NMT DOC 900-1
Nordic Mobile Telephone group

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NORDIC MOBILE TELEPHONE

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SYSTEM DESCRIPTION

CONTENTS

GLOSSARY OF TERMS

Access channel	A channel marked with a special identification signal. The channel may be used to get access to a traffic channel when the mobile station initiates a call.
Area information	Indicates which base station the signalling comes from. Prevents malfunction due to co-channel interference.
Base station (BS)	The unit which comprises the terminating equipment for the radiopath and for the supervisory and control signalling towards the mobile station as well as the mobile telephone exchange.
Base station area (BSA)	The radio coverage area of a base station.
Basic channel band	A specific frequency band with the NMT 900 frequency band. Is preprogrammed in the MS, and shall be changeable. This frequency band will be used from the outset.
Calling channel (CC)	Normally one of the channels assigned to a base station is a calling channel used for setting up calls to mobile stations. During peak traffic a calling channel may be used as a traffic channel.
Calling channel band (CC band)	Information given on the calling channel about the frequency band in use for calling channels. Reduces the scanning time when calling channels are searched. Will normally be a part of the basic channel band.
Control unit (CU)	Part of the base station, providing start and stop of transmitter, fault indication etc.
Data channel	One of the channels (calling channel, traffic channel or dedicated channel between MTX and base station) used for data signalling.
dBm0	The term - x dBm0 indicates a power level of x dB below 1 mW at a point of zero relative level.
DSS	Digital Supervisory signal, out-band digital signal to supervise the transmission on the traffic channel during conversation.
Fast frequency shift keying (FFSK)	Modulation principle used between the MTX and MS, utilizing the frequencies 1200 Hz for logical one and 1800 Hz for logical zero.
Fixed subscriber (SF)	A subscriber in the ordinary telephone network.
Free traffic channel	Traffic channel positively marked as free.

Handover request [OPTIONAL]	The speech quality of a call falls below acceptable limits and a handover is initiated to another channel.
Handover request [OPTIONAL] channel (HC)	A channel used for handover signalling from the BS or the SSE to the MTX
Home mobile telephone exchange	The MTX where the mobile station (MTXH) is registered.
Idle radio channel	Radio channel assigned to a base station and not in use, i.e. not occupied and not free marked.
Local exchange	An exchange in which subscriber lines terminate.
Mobile station (MS)	The equipment used by a mobile subscriber.
Mobile subscriber (SM)	A subscriber with a mobile station in the NMT system.
Mobile telephone exchange (MTX)	The unit which controls the traffic between the mobile stations in its area of operation and the telephone network, as well as supervises the operation of its subordinate base stations.
MTX-area	All the traffic areas controlled by the same MTX.
Multi-frequency code signalling (MFC)	Signalling system used between exchanges in the telephone network according to CCITT Rec.R2, utilizing compelled signalling with codes consisting of 2 out of 6 frequencies.
Nordic mobile telephone system (NMT)	The public automatic mobile telephone system in the 450 MHz and 900 MHz range, common to the four member countries. NMT 450 denotes the version using the 450 MHz band, and NMT 900 the version using the 900 MHz band.
Occupied traffic channel	Traffic channel engaged for conversation or call set-up.
Password	A three digit number added automatically to the end of the subscriber number to prevent unauthorized use of a subscriber number.
Push-button multi-frequency tone signalling (MFT)	Signalling system used for signalling from subscriber sets in the telephone network according to CCITT Rec. Q23, utilizing 2x1 out of 4 frequencies in pulses, controlled by push-buttons.

Radio frequency (RF)	The frequencies in the 900 MHz range on the radio path.
Random Challenge (RAND)	A seven digit number, transmitted from MTX to MS during the authentication procedure.
RF-link disconnection [OPTIONAL]	The speech quality of a call falls below acceptable limits and the call is terminated.
Roaming mobile subscriber	Mobile subscriber having left his home mobile telephone exchange.
Scanning supervisory equipment (SSE) [OPTIONAL]	The unit which continuously supervises the channels in the system and initiates handover attempts in the MTX
Signal strength receiver (SR)	Part of the base station, providing measurement of radio frequency signal strength on the channel ordered from the supervisory unit of the base station.
Signed Response (SRES)	A four digit number, transmitted from MS to MTX during the authentication procedure. SRES is calculated based on the received and RAND end the stored SAK
Subscriber authentication key	Secret key stored in the MTXH and MS, used for (SAK) authentication purposes
Supervisory signal (ø-signal)	Out-band pilot signal (approximately 4000 Hz) to supervise the transmission on the traffic channel during conversation.
Supervisory unit (SU)	Part of the base station, providing the interface between the signal strength receiver on the one side, and the MTX or CU on the other side.
Switching call in progress	Method of securing the continuity (in-call hand-off) of an established call when the mobile subscriber moves out of one base station area into another.
Traffic area (TA)	A group of base station areas, where calls to mobile stations are sent out simultaneously.
Traffic channel (TC)	Channel assigned to a base station and primarily intended for conversation. Traffic channel is also used for call set-up from ordinary mobile subscribers.

Traffic channel band (TC band)	Information given on the calling channel about the frequency band in use for traffic channel.
Trunk exchange	An exchange, of which the principal function is to control the switching of trunk traffic.
Visited mobile telephone exchange (MTXV)	The MTX, other than the home mobile telephone exchange, controlling the traffic area the mobile subscriber is visiting at the moment.

ABBREVIATIONS

AC	Access channel
A-subscriber	Calling subscriber
B-subscriber	Called subscriber
B-key	Key for B-number encryption
BS	Base station
BSA	Base station area
CC	Calling channel
CU	Control unit
FFSK	Fast frequency shift keying
MFC	Multi frequency code signalling
MFT	Push-button multi-frequency tone signalling
MS	Mobile station
MTX	Mobile telephone exchange
MTXH	Home mobile telephone exchange
MTXV	Visited mobile telephone exchange
NMT	Nordic mobile telephone system
PMS	Mobile station with priority
RAND	Random Challenge
RF	Radio frequency
SAK	Subscriber Authentication Key
SF	Fixed subscriber
SM	Mobile subscriber
SR	Signal strength receiver
SRES	Signed Response
SU	Supervisory unit
TA	Traffic area
TC	Traffic channel
TMS	Test mobile station
ø-signal	Supervisory signal

1 INTRODUCTION

The Nordic Mobile Telephone System (NMT) is developed jointly by the Telecommunications Administrations of Denmark, Finland, Norway and Sweden in order to establish a compatible automatic public mobile telephone system in the Nordic countries. The system was put into commercial operation in the Nordic countries in 1981.

Due to the success of the first version of the NMT-system, using the 450 MHz band, an expansion based upon the same system design is introduced. This version of the NMT-system operates in the 900 MHz band (CEPT-band), and will work in parallel with the existing 450 MHz NMT-system. This document describes the system requirements for the NMT-system in the 900 MHz band, the NMT 900-system.

The NMT 900 -system may in some cases be implemented in exchanges for the 450 MHz NMT -system. In these cases traffic between mobile stations in the two systems may be served by the same exchange. Normally, however, separate exchanges will be used, and the fixed telephone network will be the interface between the two systems.

The mobile stations of the NMT 900 system are fully compatible with the landbased part of the system, regardless of which Nordic country the mobile subscriber happens to be in at the moment. All mobile subscribers are normally given full roaming capability in all the participating countries.

Mobile stations to be used in the NMT 900 system are to be typeapproved by the Telecommunications Administration. The mobile stations are to be purchased or leased by the subscribers.

Several kinds of subscriber mobile stations can be accommodated in the system:

- ordinary mobile stations;
- mobile stations with priority;
- hand-held mobile stations, and
- coin-box mobile stations.

The system is primarily intended for land mobile use. To some extent, however, the network may also be utilized for short-distance maritime mobile communications.

Detailed information on different parts of the system is given in the following NMT publications:

- Technical specification for the mobile telephone exchange (NMT Doc 450/900-2).
- Technical specification for the mobile station (NMT Doc 900-3)
- Technical specification for the base station (NMT Doc 900-4).

The basic requirements set to the NMT system are:

- Setting up and charging of calls to and from the mobile station shall be automatic.

- It shall be possible to set up calls between the mobile stations and any fixed telephone subscriber or any other mobile telephone subscriber within the system, regardless of country.

- The costs shall be charged to the calling subscriber, regardless of whether it is located in the mobile system or in the fixed telephone network. The charge shall be based upon the dialled numbers, and the duration of the call.

- The system shall provide for automatic roaming capability for the mobile subscribers within the Nordic countries.

- To the subscribers the system shall appear as similar as possible to the fixed telephone network. This applies both to the use of the mobile station, the reliability of signalling, charging, and secrecy, and to the services offered.

- The introduction of the system shall not necessitate any significant changes in the fixed telephone networks.

- The system shall have the capability of switching established calls from one base station to a neighbour base station based on the speech quality, enabling "small cell" -technique to be used.

The first version of the NMT system (NMT 450) fulfils all these requirements. NMT 900 also fulfils these requirements. In addition it is prepared for use of hand-held mobile stations. Added subscriber identity security is included in this improved version.

2 SYSTEM CONCEPTS

2.1 GENERAL

The system concept is based upon close interworking with the fixed telephone network. For reasons of compatibility, the interface between the mobile stations and the landbased parts of the system is the same in every country.

The interface between the system and the telephone network is contained in the mobile telephone exchange MTX, which thus has to absorb the differences between the various interfaces to the national networks.

The base stations, serving as the interface between the radio path and the landbased 4-wire transmission systems, perform no switching of the speech path. They are grouped into traffic areas, each connected to only one point in the telephone network, in which an MTX controls the traffic to and from the mobile stations. One MTX controls one or more traffic areas, fig.2.1. The MTX will be stored program controlled. The system is designed with a number of facilities which are expected to be of value to the subscribers, such as abbreviated dialling, follow-me etc.

On every base station, one channel is used as a calling channel and is marked with a special identification signal. In traffic areas where one calling channel would not have enough capacity two calling channels on base stations may be used. The mobile stations lock to the right calling channel depending on their identity code.

One or several of the other channels, when free, are marked with a free traffic channel or access channel identification signal. Stand-by mobile stations in a base station area are locked to the calling channel. It is, however, possible for the MTX to permit use of the calling channel for conversation in certain circumstances. This possibility is likely to be utilized only in base stations with few channels at times when all traffic channels are busy.

The calling and traffic channels are searched within a frequency band which depends on the information sent on each calling channel. Also the interleaved channels within the given band are included in the search procedures. After locking to a calling channel the information received is stored in the mobile station and used when scanning next time. In the initial phase, a defined number of channels is scanned.

In addition to the signals designating the channels as calling, traffic or access channels, there are signals in order to enable the mobile station to distinguish between traffic areas and between countries, as well as signals indicating the channel number. All signals are transmitted by means of a 1200 Baud FFSK signalling system.

The mobile stations is followed in such a way that the MTX knows in which traffic area the mobile station is situated. The updating of the location registration is initiated by the mobile station when the calling channel identification signal indicates a new traffic area. To minimize the possibility for illicit use of subscriber identity numbers, an authentication procedure will take place on mobile originated calls.

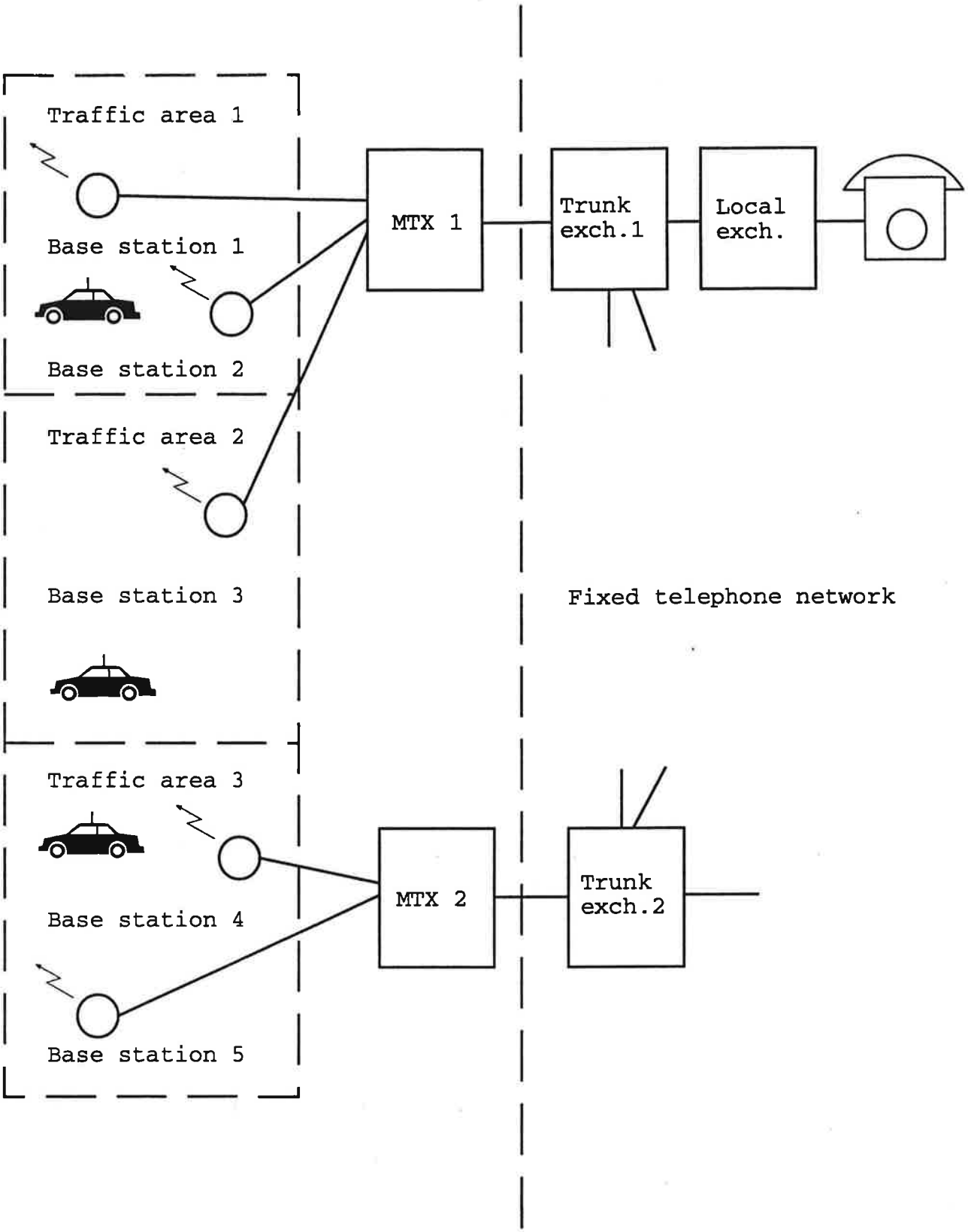


Fig. 2.1 SYSTEM STRUCTURE

2.2 RADIO FREQUENCIES

2.2.1 Frequency band

The radio frequencies where NMT 900 will operate consist of the bands 890-915 MHz and 935-960 MHz, which will be used for the paths mobile station to base station and base station to mobile station respectively. With a channel separation of 25 kHz, these bands accommodate 1000 channels. However, the system is also designed for use of interleaved channels i.e. channels with 12,5 kHz channel separation from the ordinary channels.

The mobile station shall be programmed for operation only in a specific initial band if no channel band information is received from MTX.

2.2.2 Radio coverage

In order to reach an effective frequency utilization in densely populated areas, the system is prepared for small coverage areas ("small-cells"), where mobile stations with low output power are used. As a consequence, the probability of reaching the coverage limit of a base station during a call increases. In order to reduce the inconvenience of this, the system is designed to switch calls in progress from one base station to another base station. Furthermore, the transmitter output power of all mobile stations is automatically reduced (ordered by MTX) when entering a small-cell area.

The same power reduction procedure is used in order to reduce interference in cases when mobile stations are close to base stations with conventional coverage areas.

2.3 CALL SET-UP PROCEDURES

2.3.1 Call to mobile station

Calls to all kinds of mobile stations are sent out in parallel over all base stations in the traffic area in which the mobile station is believed to operate. When a mobile station has received a calling signal containing its identification, it returns a call acknowledgement on the return frequency of the calling channel, upon this MTX allocates a traffic channel on the base station where the mobile station has answered the call. The channel number is received by the mobile station, which then switches to the allocated channel. Thereafter, all exchanges of signals between MTX and the mobile station take place on the traffic channel.

