have accepted listening to traffic messages on the radio also outside the vehicle (e.g. at home). People are, however, probably not as understanding regarding traffic messages to the mobile terminal that cannot be turned off. Within Cell Broadcast the solution is to let the user choose when to receive the information. The Cell Broadcast function can easily be turned off in the mobile terminal and hence the user will not receive any traffic messages.

The **timing** of the messages is important. Traffic information is only valid within a certain amount of time. It is also important that the time between traffic deviation and distribution to the users is short. The time can be very important when congestion has risen due to a crash or an immobilized vehicle. In this case it is critical in the beginning when, for example, the vehicle is still on the road and no warning sign has been placed out. Principally there is no difference in timing between Cell Broadcast and regular radio. If, on the other hand, the information comes from a source that the operator controls (e.g. GSM network information, manual report) the time delay can be shorter using Cell Broadcast.

When it comes to **visualization** of the traffic information, regular radio has a clear advantage over Cell Broadcast since the driver is informed via audio. Cell Broadcast can only distribute text messages so far. Eventually the goal is probably be able to distribute audio messages via Cell Broadcast, but this will not be possible in the near future. The problem can be solved if the mobile terminal is connected to some sort of stationary interface in the vehicle, which then can transform the text messages to speech (see also section 7.2.2).

7.3.2 Comparison with other distributing media

Traffic information can be distributed in many different ways. Radio is mentioned above, but more media are available. Within broadcasting media television has to be mentioned, but television is hardly suitable for traffic information in the vehicle since the amount of receivers in the vehicles is close to zero.

There are certain requirements on the distributing media for traffic information that must be met in order for them to be of interest to road users. The first requirement is that it must be possible to receive the information in the vehicle. For this requirement, until recently, the only possible media was radio. Television, Mobitex or satellite communication has never been an alternative since the receiving apparatus has never been available in the vehicles.

When the mobile terminal became almost every man's property, new equipment for traffic information became available in the vehicles. With the mobile terminal in the vehicle several different distributing techniques are possible. It is now possible to collect information from Internet via WAP or HTTP and receive information via SMS or a phone call.

WAP has been expected to encourage content or service providers to offer traffic information to road users. In this way the content providers could see business opportunities in collecting traffic information, which would improve the range of traffic information for road users. Unfortunately the interest for traffic information via WAP has been quite low. The low interest depends on different factors: one matter that is certain is the generally low penetration of WAP users. Other factors related to the characteristics of WAP as a traffic information distribution medium lead to another property of traffic information media: the information should be sent to the road user when a deviation has occurred. This is not possible with WAP 1.0/1.1 since the user has to request the information of interest.

With WAP 1.2.1 and later versions it will be possible to push information from application servers triggered by some event²⁷. This could be used to let the user log in and only send information when a traffic deviation has actually occurred. This would improve WAP as a distributing medium for traffic information. One obstacle, in addition to the low penetration of users, remains even with WAP 1.2.1: it is extremely difficult for a traffic information service to keep track of the location of specific road users. It is not possible to differentiate the information depending on location in a good way, which can be an important property of a traffic information service.

When HTTP is used to collect the traffic information, e.g. a hand-held computer connected to Internet via a mobile terminal, the visualization of the traffic information can be improved. The problem when communicating via HTTP is the same as with WAP 1.0/1.1: it is not possible to push the information to the road user and the information cannot be location-based.

SMS is a medium already being used to distribute traffic information, although so far only on a small scale. SMS is a push medium, but the challenge is to make the information location-based. It is possible to do this with GSM-positioning, but the positioning is limited due to capacity in the network and the positioning servers. The problem is that every user has to be positioned individually at short intervals.

7.3.3 Automotive telematics from the operator's view

As it looks today, automotive telematics is not a market where the operator can good profit in a short time. As discussed earlier, users might be reluctant to pay for services they can get for free via radio. The challenge lies in offering telematics services that the customers are willing to pay for. One of the most important things when designing a telematics service that people are willing to pay for might be to have an uplink from the vehicle so that information can be retrieved from the vehicle. This way the traffic information can become more dynamic and safety functions for the driver can be developed.