Alternatively the MTX may order the mobile station to search for a free marked traffic channel after having received the acknowledgement on a base station where all traffic channels are occupied.

As another alternative, the call may be put to a queue on the congested base station. The calling procedure is started from the beginning if a traffic channel becomes available within the set time limit.

2.3.2 Call from mobile station

When an ordinary mobile subscriber initiates a call, the mobile station automatically hunts for and locks to a free marked traffic channel, on which all signals are exchanged and the conversation takes place. Alternatively the mobile

station makes an access attempt on a dedicated access channel, on which the MTX responds with information about the allocated channel for this call.

2.4 NUMBERING AND ROUTING

The numbering scheme is designed to meet the following objectives:

a) to enable a calling subscriber to inform the telephone network about the identity of the called mobile station;

b) to serve as routing information for the telephone network;

c) to enable the mobile station to respond to a call from the MTX;

d) to identify a calling mobile subscriber to the MTX.

e) to secure that subscriber numbers are not used unauthorized.

The routing in the telephone network is performed by the following principles:

In Finland: $P_N M_1\ M_2\ X_1\ X_2$
In Sweden: $P_N M_1\ M_2\ M_3\ X_1\ X_2$
In Denmark $M_1\ M_2 X_1\ X_2$
In Norway $M_1\ M_2 X_1 X_2$

P_N = trunk prefix
$M_1\ M_2\ (M_3)$ = mobile prefix
$X_1X_2X_3X_4X_5X_6$ = subscriber number series

These structures satisfy the requirement b) above.

Identification of mobile subscriber requires more information than digits $P_N M_1 M_2 (M_3) X_1 \ldots X_6$ dialled by the calling subscriber, since it must be possible for MTX as well as for the mobile station to distinguish between identical subscriber numbers $X_1 \ldots X_6$ belonging to different countries. Therefore, a nationality digit Z is added to the subscriber number $X_1 \ldots X_6$ for communication on the radio path. The digit Z is only used internally in the system and is not dialled by a calling subscriber. For communication towards a mobile subscriber, Z is added to the subscriber number $X_1 \ldots X_6$ in his home MTX, even when he is visiting another MTX area. For communication from a mobile subscriber, it is automatically sent by the mobile station logic.

In all countries mobile subscribers are identified by the number $ZX_1X_2X_3X_4X_5X_6$ within the mobile telephone system, that is in all signalling between:

MTX — MTX

MTX — MS

The combination $Z\ X_1 \ldots X_6$ satisfies the requirements c) and d) above.

To summarize, in order to set up call to a mobile subscriber, the calling subscriber shall dial the following numbers to reach the relevant MTXH:
Calls to Finnish or Swedish MS:

national $P_N M_1 M_2 (M_3) X_1 X_2 X_3 X_4 X_5 X_6$

international $+ I_1\ I_2\ (I_3)\ M_1 M_2 (M_3) X_1 X_2 X_3 X_4 X_5 X_6$

In the MTXH the nationality digit Z is added in front of $X_1 X_2 X_3 X_4 X_5 X_6$

Calls to a Danish or Norwegian MS:

national $M_1 M_2 X_1 X_2 X_3 X_4 X_5 X_6$

international $+ I_1\ I_2\ M_1 M_2 X_1 X_2 X_3 X_4 X_5 X_6$

One of the basic requirements is that the system shall allow setting up calls to a roaming subscriber, i.e. a subscriber who is visiting another MTX -area than his own. This requirements necessitates introduction of facilities which the telephone network does not possess today, and the solution chosen is to supply each MTX with a subscriber register so that it can keep track of its own subscribers. When a mobile station moves from one traffic area into another, it automatically sets up an updating call to the MTX. If the new traffic area is controlled by another MTX, information is forwarded through the telephone network to the subscriber's home MTX about his change of "address". The updating communication which takes place between the mobile station and the visited MTX does not normally require any action on the part of the mobile subscriber.

The subscriber register for the mobile station in the MTXH is then updated and all calls to this mobile subscriber are rerouted to the new MTX-area.

The mobile station is equipped with a "country selector" which prevents it from locking to other base stations than those of the selected country.

To prevent unauthorized use of a subscriber number a three digit password $K_1 K_2 K_3$ (given by the operator) is added automatically to the end of the subscriber number $Z X_1 X_2 X_3 X_4 X_5 X_6$ by the logic in the MS.

This password $K_1 K_2 K_3$ is not known by the subscriber and is used on the radio path from MS to MTX only in the identification phase. The code is checked in the MTX, where the same password is stored together with other subscriber data.

For mobile station with added subscriber identity security a special authentication procedure between MTX and MS will take place on all mobile originated calls.

These structures satisfies the requirement e) above.

2.5 SWITCHING CALL IN PROGRESS

During a call a continuous supervisory signal (a tone of approximately 4000 Hz) is generated at the BS (on order from MTX) and sent to the MS, where it is looped back to the BS. The received return signal is detected and evaluated by the BS which decides if the transmission quality (signal to noise ratio integrated over a certain period of time) necessitates switch-over to another BS or disconnection of the call. Information about switch-over or disconnection is then sent to the MTX.

During the call also the signal strength received from the MS is measured and evaluated in the BS, which sends information to the MTX if the signal strength is so low as to necessitate switch-over to another BS or disconnection of the call.

In case switching call in progress shall be performed, the MTX orders the actual and surrounding base stations to perform signal strength measurements on the radio channel on which the MS is transmitting. For signal strength measuring, all BS are equipped with an all-channel monitor receiver. Information about the measurement results enables the MTX to decide to which BS (if any) the call shall be transferred. If no switching takes place, the MTX may repeat the signal strength measurement process.

The measuring action is also ordered on the BS in use immediately at the start of a call set-up in order to determine whether the actual BS is suitable.

The result of the measurement at the beginning of each call is also used to determine whether the received signal from MS is above a given high level in which case the MTX orders the MS to change to a lower output power level mode.

2.6 CHARGING PRINCIPLES

Charging of calls from a fixed subscriber to mobile subscribers is performed by the equipment already existing in the telephone network, and is based upon an analysis of the dialled digits regardless of the actual location of the mobile subscriber.

Conversely, calls from mobile subscribers are charged according to the dialled digits and the location of the calling subscriber. This information is stored for each call by the MTX for further debiting purposes (toll ticketing).

The mobile subscriber may be charged with additional costs e.g for incoming or forwarded calls.

3 TRANSMISSION MEDIA

In addition to the fixed telephone network, two transmission media with very different properties will influence the overall transmission quality, namely on the one hand the landbased transmission system connecting the base stations with MTX and on the other hand the radio path between the base station and the mobile station. These two transmission media will be described in the following.

3.1 LAND BASED CIRCUITS

The communication between MTX and the base station is established via leased 4-wire lines, analog or digital. Normally, the lines are through connected to the radiopath, but for testing purposes, any such line may be looped in the base station so as to enable the MTX to decide whether a fault is located in the line or in the base station equipment. The requirement regarding the parameters of the lines are essentially the same as for other 4-wire circuits used for speech transmission, except that an upper limit is set on the acceptable group delay distortion in the band 900-2100 Hz because of the data signalling between MTX and base station, respectively MTX and mobile station. The signal-to-noise ratio will normally be satisfactory. Limits must be placed on the overall loss between MTX and base station in accordance with the various national level plans. In carrier frequency systems, a maximum frequency shift of ±5 Hz must be taken into account. National requirements will be set to this type of lines.

3.2 RADIO PATH

The transmission channel between the base station and the mobile station consists of the radio path. The quality of this channel varies with time due to the movements of the mobile station. It decreases rapidly when either the field strength received or the co-channel interference-ratio between wanted and unwanted signal is below a certain threshold.

The communication to and from the mobile station consists of speech as well as signalling information. The reliability of the transmission of the latter kind of information can be increased greatly under adverse condition by redundancy techniques, known from the data transmission field. However, there is no reason to require reliable signalling under conditions on the radiopath which are too bad to be used for speech. The worst case to account for is the condition of co-channel interference in combination with fading. Considering the repetition rate of the fading minima at an average speed of 50 km/h, and the need for a certain length of time during which the S/N ratio is sufficiently great for the data signalling, one can show that a signalling rate of 1200 Baud is reasonable value.

3.3 COMPANDER

In order to increase the speech quality on the radio channel, compressor/ expander circuits are utilized. The circuits are placed in the BS and in the MS's, and the compression ratio is 2:1.

4 SIGNALLING SYSTEMS

This chapter describes the signalling between the MTX, BS and MS.

This signalling can be divided in 3 groups (see fig.4.1a and 4.1b)

- Signalling between MTX and MS;
- Signalling between BS and MS
- Signalling between MTX and BS

The signalling between the MTX and the fixed telephone network will follow the normal national telephony signalling procedure. The signalling between the different MTX:es is specified in detail in NMT Doc 450/900-2.

4.1 FUNCTIONAL DESCRIPTION OF SIGNALS

4.1.1 Signalling between MTX and MS

4.1.1.1 Signalling from MTX to all stand-by MS:s

- Number of actually used channel. In order to decrease the risk for a mobile to find a false calling or traffic channel (intermodulation product) this information about the actually used channel is needed.

- Power bit information. The MTX informs the MS about power level to be used when transmitting on this channel towards the MTX, and also which type of base station the channel belongs to.

- Channel indication. The MS:s must be able to distinguish between a calling channel, a free traffic channel, an access channel or an occupied traffic channel with data transmission, and therefore a channel indication (prefix) must be transmitted.

- The MS:es are divided into two groups. MS:es with odd K_3 in their password belong to group A. MS:es with even K_3 in their password belong to group B.

- Traffic area number. In order to discover a change in traffic area, for roaming updating, this information must be transmitted. The traffic area number contains also information about which country the area belongs to.

- Additional information. Information about e.g. available frequency bands are specified in para 4.3.3.12.

4.1.1.2 Signalling from MTX to a specific MS

- Identity. In order to get in touch with one specific mobile there is a need of an identification. This consists of seven digits (nationality digit Z and mobile number $X_1 \ldots X_6$). This is also needed for charging purposes.

- Area information. To prevent malfunction due to co-channel interference this information is sent to the MS, and returned back to the MTX.

- Channel order. MS is ordered to change to a specific channel by means of a channel order, which contains the mobile subscriber number and the channel number to which the mobile has to go.

- Random Challenge. A random number, RAND, is transmitted to the MS as soon as this MS initiates a call set up. This number is used for authentication purposes by this actual MS. RAND will be selected by the MTX.

- Power bit information. This informs the MS about the actual maximum power level which shall be used from the MS, and which type of base station the channel belongs to.

- Queuing information to MS with priority.

- Queuing information to ordinary MS. Informs MS that a call is queued in the MTX.

- Scanning order, which may be sent instead of the channel order.

- Line signals. In order to set up and clear a call to or from an MS, line signals of the same type as in the ordinary telephone network are needed. They are:

    - Address complete

    - Ringing order

    - Proceed to send (roaming updating confirmation)

    - Clearing

    - Clearing, call transfer activated

    - Answer to coin-box (only for coin-box category MS:s)

4.1.1.3 Signalling from an MS to MTX

- Number of actually used channel

- Mobile subscriber identity (7 digits supplied with a 3 digit password).

- Area information. This informs the MTX from which BS group the MS received the signalling.

- Call acknowledgement. This signal is a reply from an MS to a call from the MTX.

- Access signal on access channel. This signal informs MTX that an MS wants to make a call.

- Call acknowledgement seizure. This signal is a reply from a called MS, sent on a traffic channel.

- Seizure. This signal informs MTX that an MS wants to make a call. The same signal is used as MS identity on identity request on TC.

- Seizure from coin-box MS. The same signal is used as MS identity on identity request on TC.

- Roaming updating. This signal is sent from an MS to inform the MTX that the MS is now in a new traffic area. The same signal is used as MS identity on identity request on TC.

- Clearing, release guard

- Answer acknowledgement (coin-box)

- Answer (when mobile subscriber answers)

- Digit signals For mobile stations with added subscriber identity security, the digit signals are encrypted, based on the received RAND and the locally stored SAK

- MFT converter in/out. These two signals are used in order to call in/out an MFT converter in the MTX when the push-button set of the MS is used for transmission of data into the ordinary telephone network.

- Register recall. This signal is used in order to connect a register to the MS in conversation state, enabling different services, e.g three party conference, to be used.

- Signed response. This signal is sent just before the transmission of digits for mobile originated calls. The information is derived from the received RAND from the MTX and the locally stored SAK.

4.1.2 Signalling between BS and MS

Supervisory signal

Each established connection is supervised by a continuous supervisory signal (ø-signal) transmitted from the BS to the MS, where it is looped back to the BS. If the S/N of the received signal is below a predetermined value, or no signal is received, the result is reported to the MTX (see paragraph 4.5), which takes the necessary action.

4.1.3 Signalling between MTX and BS

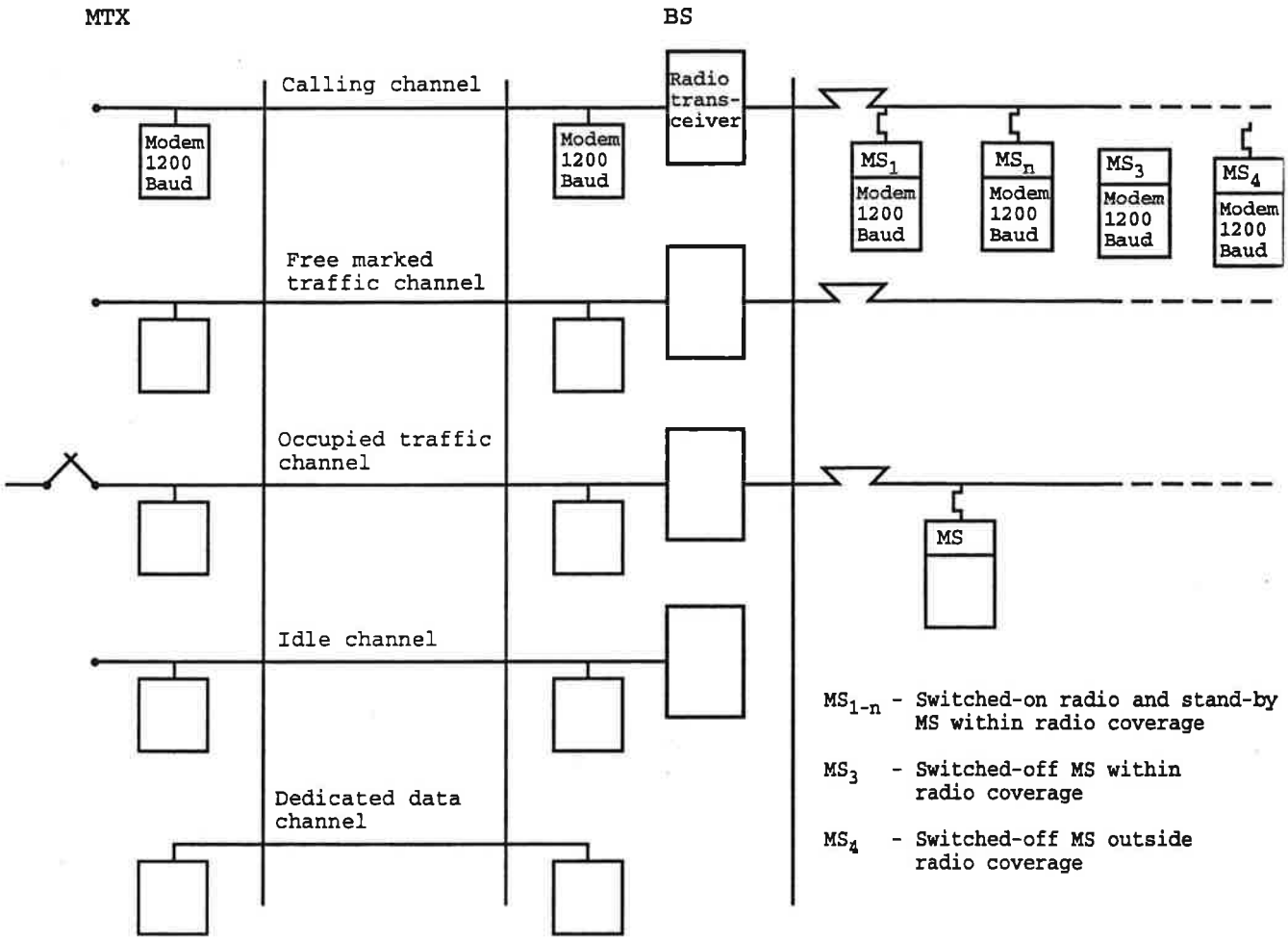
The signalling between MTX and BS can be divided into three different types:

- Individual remote control of each calling and traffic channel such as start and stop of transmitters in BS and remote control of supervisory signal between BS and MS.

- Remote control of signal strength measurements and other more detailed management and maintenance actions in BS.

- Alarms from BS.

This signalling is described in para. 4.2.3 and 4.2.4.



Note: Access channel may be used instead of free marked traffic channel.

Fig. 4.1a

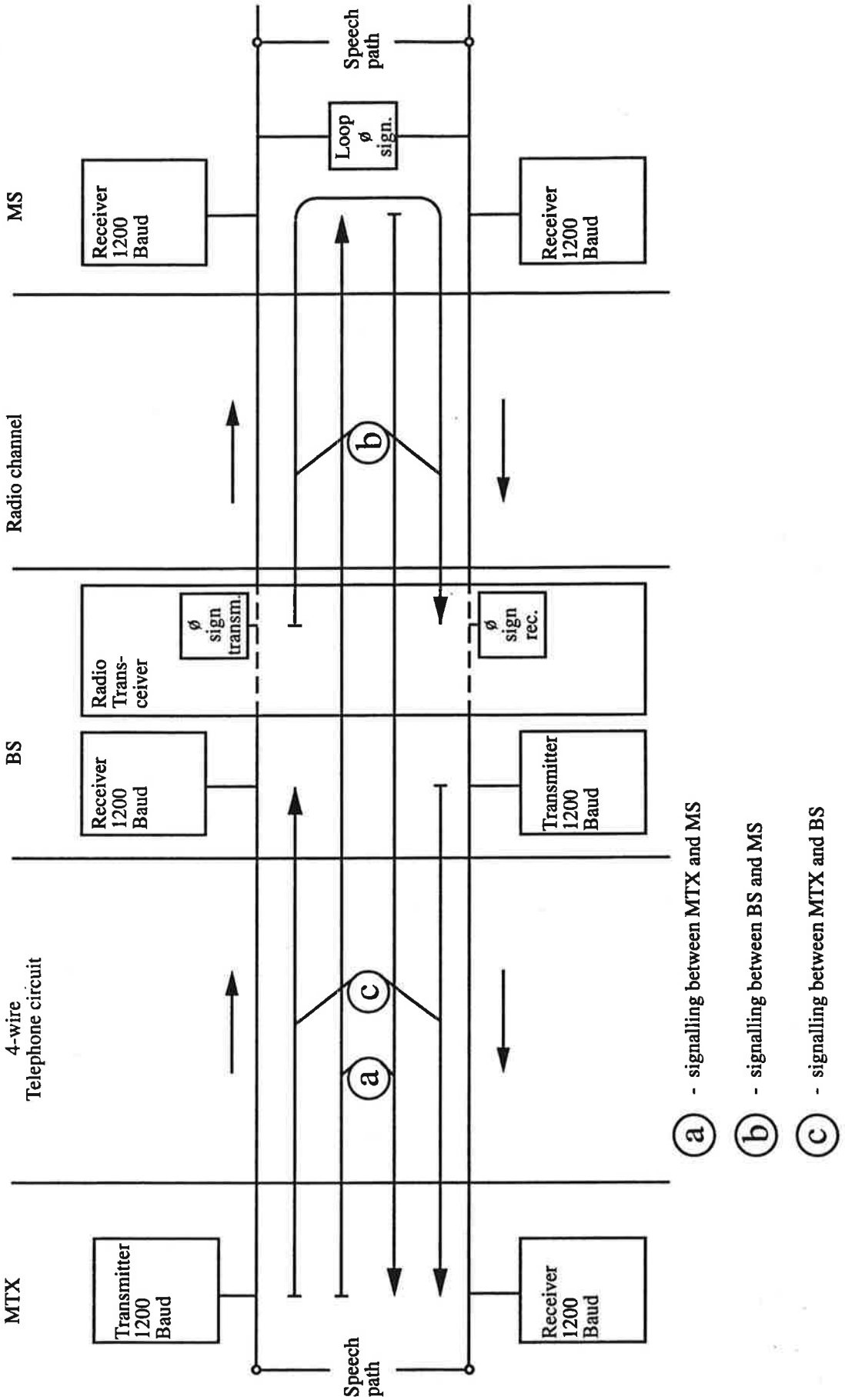

MS
BS
MTX
Radio channel
4-wire
Telephone circuit
Speech path
Loop ø sign.
Receiver 1200 Baud
Radio Trans-ceiver
ø sign transm.
ø sign rec.
Transmitter 1200 Baud
a - signalling between MTX and MS
b - signalling between BS and MS
c - signalling between MTX and BS

Fig. 4.1b

4.2 DEFINITIONS AND FUNCTIONS OF SIGNALS

The signals between MTX and MS as well as those between MTX and BS are transmitted on a 1200 Bauds signalling link, described in detail in paragraph 4.6. The signals are formatted into frames, the format being such that each frame contains 16 hexadecimal digits of information in addition to the synchronization and check bits. The details concerning the frame structures are contained in paragraph 4.3. In paragraphs 4.2.1 through 4.2.5, the frame numbers within brackets refer to the numbering in paragraph 4.3.

For the signalling between BS and MS (i.e. the supervisory signal), the details are brought forward in paragraph 4.5.

All time measurements concerning the signalling procedures are measured from the end of the particular frame, defined as transmission/reception of the last bit in the outgoing/incoming frame in the modem.

4.2.1 Signals in the direction MTX to MS

- Calling channel indication (frame 1a,1a' and 1a" continuously). Indicates the calling channel to which mobile stations shall lock when they are not busy. Normally only one channel on the base station has such an indication. Additional information about e.g. available frequency bands is also given.

- Combined calling and traffic channel indication (frame 1b). Indicates a channel which can be used either as a calling channel or as a traffic channel. This channel may also contain available frequency band information.

- Call to mobile subscriber on calling channel (frame 2a). When a call is generated from MTX to MS, this signal will be used. The mobile subscriber number is included in the signal.

- Traffic channel allocation on calling channel (frame 2b). After reception of call acknowledgement MTX sends this signal to inform the MS which channel it shall use for the connection.

- Queueing information to MS with priority on calling channel (frame 2c). After reception of seizure from priority MS on CC MTX sends this signal to inform the priority MS that the call is queued in the MTX.

- Traffic channel scanning order on calling channel (frame 2d). MS starts searching for a free traffic channel or access channel in order to answer a call from MTX.

- Alternative type of call to MS on combined CC/TC (frame 2e). This signal is for call to MS from an MTX which distinguishes between the frames call acknowledgement and seizure from an MS on the same channel. The signal is used exactly as frame 2a.

- Queuing information to ordinary MS (frame 2f). This signal informs MS that the call to MS is queued in the MTX. The MS shall remain on the channel and wait for further information (e.g repeated call).

- Traffic channel allocation on traffic channel (frame 3a). In the speech condition this signal may be sent to order the MS to switch to another channel (switching call in progress), or to order change of output power in the MS on the same channel.

- Identity request on traffic channel (frame 3b). This is a signal requesting MS about its identity when a connection shall be established.

- Traffic channel allocation on traffic channel, short procedure (frame 3c). To initiate a shortened switch-over procedure to another channel during speech condition this signal will be used to order the MS to the new channel.

- Traffic channel allocation on access channel (frame 3d). This signal informs the MS that the access signal from the MS is accepted by the MTX, and which channel shall be used for the rest of the call set-up.

- Free traffic channel indication (frame 4 continuously). This signal marks a free traffic channel, on which mobile stations can make calls. There may be several freemarked traffic channels on one base station.

- Access channel indication (frame 4b). This signal marks an access channel on which mobile stations can initiate calls. There may be several access channels on one base station.

- Line signal (frames 5a and 5b).The meaning of the line signal is indicated by the signal number L(n). (These signals correspond to the normal line signals in the telephone network).

    - Answer to coin-box. This signal contains the tariff information and informs the coin-box that the charging can start.

    - Proceed to send (roaming updating confirmation). This signal orders MS to send the dialled number. The signal also cuts off the roaming alarm (if set) in the MS. In case of MS with added subscriber identity security, a special proceed to send signal will be sent, indicating that the digits must be encrypted using the B-key.

    - Address complete. This signal informs MS that the necessary digits are received by the MTX.

    - Ringing order. This signal initiates the generation of a ringing signal in MS.

    - Clearing. This signal informs MS that the connection shall be released.

    - Clearing, call transfer activated. This signal informs MS that the connection shall be released and that the indicator for transferred call must be activated.

- Idle frame (frame 6). This signal is used in the signalling sequence e.g. in waiting situations.

- Authentication request indication (frame 7) This signal informs the MS about the selected RAND, which shall be used for the calculation of SRES (needed for authentication purposes) and B-key (needed for the encryption of the B-number digits).

4.2.2 Signals in the direction MS to MTX

- Call acknowledgement from MS on calling channel, and access on access channel (frame 10a). This signal is used when an MS answers a call from

MTX, and when an MS initiates a call on an access channel.

- Seizure and identity from ordinary MS, and identity on traffic channel (frame 10b). This signal is used when

  - an ordinary MS makes a call (on traffic channel)

    or

  - the MTX requests MS for identity when establishing a call.

- Seizure and identity from called MS on traffic channel (frame 10c). This signal is used when an MS answers a call after received traffic channel scanning order.

- Call acknowledgement from MS on the alternative type of call on combined CC/TC (frame 10d). This signal is used from an MS when called from an MTX using frame 2e.

- Roaming updating seizure and identity on traffic channel (frame 11a). If an MS move into another traffic area, this signal will be sent to the MTX to indicate that an automatic updating call is made.

- Seizure and call acknowledgement on calling channel from MS with priority (frame 11b). When an MS with priority shall make a call on the calling channel, this signal is used.

- Seizure and identity from coin-box MS on traffic channel (frame 12). This signal is used to indicate that a coin-box MS makes a call, and that a special procedure shall be followed during the answer sequence (tariff information).

- Line signal (frames 13a and 13b). These signals are similar to the line signals in paragraph 4.2.1.

  - Clearing, release-guard. This signal informs MTX that the connection shall be released.

  - Answer acknowledgement from coin-box. After receiving answer with tariff information from MTX, the coin-box MS sends this signal containing the received tariff information, for control purpose.

  - MFT converter in

    and

  - MFT converter out

  These two signals are intended for use when the mobile subscriber uses his push-button set for data transmission. The translation equipment from 1200 Baud signals to MFT (Multi Frequency Tones) will be activated/inactivated by these two line signals respectively.

  - Answer. This signal informs MTX that the mobile subscriber has recognized the ringing signal, and lifted the handset.

  - Register recall. In conversation state the MS (i.e. the mobile subscriber) can connect a register in the MTX to the line.

Digits can then be transmitted from MS to MTX.

- Digit signal (frames 14a and 14b). This signal is used to send the predialled digits (including *, #,A,B,C,D) to MTX. One digit is sent in each frame. The first digit is sent in frame 14a, second digit in frame 14b, third digit in frame 14a etc. If an authentication procedure has taken place, mobiles with added subscriber identity security will encrypt the digit information.

- Authentication response (frame 16). This signal shall be used as a response in the authentication procedure.

- Idle frame (frame 15). This signal is used in the signalling sequence e.g. in waiting situations.

4.2.3 Signals in the direction MTX to BS

All these signals have a special Z-value (15) which indicates a message to a BS, and not to an MS.

- Channel activation order (frame 20)

  This signal informs the BS equipment about actions to be taken (e.g. start/stop of BS transmitter, start/stop of sending of ø-signal, control of BS receiver squelch function).

- Signal strength measurement order, sent on data channel or idle or free marked traffic channel (frame 21b)

- Signal strength measurement order, sent on traffic channel actually used (frame 21c)

- Other management/maintenance orders, sent on idle channel or data channel (frame 22)

- For the purpose of transmitting Ø-signal at channels activated as CC, TC, CC/TC or AC, the base station shall be able to detect frames 1, 2, 3d, 4 and 4b sent from MTX to MS.

4.2.4 Signals in the direction BS to MTX

All these signals have a special Z-value (15) which indicates a message from a BS, and not from an MS.

- Channel status information (frame 25). Informs the MTX about the BS equipment status, and ø- signal alarms (see paragraph 4.5) on the traffic channel.

- Signal strength measurement result (frame 26).

- Response on other management/maintenance orders, sent on idle channel or data channel (frame 27).

- Other maintenance information from BS (frame 28). If a message is initiated at the BS, e.g. in connection with alarms, this signal will be used.

4.2.5 Frame for test channel indication (frame 30)

This signal indicates that the channel is reserved for test purposes. A testmarked channel can not be used by any other MS than a test MS.

4.2.6 Frames related to SSE, DSS and HC [OPTIONAL]

See para. 4.3.2.3 to 4.3.2.6

4.3 FRAME TYPES AND CODING OF SIGNALS

4.3.1 Abbreviations and notations used

The following abbreviations and notations are used in describing frame types and coding of signals whereby all notations represent hexa-decimal digits:

- Number of actually used traffic or calling channel (Channel No.) (see para 4.3.3.1): $N_1N_2N_3$

  In addition, the most significant bit in Y_1 is used in the direction MTX to MS, indicating normal or interleaved channels.

  Between MTX and BS special meaning of $N_1N_2N_3$ and Y_1 may be used, see para 4.3.2.3.

- Number of traffic channel allocated for a call or for measurement (TCNo.): $N_aN_bN_c$

- Traffic area number (TANo.): $Y_1\ Y_2$

- Mobile subscriber No.: $Z\ X_1X_2X_3X_4X_5X_6$

  The value 15 of Z, Z(15), is used to indicate that the information concerns a base station (BS)

- Tariff information (for coin-box): Q_1Q_2

- Each type of frame is characterized by a prefix: P(0....15)

- Password from MS: $K_1K_2K_3$

- Area information from MS where the two first bits in T is coded according to para 4.3.3.11, while the remaining two bits and Y_2 are the six last bits in $Y_1\ Y_2$. TY_2

- Additional information: $H_1H_2....H_{10}$

- Line signals are indicated: L

- Digit signals are indicated: S

- Idle information is indicated: J

- Channel activation orders and channel status information are indicated: A

- Management and maintenance orders and other information are indicated: $V_1V_2....$
- Signal strength measurement results are indicated: $R(n_1)R(n_2)$
- The notation P (n) indicates value n of prefix P
- Notations $N_1N_2N_3$ and $N_aN_bN_c$ indicate successive N digits. The coding of N_1 is not straightforward, see para 4.3.3.1.
- Supervisory signal information: $f_ø$
- Higher limit for signal strength evaluation: I_H
- Lower limit for signal strength evaluation: I_L
- Random challenge, transmitted from MTX to MS $C_1C_2C_3C_4C_5C_6C_7$
- Signed response, transmitted from MS to MTX $R_1R_2R_3R_4.$

Abbreviations related to SSE and/or HC [OPTIONAL]:

- Base station identity between the BS/SSE and the MTX at HC (in frames 20,22,25,27,28, 41,42,46 and 47) and between the BS and SSE (in frames 50,51,52,54 and 55) [OPTIONAL] $B_1B_2B_3$
- Information on reason for handover request in frame 25 A(7), 41 A(7) and RF-link disconnection in frame 25 A(8), 41A(8) and 46A(7) [OPTIONAL]: C
- Supervisory signal information [OPTIONAL]: F_1F_2
- Check information in the supervision (frame 54,55) of HC between SSE and BS [OPTIONAL]: $C_hC_hC_h$
- Information of which BS the MTX shall send signal strength measurement orders to at handover attempts [OPTIONAL]: G
- Identity number of a channel unit [OPTIONAL]: U_1U_2
- Information of the channels in frame 50 [OPTIONAL]: I
- Information of actual BS in frame 42 and 47 [OPT.]: $B_aB_bB_c$

4.3.2 Frame types

The information part of the frames sent from MTX to MS/BS and from MS/BS to MTX contains 64 bits, i.e. 16 hexa-decimal digits. The same frame format is used on calling and traffic channels. However, in the direction MS to MTX on the calling channel, only 13 digits are transmitted (see para 4.7.2).