Today the only widespread network where you can both collect and distribute traffic information in Sweden is the GSM network. There are interesting ideas built on an Ad-hoc network between the cars, but there is nothing that can be used in collecting or distributing information on a larger scale today. RDS/TMC (see section 1.1.1) can only be used to distribute information, not collect it. All market players within automotive telematics are more or less in need of a communicating link from the vehicle in order to develop their

telematics services. This puts the operator in a good position and the opportunities are expanded when GSM (and UMTS) can offer both an effective distributing medium in Cell Broadcast and dynamic traffic information with a short time-delay via information from the GSM network. It is important for the operators that traffic information services based on GSM and UMTS are developed before competing media such as RDS/TMC or Ad-hoc networks are widespread. Ad-hoc networks and to some extent RDS/TMC require special equipment in the vehicle (many new car stereos are equipped with a RDS/TMC receiver) and once the users have invested in such equipment, it can be more difficult to sell telematics services based on GSM or UMTS.

When better traffic information is available (collected via GSM), users might be willing to pay for it. The operator has two alternatives if the road users are interested in paying for traffic information. One alternative is to offer an interface between content providers and road users and charge the content provider for communication to and from the vehicle. In addition traffic information collected from the GSM network can be offered. Another alternative is to offer cheap telematics services based on the user's regular mobile terminal and cooperate with car manufacturers to offer more advanced services based on integrated devices.

7.3.4 Information sources

Relevant and dynamic traffic information is essential if customers are to pay for it. Today TRISS includes the most important events on the roads in Sweden, but more detailed and dynamic information is needed if customers are to be willing to pay for the service. One of the easiest ways of complementing the information from TRISS is to extract information from the GSM network. This information can probably give warnings of traffic congestions in a wide area and it should be easy to distribute it via Cell Broadcast. The question is how long it takes to detect a congestion with this method. This type of information could also be used to update navigation systems with dynamic link costs, which will be more useful as the load on the road network and the number of navigation systems increase.

The manual report of traffic incidents can be implemented by the operator itself and can be important in making the traffic information dynamic. The challenge of this information source is to ensure valid information. The problem of incorrect information can be minimized if the function is a part of a telematics service where you have to register and pay a monthly fee to receive traffic information. If the problem proves to be extensive, the user's messages can be logged to prevent inappropriate usage. Pilot projects can be performed with professional drivers who can input information that is distributed to every user of the service.

The information sources discussed above are not dependent on any equipment except the mobile terminal. Floating Car Data is a suitable information source to determine average speed on links and detect traffic congestion, but it requires a GPS receiver in the vehicle. By equipping some vehicles with a GPS receiver and a mobile terminal (GSM/UMTS) and having the vehicle send the current position and velocity to a center, average speeds can be calculated and congestions detected. This information is essential when a motorist wants to optimize his route or be warned when congestions have occurred.

If the data were extended to comprise friction, airbag inflation and other data from the vehicle, the quality of traffic information would increase significantly. Today much information is collected in the sensors of a vehicle²⁸ and this information can be very helpful when traffic deviations are detected. The positive characteristic of FCD for the operator is that it generates large amounts of data traffic.

7.4 Safety communication between vehicles

There are a number of ways to increase safety in a vehicle. One way is to increase the driver's awareness of the traffic situation. This is done within the vehicle with the help of various sensors and warning systems. In order to enhance this information, it can be complemented with further information collected from other vehicles. When this is achieved, the chances increase to predict deviations before it is detected by the driver or vehicle sensors. This can be important when it comes to preventing accidents triggered by deviations in the traffic situation.