In the following description each type of frame is given a number, which is used for reference when describing the signalling procedures.

4.3.2.1 Frames used in direction MTX to MS

These frames are divided into four fields containing:

- Number of actually used traffic or calling channel
- Prefix and traffic area number
- Mobile identification field (May also be used for additional information. See para 4.3.3.10 - 4.3.3.14)
- Information field (See para 4.3.3.10 - 4.3.3.14)

Channel No	Prefix and TA No	Mobile sub-scriber No	Information
3 digits	3 digits	7 digits	3 digits

1a Calling channel indication (general)

Channel No.	Prefix	TA No.	Additional info
$N_1N_2N_3$	P(12)	Y_1Y_2	$H_1H_2H_3H_4H_5H_6H_7H_8H_9H_{10}$

1a' Calling channel indication (for MS group A)

Channel No	Prefix	TA No.	Additional info
$N_1N_2N_3$	P(11)	Y_1Y_2	$H_1H_2H_3H_4H_5H_6H_7H_8H_9H_{10}$

1a" Calling channel indication (for MS group B)

Channel No.	Prefix	TA No.	Additional info
$N_1N_2N_3$	P(13)	Y_1Y_2	$H_1H_2H_3H_4H_5H_6H_7H_8H_9H_{10}$

Note: The MS:es are divided into two groups. MS:es with odd K_3 in their password belong to group A. MS:es with even K_3 in their password belong to group B.

1b Combined calling and traffic channel indication

Channel No.	Prefix	TA No.	Additional info
N1N2N3	P(4)	Y_1Y_2	$H_1H_2H_3H_4H_5H_6H_7H_8H_9H_{10}$

2a Call to mobile subscriber on calling channel (see note)

Channel No.	Prefix	TA No.	Mobile subscriber No.	Additional Info
$N_1N_2N_3$	P(12)	Y_1Y_2	$ZX_1X_2X_3X_4X_5X_6$	$H_8H_9H_{10}$

2b Traffic channel allocation on calling channel (see note)

Channel No.	Prefix	TA No.	Mobile subscriber No.	TCNo.
$N_1N_2N_3$	P(12)	Y_1Y_2	$ZX_1X_2X_3X_4X_5X_6$	$N_aN_bN_c$

2c Queueing information to MS with priority on calling channel (see note)

Channel No.	Prefix	TA No.	Mobile subscriber No.	Additional Info
$N_1N_2N_3$	P(12)	Y_1Y_2	$ZX_1X_2X_3X_4X_5X_6$	$H_8H_9H_{10}$

2d Traffic channel scanning order on calling channel (see note)

Channel No.	Prefix	TA No.	Mobile subscriber No.	Additional Info
$N_1N_2N_3$	P(12)	Y_1Y_2	$ZX_1X_2X_3X_4X_5X_6$	$H_8H_9H_{10}$

2e Alternative type of call to MS on combined CC/TC

Channel No.	Prefix	TA No.	Mobile subscriber No.	Additional Info
$N_1N_2N_3$	P(4)	Y_1Y_2	$ZX_1X_2X_3X_4X_5X_6$	$H_8H_9H_{10}$

2f Queuing information to ordinary MS (see note)

Channel No.	Prefix	TA No.	Mobile subscriber No.	Additional Info
$N_1N_2N_3$	P(12)	Y_1Y_2	$ZX_1X_2X_3X_4X_5X_6$	$H_8H_9H_{10}$

Note: If more then one calling channel is used at the base station, i.e. by use of frames 1a' and 1a", the prefixes P(11) and P(13) respectively shall be used in all signalling (also in frames 2a, 2b, 2c, 2d and 2f) from MTX to MS on the calling channel. See also paragraph 4.4.

3a Traffic channel allocation on traffic channel

Channel No.	Prefix	TA No.	Mobile subscriber No.	TC No.
$N_1N_2N_3$	P(5)	Y_1Y_2	$ZX_1X_2X_3X_4X_5X_6$	$N_aN_bN_c$

3b Identity request on traffic channel

Channel No.	Prefix	TA No.	Mobile subscriber No.	Additional Info
$N_1N_2N_3$	P(5)	Y_1Y_2	$ZX_1X_2X_3X_4X_5X_6$	$H_8H_9H_{10}$

3c Traffic channel allocation on traffic channel, short procedure

Ordered TC No.	Prefix	TA No.	Mobile subscriber No.	Ordered TC No.
$N_1'N_2'N_3'$	P(9)	Y_1Y_2	$Z\ X_1X_2X_3X_4X_5X_6$	$N_aN_bN_c$

Note: The channel number $N_1'N_2'N_3'$ together with first bit in Y_1 shall in frame 3c be equal to $N_aN_bN_c$

3d Traffic channel allocation on access channel

Channel No.	Prefix	TA No.	Mobile subscriber No.	TC No.
$N_1N_2N_3$	P(7)	Y_1Y_2	$ZX_1X_2X_3X_4X_5X_6$	$N_aN_bN_c$

4 Free traffic channel indication

Channel No.	Prefix	TA No.	Idle	Additional Info
$N_1N_2N_3$	P(3)	Y_1Y_2	J J J J J J J	$H_8H_9H_{10}$

4b Access channel indication

Channel No.	Prefix	TA No.	Idle	Additional Info
$N_1N_2N_3$	P(7)	Y_1Y_2	J J J J J J J	$H_8H_9H_{10}$

5a Line signal

Channel No.	Prefix	TA No.	Mobile subscriber No.	SignalNo.
$N_1N_2N_3$	P(6)	Y_1Y_2	$ZX_1X_2X_3X_4X_5X_6$	L(n)L(n)L(n)

5b Line signal: Answer to coin-box

Channel No.	Prefix	TA No.	Mobile subscriber No.	Sign No.	Tariff info
$N_1N_2N_3$	P(6)	Y_1Y_2	$ZX_1X_2X_3X_4X_5X_6$	L(0)	Q_1Q_2

6 Idle frame

Idle	Prefix	Idle	
JJJ	P(0)	JJJJJJJJ	JJJ

7 Authentication request

Channel No.	Prefix	TA No.	Random challenge	Idle
$N_1N_2N_3$	P(8)	Y_1Y_2	$C_1C_2C_3C_4C_5C_6C_7$	JJJ

4.3.2.2 Frames used in direction MS to MTX

The frames are divided into four fields containing:

- Number of actually used traffic or calling channel
- Prefix
- Mobile identification field
- Information field (See para 4.3.3.10 - 4.3.3.12)

Channel No.	Prefix	Mobile subscriber No.	Information
3 digits	1 digit	7 digits	5 digits

10a Call acknowledgement from MS on calling channel, and access on access channel (shortened frame)

Channel No.	Prefix	Mobile subscriber No.	Area info	Idle
$N_1N_2N_3$	P(1)	$ZX_1X_2X_3X_4X_5X_6$	T	J(JJJ)

10b Seizure from ordinary MS and identity on traffic channel

Channel No.	Prefix	Mobile subscriber No.	Area info	Password
$N_1N_2N_3$	P(1)	$ZX_1X_2X_3X_4X_5X_6$	TY_2	$K_1K_2K_3$

10c Seizure and identity from called MS on traffic channel

Channel No.	Prefix	Mobile subscriber No.	Area info	Password
$N_1N_2N_3$	P(6)	$ZX_1X_2X_3X_4X_5X_6$	TY_2	$K_1K_2K_3$

10d Call acknowledgement from MS on the alternative type of call on combined CC/TC (shortened frame)

Channel No.	Prefix	Mobile subscriber No.	Area info	Idle
$N_1N_2N_3$	P(10)	$Z\ X_1X_2X_3X_4X_5X_6$	T	J(JJJ)

11a Roaming updating seizure and identity on traffic channel

Channel No.	Prefix	Mobile subscriber No.	Area info	Password
$N_1N_2N_3$	P(14)	$ZX_1X_2X_3X_4X_5X_6$	TY_2	$K_1K_2K_3$

11b Seizure and call acknowledgement on calling channel from MS with priority (shortened frame)

Channel No.	Prefix	Mobile subscriber No.	Area info	Idle
$N_1N_2N_3$	P(15)	$Z\ X_1X_2X_3X_4X_5X_6$	T	J(JJJ)

12 Seizure and identity from coin-box on traffic channel

Channel No.	Prefix	Mobile subscriber No.	Area info	Password
$N_1N_2N_3$	P(11)	$ZX_1X_2X_3X_4X_5X_6$	TY_2	$K_1K_2K_3$

13a Line signal

Channel No.	Prefix	Mobile subscriber No.	Signal No.
$N_1N_2N_3$	P(8)	$ZX_1X_2X_3X_4X_5X_6$	L(n)L(n)L(n)L(n)L(n)

13b Line signal: Answer acknowledgement from coin-box

Channel No.	Prefix	Mobile subscriber No.	Signal No.	Tariff info
$N_1N_2N_3$	P(8)	$ZX_1X_2X_3X_4X_5X_6$	L(2)L(2)L(2)	Q_1Q_2

14a Digit signal (1st, 3rd, 5th .... digit)

Channel No.	Prefix	Mobile subscriber No.	Pos. ind.	Digit value
$N_1N_2N_3$	P(7)	$ZX_1X_2X_3X_4X_5X_6$	S(o)S(o)	S(n)S(n)S(n)

14b Digit signal (2nd, 4th, 6th ..... digit)

Channel No.	Prefix	Mobile subscriber No.	Pos. ind.	Digit value
$N_1N_2N_3$	P(7)	$ZX_1X_2X_3X_4X_5X_6$	S(15)S(15)	S(n)S(n)S(n)

15 Idle frame

Idle	Prefix	Idle
JJJ	P(0)	JJJ JJJJJJ JJJ

16 Authentication Response

Channel No.	Prefix	Signed Response
$N_1N_2N_3$	P(12)	$R_1R_2R_3R_4R_1R_2R_3R_4R_1R_2R_3R_4$

4.3.2.3 Frames used between MTX and BS

For communication between MTX and BS the same frame formats are used as between MTX and MS.

MTX—BS

20 Channel activation order

Channel No.	Prefix	TA No.	BS ind	Idle	Activ.order
$N_1N_2N_3$	P(15)	Y_1Y_2	Z(15)	JJJ	A(3)føføføføfø
$N_1N_2N_3$	P(15)	Y_1Y_2	Z(15)	JJJ	A(14)$I_LI_LI_H$føfø
$N_1N_2N_3$	P(15)	Y_1Y_2	Z(15)	JJJ	A(15)$I_LI_LI_H$JJ
$N_1N_2N_3$	P(15)	Y_1Y_2	Z(15)	JJJ	A(0,1,2,4-13)J JJJJ

Note 1) At [OPTIONAL] HC $N_1N_2N_3$ in frame 20 shall be coded as $B_1B_2B_3$.

Note 2) At [OPTIONAL] HC only A=0, 2 and 5 are used.

21b Signal strength measurement order on data channel or idle or free marked traffic channel

Channel No.	Prefix	TA No.BS ind	Idle	Meas.ind.	Idle	ø-info	TC No.
$N_1N_2N_3$	P(3)	$Y_1Y_2Z(15)$	JJJ	V(15)	J	$f_ø$	$N_aN_bN_c$

21c Signal strength measurement order on traffic channel actually used

Channel No.	Prefix	TA No.BS ind	Idle	Meas.ind.	Idle	ø-info	TC No.
$N_1N_2N_3$	P(5)	$Y_1Y_2Z(15)$	JJJ	V(15)	J	$f_ø$	$N_aN_bN_c$

If the digital supervisory signal [OPTIONAL] is implemented in the system a different coding of frames 20(A=3), 20(A=14), 21b and 21c is used:

Frame 20(A=3/14) Channel Activation order from MTX to BS [OPTIONAL]

Channel No.	Prefix	TA No.	BS ind.	Idle	Activation order
$N_1N_2N_3$	P(15)	Y_1Y_2	Z(15)	JJJ	A(3) J $F_1F_2F_1F_2$
$N_1N_2N_3$	P(15)	Y_1Y_2	Z(15)	JJJ	A(14) $I_LI_LI_HF_1F_2$

Frame 21b and 21c Signal strength measurement order from MTX to BS [OPTIONAL]

Channel No.	Prefix	TA No.	BS ind.	Idle	Meas ind.	Info	TC No.
$N_1N_2N_3$	P(3,5)	Y_1Y_2	Z(15)	JJJ	V(15)	F_1F_2	$N_aN_bN_c$

22 Other management/maintenance order on idle channel or data channel

Channel No.	Prefix	TA No.BS ind	Idle	BS Manag./maint.order
$N_1N_2N_3$	P(14)	$Y_1Y_2Z(15)$	JJJ	$V_1V_2V_3V_4V_5V_6$

Separate data line MTX to BS is indicated with Y_1 = Oyyy and N_1=N_2=N_3=15.

Note 1) At [OPTIONAL] HC $N_1N_2N_3$ in frame 22 shall be coded as $B_1B_2B_3$.

Note 2) At [OPTIONAL] HC only V_1=1 and 4 are used and character V_2-V_6 are set to 0000.

46 Acknowledge of handover request [OPTIONAL]

BSno	Prefix	TCno	Status	Idle	Cause	Idle
$B_1B_2B_3$	P(2)	$N_aN_bN_c$	A(7)	JJJ	CCC	JJ

Note: All the information in frame 41 is echoed in frame 46.

BS — MTX

15 Idle frame

Idle	Prefix	Idle
JJJ	P(0)	JJJJJJJJJ JJJ

25 Channel status information

Channel No.	Prefix	BS ind.	Idle	Status info	Idle	Info	Idle
$N_1N_2N_3$	P(9)	Z(15)	JJ	A(2,6)	JJJ	$f_Ø I_H I_L$	JJ
$N_1N_2N_3$	P(9)	Z(15)	JJ	A(14)	JJJ	$J I_H I_L$	JJ
$N_1N_2N_3$	P(9)	Z(15)	JJ	A(0,1,3-5,7-13,15)	JJJ	JJJ	JJ

or [OPTIONAL] for A = 7 or 8]

$N_1N_2N_3$	P(9)	Z(15)	JJ	A(7,8)	JJJ	CCC	JJ

Note 1) At [OPTIONAL] HC $N_1N_2N_3$ in frame 25 shall be coded as $B_1B_2B_3$.

Note 2) At [OPTIONAL] HC only A=1 and 3 shall be used, since frame 25 is used as acknowledge of frame 20.

26 Signal strength measurement result

Channel No.	Prefix	BS ind	Idle	ø-info	Chan.No. (meas.)	Measurement result
$N_1N_2N_3$	P(2)	Z(15)	J	$f_ø$	$N_aN_bN_c$	$R(n_1)R(n_2)R(n_1)R(n_2)R(n_1)R(n_2)$

If the digital supervisory signal [OPTIONAL] is implemented in the system a different coding of frames 25(A=2/6) and 26 is used:

Frame 25 (A=2/6) Channel status information from BS to MTX [OPTIONAL]

Channel No.	Prefix	BS ind.	Idle	Sta.info	Idle	Info	Idle
$N_1N_2N_3$	P(9)	Z(15)	JJ	A(2,6)	JJ	$F_1F_2\|H\|L$	JJ

Frame 26 Signal strength measurement result from BS to MTX [OPTIONAL]

Chan.No.	Prefix	BS ind.	Ø-info	Chan.No.	Measurement result
$N_1N_2N_3$	P(2)	Z(15)	F_1F_2	$N_aN_bN_c$	$R(n_1)R(n_2)R(n_1)R(n_2)R(n_1)R(n_2)$

27 Response on other management/maintenance order on idle channel or data channel

Channel No.	Prefix	BS ind	Idle order	Manag./maint	Idle
$N_1N_2N_3$	P(4)	Z(15)	JJ	$V_1V_2V_3V_4$	JJJJJ

Note 1) At [OPTIONAL] HC $N_1N_2N_3$ in frame 27 shall be coded as $B_1B_2B_3$.

Note 2) At [OPTIONAL] HC only V_1=2, 5 and 6 shall be used and characters V_2-V_4 shall be set to 0000, since frame 27 is used as acknowledge of frame 22.

28 Other maintenance information from BS

Channel No.	Prefix	BS ind.	Idle	Maint.info	Idle
$N_1N_2N_3$	P(13)	Z(15)	JJ	$V_1V_2V_3V_4$	JJJJJ

Frame 28 is used for maintenance information, e.g. alarm, initiated by BS. If the channel number register in BS is empty N_1=N_2=N_3=0 is sent from BS.

Note: At [OPTIONAL] HC $N_1N_2N_3$ in frame 28 shall be coded as $B_1B_2B_3$.

41 Handover request [OPTIONAL]

BSno	Prefix	TCno	Status	Idle	Cause	Idle
$B_1B_2B_3$	P(3)	$N_aN_bN_c$	A(7)	JJJ	CCC	JJ

4.3.2.4 Frame for test channel indication

For use by a test mobile station the following frame is provided in the direction MTX to TMS.

30 Test channel indication

Channel No.	Prefix	TA No.	Idle	Additional Info
$N_1N_2N_3$	P(10)	Y_1Y_2	JJJJJJJ	$H_8H_9H_{10}$

4.3.2.5 Frames used between SSE and MTX

41 Handover request (from SSE) [OPTIONAL]

BSno	Prefix	TCno	Status	Idle	Cause	Idle
$B_1B_2B_3$	P(3)	$N_aN_bN_c$	A(7,8)	JJJ	CCC	JJ

42 Handover offer (from SSE) [OPTIONAL]

BSno	Prefix	TCno	Idle	Info	Idle	Ø
$B_1B_2B_3$	P(5)	$N_aN_bN_c$	J	GG	JJJJ	F_1F_2

42b Handover offer (from SSE) [OPTIONAL]

BSno	Prefix	TCno	Idle	Info	Act BS	Idle
$B_1B_2B_3$	P(5)	$N_aN_bN_c$	J	GG	$B_aB_bB_c$	JJJ

47 Acknowledge of Handover offer (from MTX) [OPTIONAL]

BSno	Prefix	TCno	Idle	Info	Act BS	Idle	Ø
$B_1B_2B_3$	P(3)	$N_aN_bN_c$	J	GG	$B_aB_bB_c$	J	F_1F_2

4.3.2.6 Frames used between BS and SSE [all OPTIONAL]

50 Channel information (from BS)

BSno	Prefix	TCno	Identity	Inf.	Idle
$B_1B_2B_3$	P(12)	$N_aN_bN_c$	U_1U_2	I	JJJJJJ

51 Channel activation via HC (from SSE)

BSno	Prefix	TCno	Identity	Idle	Activ.order
$B_1B_2B_3$	P(1)	$N_aN_bN_c$	U_1U_2	J	Note 1

Note 1) See paragraph 4.3.2.3 frame 20 (six last characters)

52 Acknowledge of channel activation via HC (from BS)

BSno	Prefix	TCno	Identity	Status	Info	Idle
$B_1B_2B_3$	P(6)	$N_aN_bN_c$	U_1U_2	A(2,6)	$F_1F_2I_HI_L$	JJ
$B_1B_2B_3$	P(6)	$N_aN_bN_c$	U_1U_2	A(14)	JJI_HI_L	JJ
$B_1B_2B_3$	P(6)	$N_aN_bN_c$	U_1U_2	A(0,1,3-5,9-13,15)		JJJJJJ

54 Supervision (from BS)

BSno	Prefix	Check	Idle
$B_1B_2B_3$	P(15)	$C_hC_hC_h$	JJJJJJJJJ

55 Acknowledge of supervision (from SSE)

BSno	Prefix	Check	Idle
$B_1B_2B_3$	P(8)	$C_hC_hC_h$	JJJJJJJJJ

4.3.3 Coding of signal information

The 16 hexa-decimal digits in a normal frame and the 13 digits in a shortened frame consist each of 4 bits. These digits are coded according to paragraphs 4.3.3.1 - 4.3.3.15.

4.3.3.1 Digits of numerical information

The table below applies to digits of the following numerical information.

- Channel No. $N_1N_2N_3$ 1)4)
- TA No.Y_1Y_2 3)4)
- Mobile subscriber No. $ZX_1X_2X_3X_4X_5X_6$ 2)
- TC No. (Channel order) $N_aN_bN_c$ 4)
- Tariff information Q_1Q_2
- Measurement results $R(n_1)R(n_2)$
- Password $K_1K_2K_3$ 8)
- Additional information $H_1H_2.....H_{10}$
- Random challenge $C_1C_2C_3C_4C_5C_6C_7$
- Signed response $R_1R_2R_3R_4$

The coding of the digits is as follows:

Digits in - $C_1C_2C_3C_4C_5C_6C_7$ - $R_1R_2R_3R_4$ - $N_1N_2N_3$ - $N_aN_bN_c$ - R(n1)R(n2) - Q_1Q_2 - Y_1Y_2 - H_1H_2.....H_{10} - $B_1B_2B_3$	Digits in - $ZX_1X_2X_3X_4X_5X_6$ - $K_1K_2K_3$	Binary code Bit No 1234
0	10	0000
1	1	0001
2	2	0010
3	3	0011
4	4	0100
5	5	0101
6	6	0110
7	7	0111
8	8	1000
9	9	1001
A	0	1010
B	11	1011
C	12	1100
D	13	1101
E	14	1110
F	15	1111

Note 1 In digits N_1 the most and least significant bits (bits no 1 and 4) is used for the channel numbering (see note 3). Bits no. 2 and 3 contain information about power level, high power 11 and 10, medium power 01 and low power 00. These bits also informs MS about the actual BS type.

In signalling between MTX and BS, the power bits in N_1 shall have the value 11 in both directions. However, between MTX and BS special values and meanings of N_1 may be used (see para. 4.3.1).

The MS output power will be controlled by the power bits in N_1, received from the MTX but only in the relevant parts of the signalling scheme (i.e. frames 1, 2a, 2e, 3a, 3b, 3c, 3d, 4 and 4b). Signalling frames in the direction MS to MTX shall have the same power bits in N_1 as in the received frames from MTX.

Note 2 The values of digit Z are:

- Z(10) = H_1(0) indicates no additional info (see para 4.3.3.12 - 4.3.3.14)
- Z(1) is reserved for Switzerland
- Z(2) is reserved for the Benelux -countries
- Z(4) is reserved for Cyprus
- Z(5) indicates Denmark
- Z(6) indicates Sweden
- Z(7) indicates Norway
- Z(8) indicates Finland
- Z(9) is reserved for Nordic countries
- Z(14) indicates additional info (see para 4.3.3.12 - 4.3.3.14)
- Z(15) indicates information to/from BS

Additional values of Z in the range 0...9, 11...13 may be allocated to other operators.

Note 3 In the direction MTX to MS/BS, the most significant bit in Y_1 gives information about interleaved channels. If the bit is 1, the channel number in $N_1N_2N_3$ denotes an interleaved channel. If the bit is 0, the channel number denotes an ordinary channel.

In the direction MS/BS to MTX, information about channel interleaving is suppressed.

Note 4 The channel numbering correspondence between the different bits in $N_1N_2N_3$ and Y_1, and $N_aN_bN_c$ is as follows:

$N_1N_2N_3$ = (binary) $a_9xxa_8\ a_7a_6a_5a_4\ a_3a_2a_1a_0$, Y1 = (binary) $a_{10}yyy$

corresponds to

$N_aN_bN_c$ = (binary) $0a_{10}a_9a_8\ a_7a_6a_5a_4\ a_3a_2a_1a_0$

where - a_{10} - - a_0 is for channel numbering
- xx denotes power bits
- yyy gives the country information for the actual TA

In the NMT 900 documents the notation "channel number $N_1N_2N_3$ " also includes the channel information in Y_1, if not otherwise stated.

Note 5 The frequencies below channel 1 (f_0 - 12.5 kHz, f_0 - 25 kHz) are never used in the system. The corresponding numbers $N_1N_2N_3$ = 0xx0 0000 0000, Y_1 = 0yyy or 1yyy and $N_aN_bN_c$ = 0000 0000 0000 or 0100 0000 0000 may be used, however, as fictitious channel numbers.

Note 6 In the direction BS to MTX N_1=N_2=N_3=0 means empty channel register in BS.

Note 7 The values of Y_1 are reserved as follows

- X000	Reserved
- X001	Denmark
- X010	Sweden, Cyprus
- X011	Norway
- X100	Finland
- X101	Switzerland
- X110	Netherlands
- X111	Recommended for systems with no roaming with the existing NMT 900 countries

Note 8 Values 900 to 999 of $K_1K_2K_3$ have been reserved for MS's with added subscriber identity security (SIS) and cannot be used by other (= non-SIS) MS's.

Note 9 In $X_1X_2X_3X_4X_5X_6$ all hexadecimal values can be used.

Examples:

Channel 1: (f_0)
$N_1N_2N_3$ = 0xx0 0000 0001, Y_1 = 0yyy
$N_aN_bN_c$ = 0000 0000 0001

Channel 1025: (f_0+12,5 kHz)
$N_1N_2N_3$ = 0xx0 0000 0001, Y_1 = 1yyy
$N_aN_bN_c$ = 0100 0000 0001

Channel 2023: (f_0+24.962,5 kHz)
$N_1N_2N_3$ = 1xx1 1110 0111, Y_1 = 1yyy
$N_aN_bN_c$ = 0111 1110 0111

Channel 1000: (f_0+24.975 kHz):
$N_1N_2N_3$ = 1xx1 1110 1000, Y1 = 0yyy
$N_aN_bN_c$ = 0011 1110 1000

4.3.3.2 Prefixes

Notation	Coding	Meaning in direction MTX to MS/BS	MS/BS to MTX
P(0)	0000	Idle	Idle
P(1)	0001	Spare	Call acknowledgement, seizure,access and identity
P(2)	0010	Spare	Measurement results
P(3)	0011	Traffic channel	Spare
P(4)	0100	Combined calling and traffic channel	Response on management/ maintenance orders
P(5)	0101	Channel allocation and identity request on traffic channel	Spare
P(6)	0110	Line signal	Seizure and identity from called MS on traffic channel
P(7)	0111	Access channel	Digit signal
P(8)	1000	Authentication request	Line signal
P(9)	1001	Channel allocation, short procedure	Channel status information
P(10)	1010	Test channel	Call acknowledgement from MS on new type combined CC/TC
P(11)	1011	Calling channel (P')	Coin-box seizure and identity
P(12)	1100	Calling channel (P)	Authentication Response
P(13)	1101	Calling channel (P")	Other maintenance information
P(14)	1110	Measurement/ maintenance	Roaming updating and identity
P(15)	1111	Channel activation order	Seizure and call acknowledgement for MS with priority

4.3.3.3 Line signal number L(n) in frames 5 and 13

Notation	Coding	Meaning in direction	
		MTX to MS (frame 5a/5b)	MS to MTX (frame 13a/13b)
L(0)	0000	Answer to coin-box	Spare
L(1)	0001	Spare	Clearing,release guard
L(2)	0010	Spare	Answer acknowledgement, (coin-box)
L(3)	0011	Proceed to send unencrypted digits (Roaming updating confirmation)	Spare
L(4)	0100	Acknowledge MFT converter in	Spare
L(5)	0101	Spare	Register recall
L(6)	0110	Address complete	Spare
L(7)	0111	Spare	MFT converter out, acknowledge Forced release MFT converter state
L(8)	1000	Spare	MFT converter in
L(9)	1001	Ringing order	Spare
L(10)	1010	Acknowledge MFT converter out and forced release MFT converter state	Spare
L(11)	1011	Proceed to send encrypted digits (Roaming updating confirmation)	Spare
L(12)	1100	Spare	Spare
L(13)	1101	Clearing,call transfer activated	Spare
L(14)	1110	Spare	Answer
L(15)	1111	Clearing, call transfer not activated	Spare

4.3.3.4 Digit value S(n) and position indication S(0/15) in frames 14a and 14b

Notation set	Coding	Meaning on the MS push button
S(0)	0000	D or position indication (1st, 3rd .....digit)
S(1)	0001	1
S(2)	0010	2
S(3)	0011	3
S(4)	0100	4
S(5)	0101	5
S(6)	0110	6
S(7)	0111	7
S(8)	1000	8
S(9)	1001	9
S(10)	1010	0
S(11)	1011	*
S(12)	1100	#
S(13)	1101	A
S(14)	1110	B
S(15)	1111	C or position indication (2nd, 4th .... digit)

Note: for mobile station with added subscriber identity security the coding of the the digits will be modified (encrypted).

4.3.3.5 Idle information

Idle information J is coded 0000.

4.3.3.6 Channel activation order in frame 20 and channel status information in frame 25

Notation	Coding	Meaning in direction	
		MTX to BS (frame 20)	BS to MTX (frame 25)
A(0)	0000	Idle radio channel (stop BS transmitter, open line loop, stop sending of ø-signal, switch squelch function in, mute receiver, stop signal strength evaluation	Spare
A(1)	0001	Spare	Acknowledge idle radio channel
A(2)	0010	General channel reset	Acknowledge start ø-signal
A(3)	0011	Send ø signal ($f_ø$ = 1,2,3,4) Switch squelch function out, start signal strength evaluation	Acknowledge general channel reset
A(4)	0100	Suppress frame 25 A(7) from BS	Spare
A(5)	0101	Loop line in BS	Acknowledge suppress frame 25 A(7)
A(6)	0110	Spare	Acknowledge A(14)
A(7)	0111	Spare	Received ø-signal below 1:st limit but above 2:nd limit, or received signal strength below the higher limit (handover request)
A(8)	1000	Spare	Received ø-signal below 2:nd limit, or received signal strength below the lower limit (RF-link disconnection)
A(9)	1001	Spare	Reserved for: acknowledge squelch function out
A(10)	1010	Cancel suppression of frame 25 A(7)	Spare

A(11)	1011	Reserved for: Switch squelch function out	Acknowledge Cancel suppression of frame 25 A(7)
A(12)	1100	Stop sending ø-signal, switch squelch function in, stop signal strength evaluation	Spare
A(13)	1101	Spare	Acknowledge stop sending ø-signal
A(14)	1110	Start BS transmitter, deactivate muting, send ø-signal ($f_ø$=1,2,3,4), switch squelch function out, set signal strength level limits, start signal strength evaluation	Acknowledge start BS transmitter A(15)
A(15)	1111	Start BS transmitter,deactivate muting, set signal strength level limits	Spare

Note:
- General channel reset 20 A(2) gives the same result in the BS as the frames 20 A(0), 22 V1(1) and 22 V1(9) together.
- Frames 20 A(3) and 20 A(14) shall activate compander in BS.
- Frames 20 A(0), 20 A(2) and 20 A(12) shall also deactivate the compander and have the function cancel suppression of frame 25 A(7)
- In BS the start of the ø-signal and squelch function out initiated by 20 A (14) shall be delayed until the MS carrier opens the squelch. In this case the activation of the compander shall be delayed 830 ms after the end of frame 20 A(14).

4.3.3.7 Other management/maintenance orders (frame 22)

Notation V_1	Coding	Meaning in direction MTX — BS (frame 22)
0	0000	Idle
1	0001	Alarm reset
2	0010	SU/SR alarm reset
3	0011	Suppress RF receiver blocking alarm
4	0100	Self test
5	0101	Spare

6	0110	RF test loop in
7	0111	Suppress supervision of freemarked CC/TC/AC
8	1000	Spare
9	1001	RF test loop out
10	1010	Cancel suppression of supervision of freemarked CC/TC/AC
11	1011	Spare
12	1100	Cancel suppression of RF receiver blocking alarm
13 - 15	1101-1111	Spare

Note: Alarm reset means that all alarm indicators in BS shall be reset. This makes it possible to see if alarm state has been changed.

Characters V_2 - V_6 not specified in the table above shall have the value 0000.