Instead of letting the vehicles communicate with each other, it is possible to measure parameters in the traffic situation at fixed places and send this information to the vehicles. This way of distributing traffic information is sufficient when the vehicles are incapable of sending their own information, but can be unnecessarily expensive and it is only valid in the surroundings of where the measures were taken. A more dynamic and more detailed traffic information communication system can be established if the vehicles communicate with each other.²⁹

When it comes to the communication between the vehicles the operators will have an important role since the GSM or UMTS are the best suited communication networks today, especially since these networks are becoming more and more adapted to sending other data than only speech.

8 Conclusions

8.1 Automotive telematics

The conclusion regarding automotive telematics based on Cell Broadcast is that Cell Broadcast can be an important distributing medium for automotive telematics services. Cell Broadcast has obvious advantages compared to existing distributing media in Sweden. The most important advantages are that the information is location based, of push character and it is closely connected to the GSM/UMTS network. Location based push information is probably necessary if customers are going to pay for the services. The close connection to the GSM/UMTS network provides the opportunity to extend the available traffic information sources with real-time information from the vehicles. The lack of available traffic information today is one of the problems in automotive telematics, and to let the vehicles communicate with each other is an important step towards better and more dynamic traffic information.

The added value in the automotive telematics services based on Cell Broadcast is the increased awareness of the current traffic situation for the drivers. This increased awareness can lead to both prevention of accidents and better choice of routes. The prevention of accidents is caused by increased attention and decreased mental workload around traffic deviations. Information about traffic deviations can lead to better route choices based on the driver's own knowledge or guiding messages.

A basic automotive telematics service with information from the TRISS database (see section 4.1.5) and distribution via Cell Broadcast could be offered by the operator today if an application that distributes the information from TRISS to the right databases is developed. This service can be developed with better traffic information and integrated functions in the vehicle. With services that are based on a hand-held mobile terminal, it will be possible to cater for many users but the functions will be limited. If vehicle-integrated terminals are used, the added value to the user will increase but so will the development cost.

The operators have control over three important parts of an automotive telematics system:

1. A suitable distribution media in Cell Broadcast
2. The important uplink from the vehicle via GSM/UMTS
3. The traffic information that can be extracted from the GSM network (generated by the subscribers)

This makes the operator one of the most important players in the automotive telematics market and the operator has everything to win from an increase in communication to and from the vehicles.

8.2 Cell Broadcast in Telia's network

An implementation of Cell Broadcast in Telia's network will lead to extended possibilities regarding service development. As described in *chapter 4*, automotive telematics services can be realised based on Cell Broadcast. The technique also offers possibilities outside the automotive telematics market. Mainly the technique allows differentiating SMS services with location and push function. Cell Broadcast can also be important in accelerating the usage of WAP and SMS. The fact that this function is new in Sweden and that it already exists in almost every mobile terminal can have positive effects on the usage of Cell

Broadcast. Telia can take advantage of this characteristic by being the first operator in Sweden that deploys Cell Broadcast.

The main question regarding Cell Broadcast is whether Cell Broadcast can generate revenue for Telia. The answer to this question is highly dependent on how the Cell Broadcast services can be charged and how much the users are willing to pay for the added value by the technique. To determine this, more studies have to be made within the area.

8.3 Further work

To determine whether Cell Broadcast should be deployed by Telia or not, more studies have to be made within the area. What must be determined is whether OTA activation of Cell Broadcast channels can be made and if this can be used to charge the end customers for the Cell Broadcast services they use.

Regarding the automotive telematics services it is important to analyse the position and coverage of the base stations to see how traffic information should be mapped to the base stations. It is also important to determine whether it is possible to implement the functions for input of information from the vehicle. Moreover is it essential to determine how willing the end customers are to pay for the type of information distributed within the automotive telematics services based on Cell Broadcast.

As for the effects on traffic safety a more thorough investigation of an incident warning system based on Cell Broadcast should be performed. More detailed information can be analysed to determine the potential to reduce the number and severity of accidents.

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