4.3.3.8 Response on other management/maintenance orders (frame 27)

Notation V_1	Coding	Meaning in direction BS — MTX (frame 27)
0	0000	Idle
1	0001	Spare
2	0010	Acknowledge alarm reset
3	0011	Acknowledge SU/SR alarm reset
4	0100	Acknowledge suppress RF receiver blocking alarm
5	0101	Acknowledge self test
6	0110	Selftest completed
7	0111	Acknowledge RF test loop in
8	1000	Acknowledge suppress supervision of freemarked CC/TC/AC
9	1001	Spare
10	1010	Acknowledge RF test loop out

11	1011	Acknowledge cancel suppression of supervision of freemarked CC/TC/AC
12	1100	Spare
13	1101	Acknowledge cancel suppression of RF receiver blocking alarm
14, 15	1110-1111	Spare

Note: Characters V_2-V_4 not specified in the table above shall have the value 0000.

4.3.3.9 Other maintenance information from BS (frame 28)

Notation of V	Coding	Meaning in direction BS-MTX (frame 28)
$V_1(10)$	1010	Don't care
$V_1(11)$	1011	Don't care
$V_1(6)$	0110	Block the channel
$V_1(3)$	0011	Don't care
$V_1(2)$	0010	Block the channel
$V_1(9)$	1001	Deblock the channel
$V_1(12)$	1100	SU/SR alarm via channel line
$V_1(15)$	1111	Shall not be used
$V_2(15)$	1111	NMT-alarms
$V_2(1)$	0001	House alarms
$V_2(8)$	1000	External alarms

$V_1(3)$ and $V_1(2)$ are used only in combination with $V_2(15)$

Notation of V_1	V_2	V_3	Meaning in direction BS-MTX (frame 28)
10	15	0	TX antenna fault level 1
10	15	1	Transmitter level 1
10	15	2	Selftest failed
10	15	3	Spare NMT Alarm 1
10	15	4	RX antenna fault level 1
10	15	5	RF receiver blocking alarm
10	15	6	Combiner alarm level 1
10	15	7	High temperature fault
10	15	8	RF receiver blocking alarm ceasing
10	15	9	Diversity alarm
10	15	12	Redundant power supply
10	15	13	Redundant master oscillator
10	15	14	Cooling fan fault
10	15	15	Redundant amplifier in receiver multicoupler
6	15	0	RX antenna fault level 2
6	15	1	Missing deviation
6	15	2	Ø-signal test loop
6	15	3	Spare NMT Alarm 2
6	15	4	Channel unit fault level 2
6	15	5	Spare NMT Alarm 3
6	15	6	Local blocking
9	15	6	Local deblocking
6	15	7	Receiver
6	15	8	Combiner alarm level 2
6	15	9	CU
6	15	10	SU, via data line
12	15	10	SU, via channel line and CU
6	15	11	SR, via data line
12	15	11	SR, via channel line and CU
6	15	12	Power supply
6	15	13	Receiver multicoupler
6	15	14	Transmitter level 2
6	15	15	TX antenna fault level 2
2	15	0-15	Spare NMT Alarm 4-19
3	15	0	Reserved for HC 1 [OPTIONAL]
3	15	1	Reserved for HC 2 [OPTIONAL]
3	15	2	Reserved for SSE 1 [OPTIONAL]
3	15	3	Reserved for SSE 2 [OPTIONAL]
3	15	4	Reserved for SSE 3 [OPTIONAL]
3	15	5	Missing CC indication
3	15	6	Missing CC indication ceasing
3	15	7	Missing TC or AC indication
3	15	8	Missing TC or AC indication ceasing
3	15	9-15	Spare NMT Alarm 20-26

10	1	0	Fire alarm
6	1	1	Mains break-down alarm
10	1	2	Intruder alarm
10	1	3	Obstruction light alarm
9	1	4	Mains return
10	1	5	Mains break-down alarm at channel with battery back-up
10	1	6	Spare house alarm 1
10	1	7	Spare house alarm 2
10	1	8	Environment temperature alarm
10	8	8	Spare external alarm 1
10	8	9	Spare external alarm 2
10	8	10	Spare external alarm 3
10	8	11	Spare external alarm 4
10	8	12	Alarm unit alarm
10	8	13	MUX alarm
10	8	14	Spare external alarm 5
10	8	15	Spare external alarm 5

All other combinations of V_1 V_2 V_3 shall be spare.

Parameters V_4 can be used in case of manufacturer/operator defined alarms but shall not be interpreted by the MTX. In case parameter V_4 is not specified it shall have value 0000.

Note 1 Level 1 Degradation which does not require an immediate service action.

Level 2 Not in function.

Note 2 Blocking, deblocking, don't care (see also NMT Doc 450/900-2 chapter 8, Maintenance of BS).

Three different categories of alarm information shall be sent to the MTX from the base station:

- Blocking. The MTX shall block the channel when it receives this information, i.e. the channel is no longer available for traffic. A blocked channel shall be indicated at the base station. The blocking is initiated by frame 28 from the base station.

-Deblocking. The MTX shall deblock the channel when it receives this information, i.e. the channel is now available for traffic again.

-Don't care. The MTX shall not act on this information.

Note 3 Different classes of alarms

The alarms from the BS are divided in three classes:

-NMT-alarms. Includes the alarms which are released by the equipment that is included in the NMT system.

-House alarms. Includes the alarms which are released from common equipment at the base station such as fire alarm and intruder alarm.

-External alarms. Includes the alarms which are released by all other equipment at the base station by using the NMT signalling system for alarm information.

It shall be possible to forward information in frame 28 together with circuit identity both to remote and to local I/O devices.

Note 4 Idling of radio channel at blocking alarm

After the CU has sent an alarm containing V_1(6), block the channel, the radio channel equipment shall be idled locally. This has the same function as reception of frame 20(A=0) from the MTX.

4.3.3.9.1 Coding of the V_4-parameter on HC [OPTIONAL]

In addition to the V-parameters defined above, the following V-parameters are used on HC.

V_1	V_2	V_3	V_4	Meaning in frame 28
3	15	0		Reserved for HC
3	15	0	1	Faulty HC1 level 1
3	15	0	2	Faulty HC2 level 1
3	15	0	3	Faulty HC3 level 1
3	15	0	4	Faulty HC4 level 1
3	15	0	5	Faulty HC1 level 2
3	15	0	6	Faulty HC2 level 2
3	15	0	7	Faulty HC3 level 2
3	15	0	8	Faulty HC4 level 2
3	15	0	9	Not enough capacity for handover request
3	15	0	10	Not enough capacity for signalling between BS and SSE

3	15	1		Reserved for HC
3	15	1	1	Cease faulty HC1 level 1
3	15	1	2	Cease faulty HC2 level 1
3	15	1	3	Cease faulty HC3 level 1
3	15	1	4	Cease faulty HC4 level 1
3	15	1	5	Cease faulty HC1 level 2
3	15	1	6	Cease faulty HC2 level 2
3	15	1	7	Cease faulty HC3 level 2
3	15	1	8	Cease faulty HC4 level 2
3	15	1	9	Cease not enough capacity for handover request
3	15	1	10	Cease not enough capacity for signalling between BS and SSE
3	15	2		Reserved for SSE
3	15	2	1	Faulty HC1 level 1, SSE
3	15	2	2	Faulty HC2 level 1, SSE
3	15	2	3	Faulty HC3 level 1, SSE
3	15	2	4	Faulty HC4 level 1, SSE
3	15	2	5	Faulty HC1 level 2, SSE
3	15	2	6	Faulty HC2 level 2, SSE
3	15	2	7	Faulty HC3 level 2, SSE
3	15	2	8	Faulty HC4 level 2, SSE
3	15	2	9	Not enough capacity for signalling between SSE and MTX.
3	15	3		Reserved for SSE
3	15	3	1	Cease faulty HC1 level 1, SSE
3	15	3	2	Cease faulty HC2 level 1, SSE
3	15	3	3	Cease faulty HC3 level 1, SSE
3	15	3	4	Cease faulty HC4 level 1, SSE
3	15	3	5	Cease faulty HC1 level 2, SSE
3	15	3	6	Cease faulty HC2 level 2, SSE
3	15	3	7	Cease faulty HC3 level 2, SSE
3	15	3	8	Cease faulty HC4 level 2, SSE
3	15	2	9	Cease not enough capacity for signalling between SSE and MTX.
3	15	4		Reserved for SSE
3	15	4	1	Faulty SSE, level 1
3	15	4	2	Faulty SSE, level 2
3	15	4	3	Fast scan alarm
3	15	4	4	Slow scan alarm
3	15	4	5	Spare
3	15	4	6	Cease faulty SSE, level 1
3	15	4	7	Cease faulty SSE, level 2
3	15	4	8	Cease fast scan alarm
3	15	4	9	Cease slow scan alarm
3	15	4	10	Spare

Note 1) HCn means HC with priority n according to the priority list (n=1,2,3 or 4).

Note 2) V_1=3, V_2=15 and V_3=0 or 1 implies that the message is initiated in the BS. V_1=3, V_2=15 and V_3=2,3 or 4 implies that the message is initiated in the SSE.

4.3.3.10 Coding of speech quality supervision data

4.3.3.10.1 Coding of supervisory signal information

The following coding is used between the MTX and BS/MS indicating the 4 different supervisory signal information:

- In frames 20, 21b, 21c, 25 and 26:

Notation	Coding (binary)	Meaning
$f_{ø0}$	0101	ø-signal incorrect (used only in frame 26 from BS to MTX)
$f_{ø1}$	0011	ø-signal frequency 1
$f_{ø2}$	1100	ø-signal frequency 2
$f_{ø3}$	1001	ø-signal frequency 3
$f_{ø4}$	0110	ø-signal frequency 4
$f_{øi}$	0000	No ø-signal information

The implementation of digital supervisory signal [OPTIONAL] leads to changes in coding of frames 20(A=3/14), 21b, 21c, 25(A=2/6) and 26. In order to be able to transmit different supervisory signals at different base stations every data stream has an embedded reference number in the code which is sent out. The following coding for this reference number, F_1F_2, is used between MTX and BS (This is also valid for frames 42,47,51,52):

ASS=Analogue Supervisory Signal
DSS=Digital Supervisory Signal [OPTIONAL]

Used in frame	Meaning	Coding F_1	F_2
All frames	No information	0000	0000
20,51,52	ASS #1	0011	0011
"	ASS #2	1100	1100
"	ASS #3	1001	1001
"	ASS #4	0110	0110
21, 25, 26, 42, 47	ASS #1	0000	0011
"	ASS #2	0000	1100
"	ASS #3	0000	1001
"	ASS #4	0000	0110
26	Incorrect ASS or DSS	0000	0101

Used in frame	Meaning	Coding F_1	F_2	Sequence
20,21,25, 26, 42, 47, 51, 52	DSS #0	0000	0001	000000000000000000000000000000
	DSS #1	0000	0010	000000000110101011110010010100 1
	DSS #2	0000	0100	000000001011111110001011011110 11
	DSS #3	0000	0111	000000010001010011011111110111 11
	DSS #4	0000	1000	000000011100000100111011000 1101
	DSS #5	0000	1011	000000100100001101001101001 0111
	DSS #6	0000	1101	000000101001011010101001100 0101
	DSS #7	0000	1110	000000110011111010110000011000 01
	DSS #8	0001	0000	000000111111010001000010001 10011
	DSS #9	0001	0011	000001000011100110001100101 0101
	DSS #10	0001	0101	000001010100011111010000101000 11
	DSS #11	0001	0110	000001011001001001000101111 10001
	DSS #12	0001	1001	000001101100010111010111 0111001
	DSS #13	0001	1010	000001110110111000011111000 11101
	DSS #14	0001	1100	000001111011101111111101 01001111
	DSS #15	0001	1111	000010010110011111100011 0111010 1
	DSS #16	0010	0000	000010011011001000100010 0100111
	DSS #17	0010	0011	000010101110010110110000 1101111
	DSS #18	0010	0101	000010110100111001111001 1001011
	DSS #19	0010	0110	000010111001101110011101 0011001
	DSS #20	0010	1001	000011000100101010010101 1111111
	DSS #21	0010	1010	000011001001111110111000 1010110 1
	DSS #22	0010	1100	000011101011011011001110 0010011
	DSS #23	0010	1111	000011111100100011100011 1100101
	DSS #24	0011	0001	000100011111001011101101 0001011
	DSS #25	0011	0010	000100111101101101010010 0110101
	DSS #26	0011	0100	000101010111010001110111 0100101
	DSS #27	0011	0111	000110001111111111101100 1101011 1
	DSS #28	0011	1000	000110101101011001100 1101101001
	DSS #29	0011	1011	000110111011111011010111 1001101
	DSS #30	0011	1101	000111001010110010100 1110101011
	DSS #31	0011	1110	001001011111010111101001 1111101
	DSS #32	0100	0000	001001100111011111001 1111110 0111
	DSS #33	0100	0011	001011110111101010101 0110111011
	DSS #34	0100	0101	111111111111111111111 1111111111

Note 1: The actual coding of F_1F_2 corresponds to the earlier coding of $f_{\emptyset}$ for the ASS. For DSS, the last bit in F_2 is used to give an odd parity and the first seven bits in F_1F_2 is a binary coding of the DSS number.

The BS equipment shall be able to handle both ASS and DSS. This can be done by checking the parity: even parity gives ASS and odd parity gives DSS.

Note 2: There are no generated translation between F_1F_2 and the cyclic code sequences.

Note 3: The cyclic sequences are Gold sequences of length 31 given above in phase 1. The generator polynomial $h_0(x) = x^{10} + x^9 + x^8 + x^6 + x^5 + x^3 + 1$ is used. Added are the all-1-sequence and the all-0-sequence.

Note 4: The bit transmission order for each sequence is from left to right.

4.3.3.10.2 Coding of the alarm levels for received MS signal strength in the BS

Coding	Meaning	
(Binary)	High level, l_H	Low level, l_L
0000	Suppress the function	Suppress the function
0001	30 dB (1µV) E.M.F.	20 dB (1µV) E.M.F
0010	25 "	16 "
0011	20 "	12 "
0100	16 "	8 "
0101	12 "	4 "
0110	8 "	0 "
0111	4 dB (1µV)E.M.F.	-4 dB(1µV)E.M.F.
1000	0 dB (1µV)E.M.F.	Spare
1001	40 dB (1µV)E.M.F.	Spare
1010	35 dB (1µV)E.M.F.	Spare
1111	Spare	Spare

High level and low level, including suppression of the function, can be coded independently of each other. The information is given to the BS in the frames 20 (A=15) and 20 (A=14).

4.3.3.10.3 Coding of cause value in frames 25 A(7) and 25 A(8) [OPTIONAL]

Notation	Coding	Meaning in direction BS to MTX
C(0)	0000	No information given
C(1)	0001	Caused by Ø-signal
C(2)	0010	Caused by RF-signal supervision
C(4)	0100	Caused by co-channel interference
C(8)	1000	Reserved for digital supervisory signal (BER)
C(9)	1001	Caused by the 3 s evaluation period of supervisory signal

Other bit combinations in C are used when several conditions are fulfilled simultaneously by adding the corresponding values of C.

4.3.3.11 Coding of area information

4.3.3.11.1 In the direction MTX to MS.

Due to limited space for transmitting area information from MTX to MS, this information is transmitted in frames 1b, 2a, 2e, 3b, 4, 4b and 30 as fictitious channel number, according to the coding below.

Notation	Coding (fictitious channel No)	Meaning
$H_8H_9H_{10}$	ch.1011	Area no. 1
$H_8H_9H_{10}$	ch.1012	Area no. 2
$H_8H_9H_{10}$	ch.1013	Area no. 3
$H_8H_9H_{10}$	ch.1014	Area no. 4
$H_8H_9H_{10}$	ch.0	No area information

4.3.3.11.2 In the direction MS to MTX

The area information and the traffic area information received from the MTX is transmitted back to the MTX by the MS as TY_2 in frames 10b, 10c, 11a and 12.

The coding is as follows:

- $T = t_1\ t_2\ t_3\ t_4$

where

-- t_1t_2 = area info (translated from $H_8H_9H_{10}$), coded as

t_1t_2 = 01 (binary) for Area no. 1
t_1t_2 = 10 " for Area no. 2
t_1t_2 = 11 " for Area no. 3
t_1t_2 = 00 " for Area no. 4 or if no area information is received

-- t_3t_4 = 2 last bits in Y_1

- Y_2 = Y_2 received from MTX

In shortened frames 10a, 10d and 11b only the character T is transmitted as area information. In frame 11b on calling channel, the area information t_1t_2 in character T is set to 00 (binary).

4.3.3.12 Coding of additional information, fictitious channel numbers

Coding of $H_8H_9H_{10}$ in frame 1b is specified in para 4.3.3.11.1.

Coding of $H_8H_9H_{10}$ in frames 2c, 2d and 2f

Notation	Coding (fictitious channel No.)	Meaning
$H_8H_9H_{10}$	ch.1008	Queuing information to ordinary MS in frame 2f.
$H_8H_9H_{10}$	ch.1009	Queuing information to PMS in frame 2c.
$H_8H_9H_{10}$	ch.1010	Traffic channel scanning order in frame 2d.

In the scanning procedures $H_2(0)$ and $H_2(12)$ shall, however, not be differentiated (i.e. both channel types are accepted). The access method depends on the received channel indication on the actual free traffic or access channel.

4.3.3.13 Coding of additional information, channel band information

4.3.3.13.1 General

The system allows for the MTX, BS and MS to work over 1999 channels. The additional information transmitted on the calling channels informs the MS about actual bands in use for calling channels and for traffic or access channels. From the outset a basic channel band, preprogrammed in MS, is used for channel scanning.

If no additional information is given, or this information is lost in MS, the MS shall scan for CC or TC over the basic channel band.
On combined calling and traffic channels H_1-H_6 is coded as on calling channel, while H_7 is set to J.

4.3.3.13.2 Coding of H_1H_2

For this additional information two values of H_1 are used, $H_1(0)$ and $H_1(14)$. See also 4.3.3.1.

$H_1(0)$ $H_2(0)$ indicates that only the channels within the basic channel band N(X)N(X)N(X) to N(Y)N(Y)N(Y) are used for scanning. For the MS this means that one scan is a search through the channels (in 12,5 kHz steps) from a random starting point and taking N(X)N(X)N(X) after N(Y)N(Y)N(Y).

The values for the basic channel band N(X)N(X)N(X) to N(Y)N(Y)N(Y) shall be preprogrammed into the MS in the same way as the MS identity. See also NMT Doc 900-3.

$H_1(14)$ $H_2(0)$ indicates that information about where to find CC band and/or TC band is given. $H_1(14)H_2(12)$ indicates that information about the position of CC band and/or access channel band is given. This information shall be stored in the MS according to NMT Doc 900-3.

In the scanning procedures $H_2(0)$ and $H_2(12)$ shall, however, not be differentiated (i.e. both channel types are accepted). The access method depends on the received channel indication on the actual free traffic or access channel.

4.3.3.13.3 Coding of additional information concerning calling channel band

Information about calling channel band is coded in the characters $H_3H_4H_5H_6$.

The band limits are identified by 8 bits.

H_3H_4 Start point of calling channel band

H_5H_6 End point of calling channel band

The start point must always be a lower channel number than the end point. Translation into channel numbers, see para 4.3.3.13.5.

If $H_3H_4=H_5H_6=00$ no information concerning calling channel band is given. The preprogrammed basic band is used for calling channel scanning.

4.3.3.13.4 Coding of additional information concerning traffic channel band or access channel band.

Information about traffic channel band or access channel band is coded in the characters $H_7H_8H_9H_{10}$.

The band limits are identified by 8 bits.

H_7H_8 Start point of traffic channel band or access channel band

H_9H_{10} End point of traffic channel band or access channel band

The start point must always be a lower channel number than the end point. Translation into channel numbers, see para 4.3.3.13.5.

If $H_7H_8 = H_9H_{10} = 00$ no information concerning traffic channel band or access channel band is given. The preprogrammed basic channel band is then used for traffic or access channel scanning.

4.3.3.13.5 Translation of band limits to channel numbers

It is always an ordinary channel (not interleaved) given as a band limit. The given band always includes the lower and the upper channels and the channels (included the interleaved channels) in between.

The eight bits in H_3H_4, H_5H_6, H_7H_8 and H_9H_{10} respectively denotes eight of the bits in the channel number, coded as in $N_aN_bN_c$ (see para 4.3.3.1 note 4). The bits a_9 to a_2 are given. The bits a_{10}, a_1 and a_0 are set to 0. The band limits will therefore be given in steps of 100 kHz.

Because channel 1 cannot be given as a band limit, H_3H_4 = 00 or H_7H_8 = 00 shall be interpreted as the band limit being channel 1.

4.3.3.14 Coding of additional information, battery saving for handheld mobile stations.

4.3.3.14.1 General

The system makes battery saving function possible in handheld mobile stations. The battery saving period starts at reception of following additional information which is sent on calling channels and combined calling and traffic channels. The handheld mobile station may then close the receiver for the period indicated in the information field. Calls to these mobile stations will be stored in the MTX the necessary time.

4.3.3.14.2 Coding of H_1H_2

H_1(14) and H_2(11) indicates that information for battery saving circuit synchronization is given.

4.3.3.14.3 Groups of mobiles

The mobile stations are divided up into groups according to the last digit X_6 in the mobile station subscriber number. The groups are addressed by the character H_7 ...H_7 in the signalling. The mobile station accepts the battery saving information only if X_6 is included in the groups specified by H_7 in the following table:

H_7	X_6
0	-
1	1, 3, 5, 7, 9
2	2, 4, 6, 8, 0
3	1, 2
4	3, 4
5	5, 6
6	7, 8
7	9, 0
8	1, 2, 3, 4, 5, 6, 7, 8, 9, 0
9-15	Spare

The MTX shall use one of the following combinations:

A) H_7(1) and H_7(2)
B) H_7(3), H_7(4), H_7(5), H_7(6) and H_7(7)
C) H_7(8)

4.3.3.14.4 Battery saving period

Coding of H_3	Battery saving period in frame times (1 frame = 138,33 ms)	
0	0	frames
1	24	"
2	40	"
3	56	"
4	72	"
5	88	"
6	112	frames
7	168	"
8	224	"
9	280	"
10-15	Spare	

The time between two battery saving information frames to each group depends on the period given in H_3 and the traffic load on the calling channel. Battery saving information will be sent after other necessary information (calls etc.) has been sent. Also the value of H_3 depends on the traffic situation in the MTX and it will be changed manually or automatically.

4.3.3.15 Coding of parameters for the handover request channel (HC) [OPTIONAL]

4.3.3.15.1 BSno

$B_1B_2B_3$ is coded as defined by the administration. The default value shall be FF0. The BSno shall be settable through the remote control.

4.3.3.15.2 Identity number U_1U_2 in frames 50 and 51

Coding	U_1U_2	Meaning
00000001	$U_1(0)U_2(1)$	
.	.	The identity number of a specific channel unit.
.	.	
.	.	
01000000	$U_1(4)U_2(0)$	
11111111	$U_1(15)U_2(15)$	All channel units

All other values are reserved for future use. The identity number is coded as a hexadecimal value which implies that up to 64 channel units can have a unique identity.

4.3.3.15.3 Information (I) of the channels in frame 50

Coding	I	Meaning
0001	I(1)	CC
0010	I(2)	AC/free TC
0011	I(3)	Combined CC and free TC
0100	I(4)	RF-link disconnection terminated the call.
1000	I(8)	Normal termination of the call.
1111	I(15)	Start of call

All other values are reserved for future use.

4.3.3.15.4 Check in frame 54

Parameter C_h shall be coded as a random hexadecimal number between 1 and 15.

4.3.3.15.5 Actual BS in frame 42b

$B_aB_bB_c$ is coded as defined in the implementation and decided by the administration. The information identifies the actual BS.

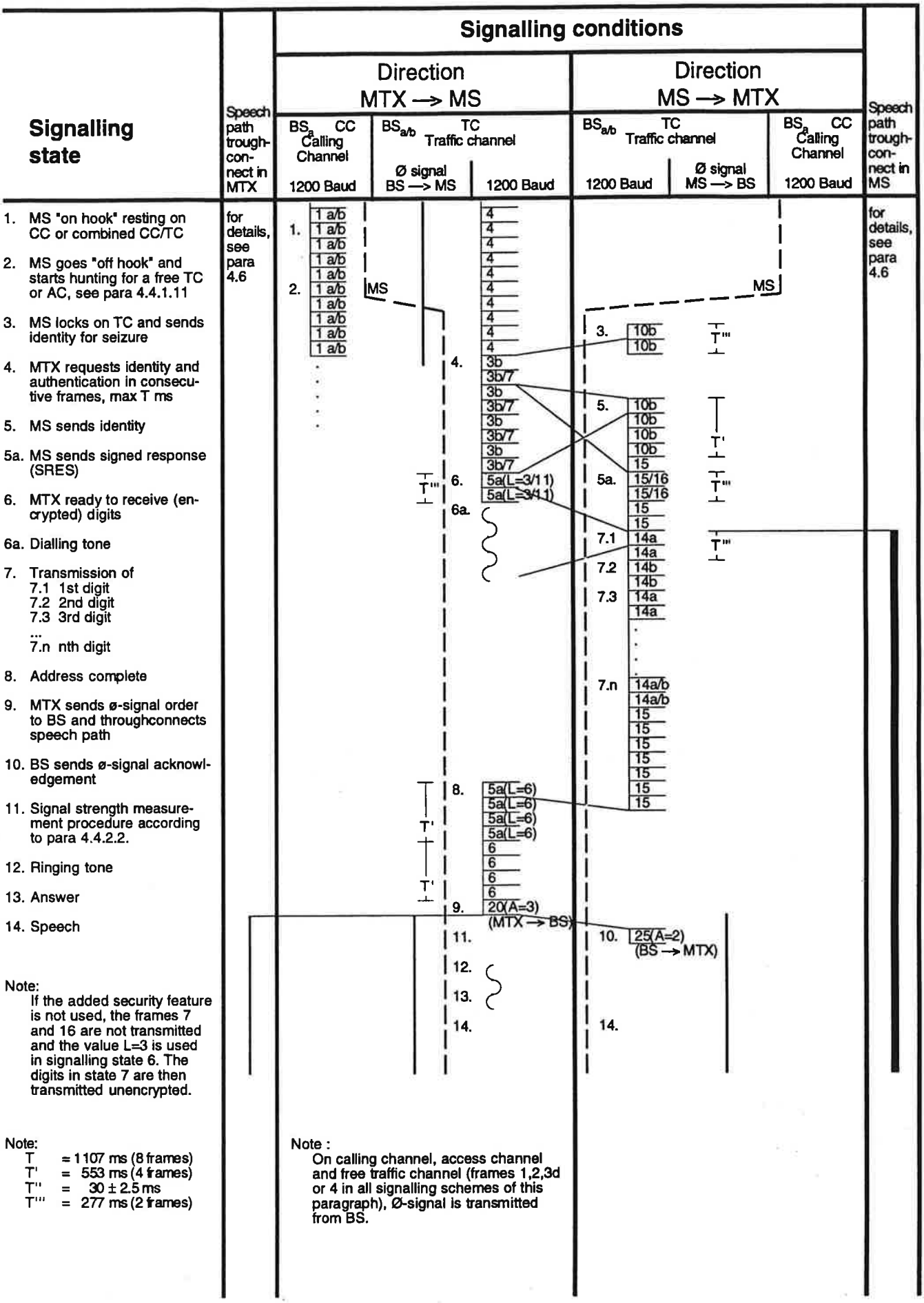
4.3.3.15.6 Information in frame 42 and 42b

Coding GG		Meaning	
0000	0000	G(0)G(0)	A normal handover attempt
0001	0001	G(1)G(1)	As for G(0) but a special reduced list of neighbouring base stations is used.
0010	0010	G(2)G(2)	Signal strength measurements are performed only on the target BS and actual BS.
0100	0100	G(4)G(4)	Signal strength measurements are performed only on the target BS.
1000	1000	G(8)G(8)	No signal strength measurements are performed. A handover is initiated at once.

4.4 SIGNALLING PROCEDURES

4.4.1 Signalling between MTX and MS

4.4.1.1 Call mobile station to mobile telephone exchange **SCHEME A**



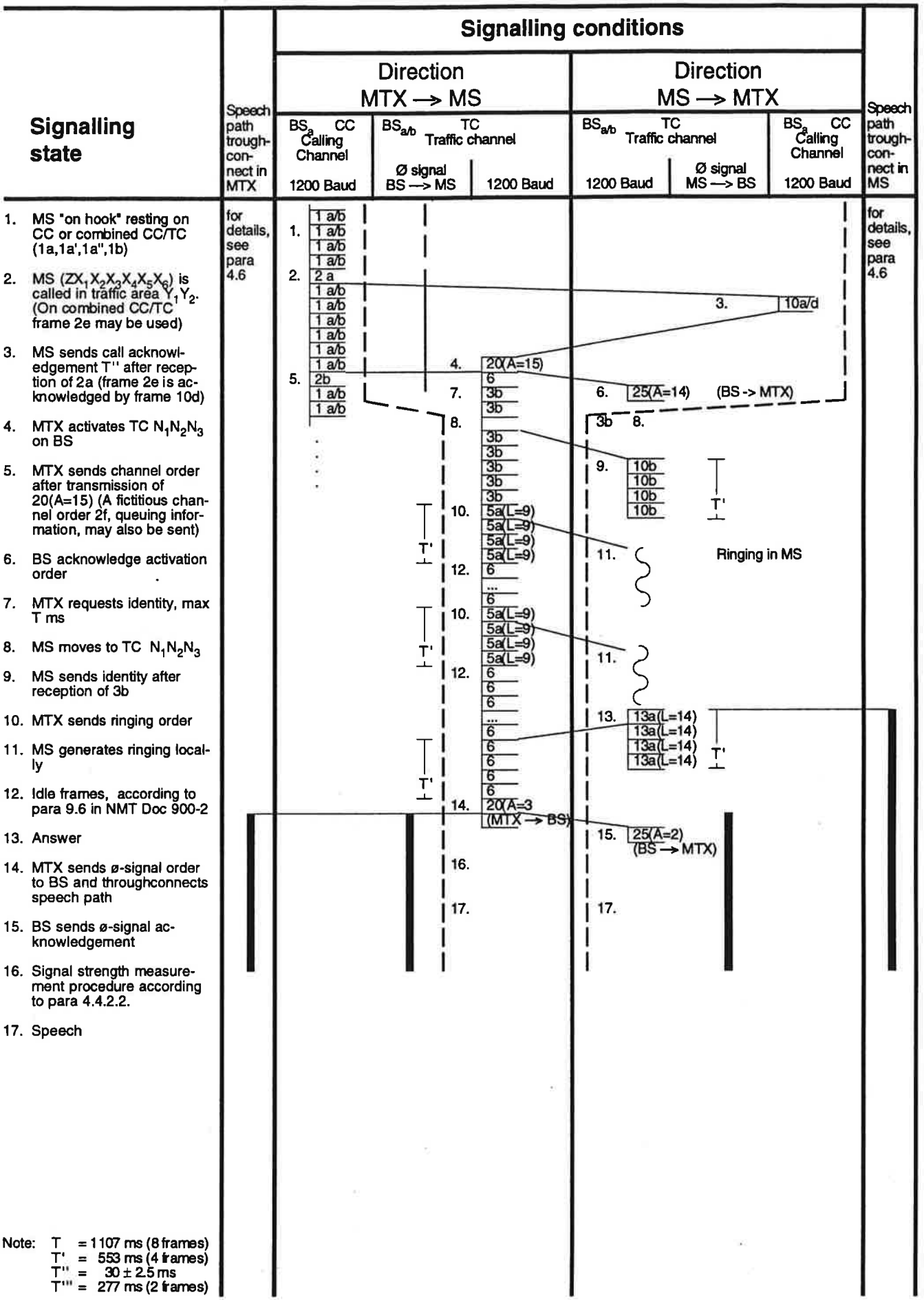
Note:
If the added security feature is not used, the frames 7 and 16 are not transmitted and the value L=3 is used in signalling state 6. The digits in state 7 are then transmitted unencrypted.

Note:
T = 1107 ms (8 frames)
T' = 553 ms (4 frames)
T'' = 30 ± 2.5 ms
T''' = 277 ms (2 frames)

Note :
On calling channel, access channel and free traffic channel (frames 1,2,3d or 4 in all signalling schemes of this paragraph), Ø-signal is transmitted from BS.

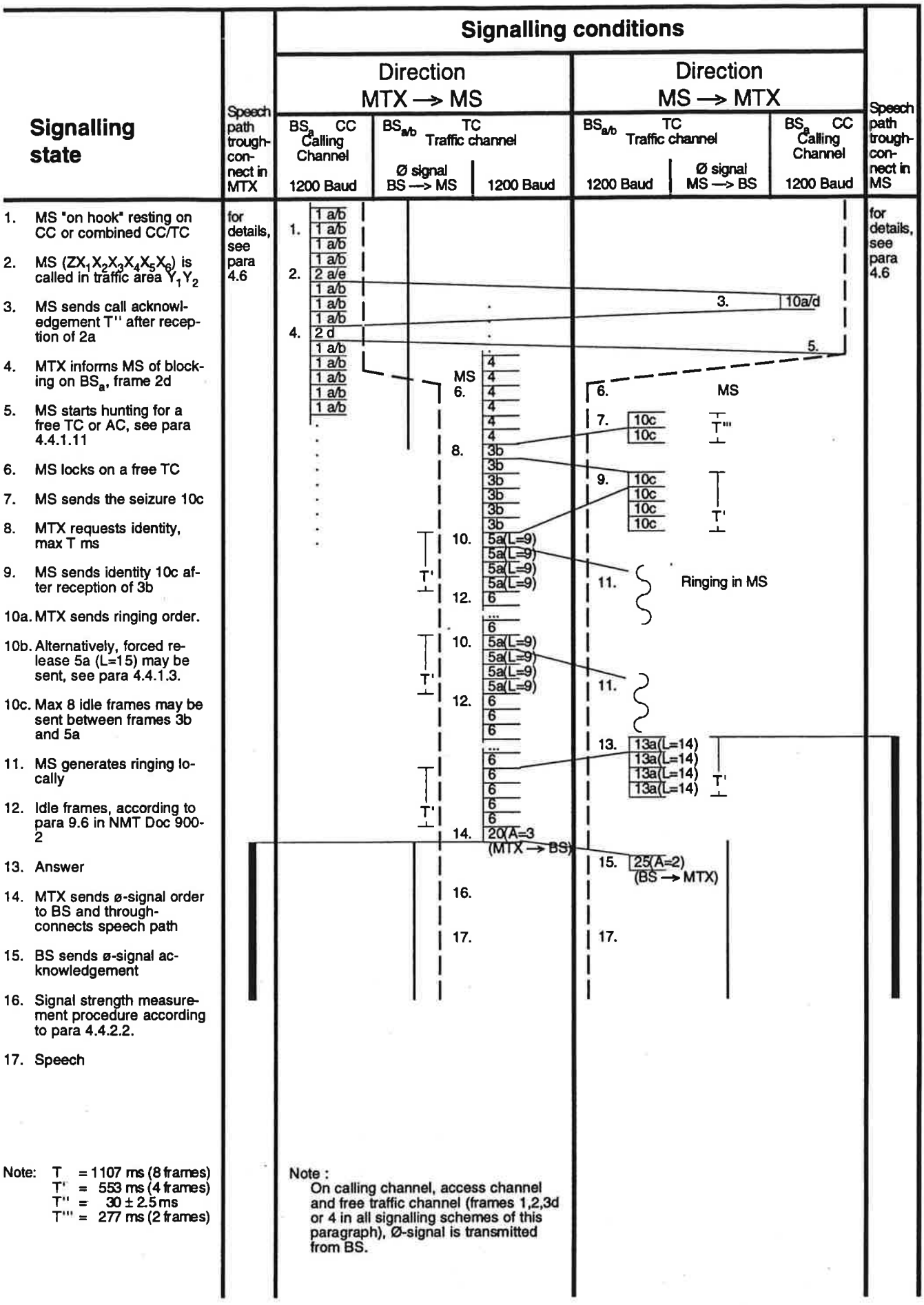
4.4.1.2 Call mobile telephone exchange to mobile station

4.4.1.2.1 Call mobile telephone exchange to mobile station, normal case **SCHEME B**

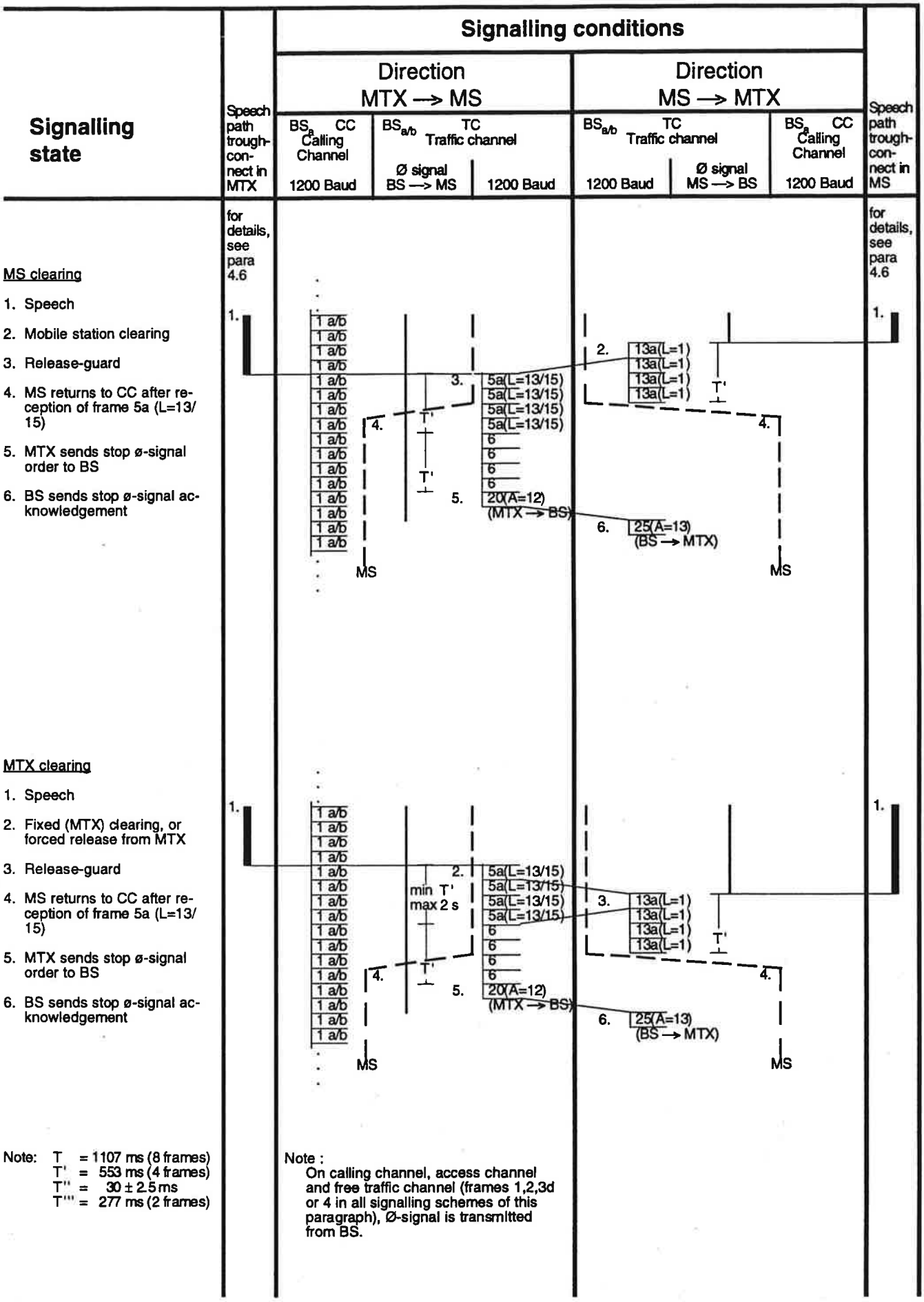


Note: T = 1107 ms (8 frames)
T' = 553 ms (4 frames)
T'' = 30 ± 2.5 ms
T''' = 277 ms (2 frames)

4.4.1.2.2 Call mobile telephone exchange to mobile station, congestion or blocking on BS_a. **SCHEME B.1**

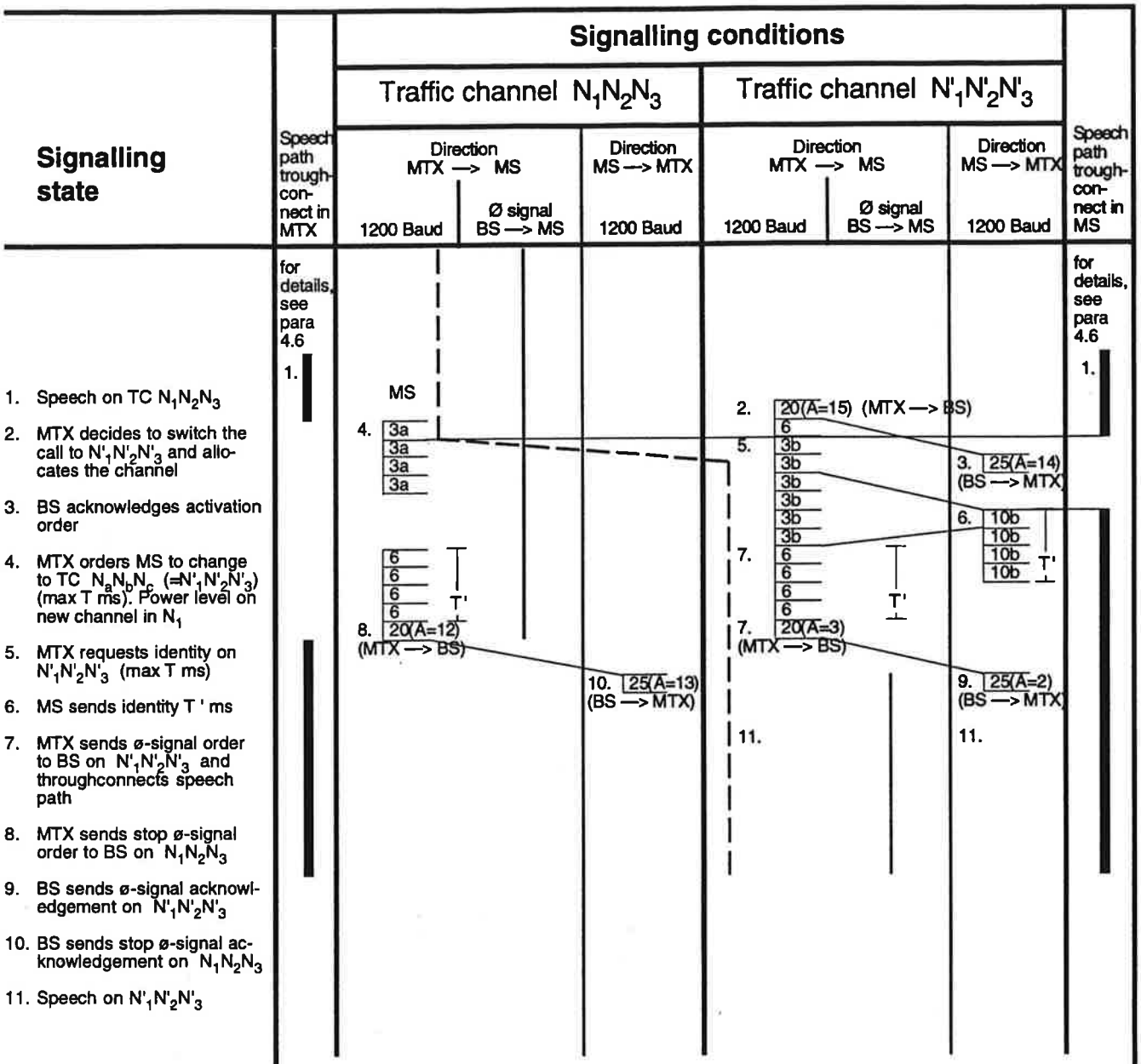


4.4.1.3 Clearing sequences



4.4.1.4 Switching call in progress

4.4.1.4.1 Switching call in progress, ordinary procedure. **SCHEME C**



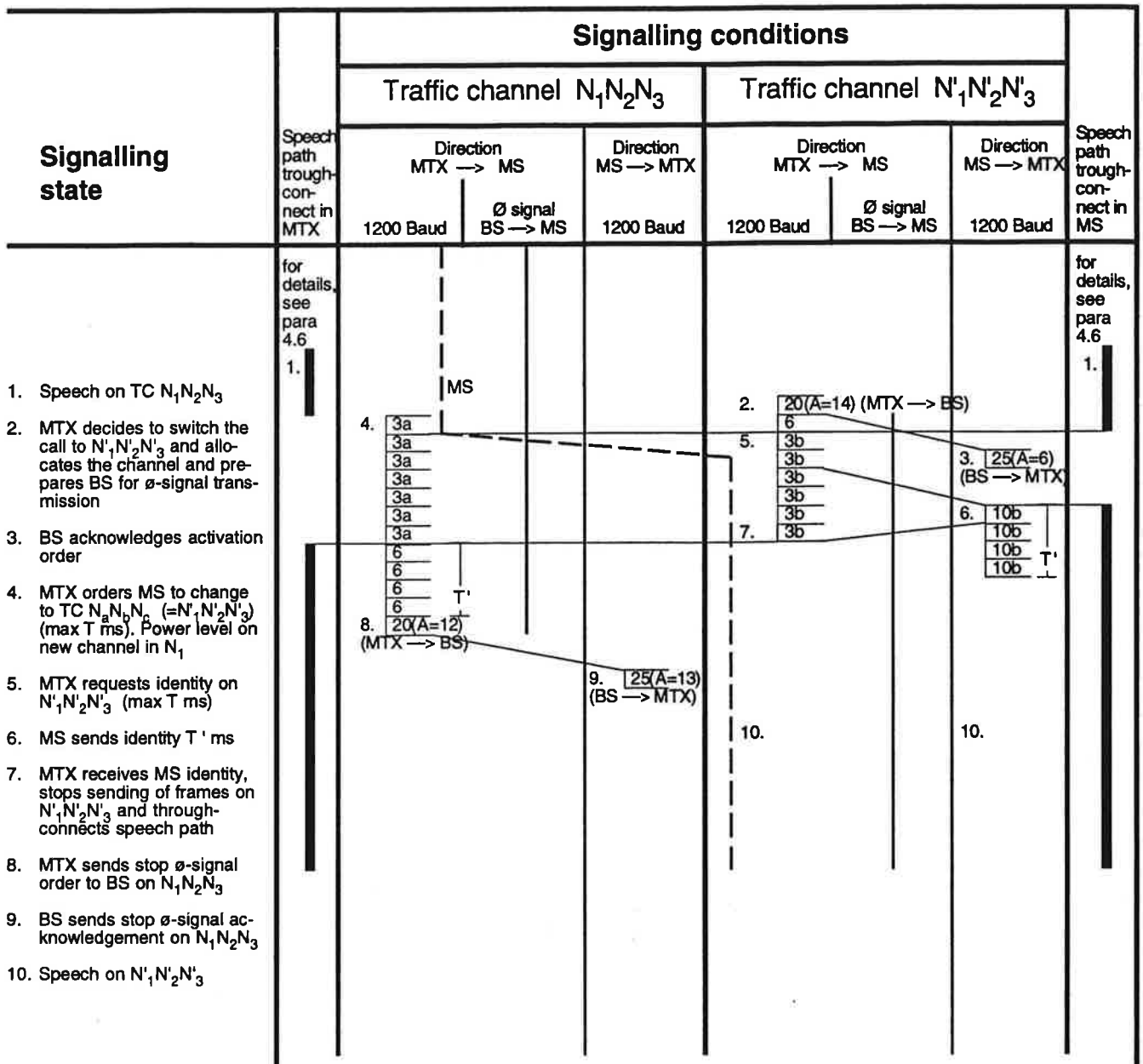
If MS does not receive identity request on the new TC, it will return to the previous TC and throughconnect speech path.

If MTX does not receive identity on the new TC within T ms, it will throughconnect speech path on the previous TC and send forced release on the new TC.

Note that the supervisory signal will control the previous TC in the last case when the speech path is throughconnected.

Note: T = 1107 ms (8 frames)
T' = 553 ms (4 frames)
T'' = 30 ± 2.5 ms
T''' = 277 ms (2 frames)

4.4.1.4.2 Switching call in progress, improved procedure **SCHEME C.1**



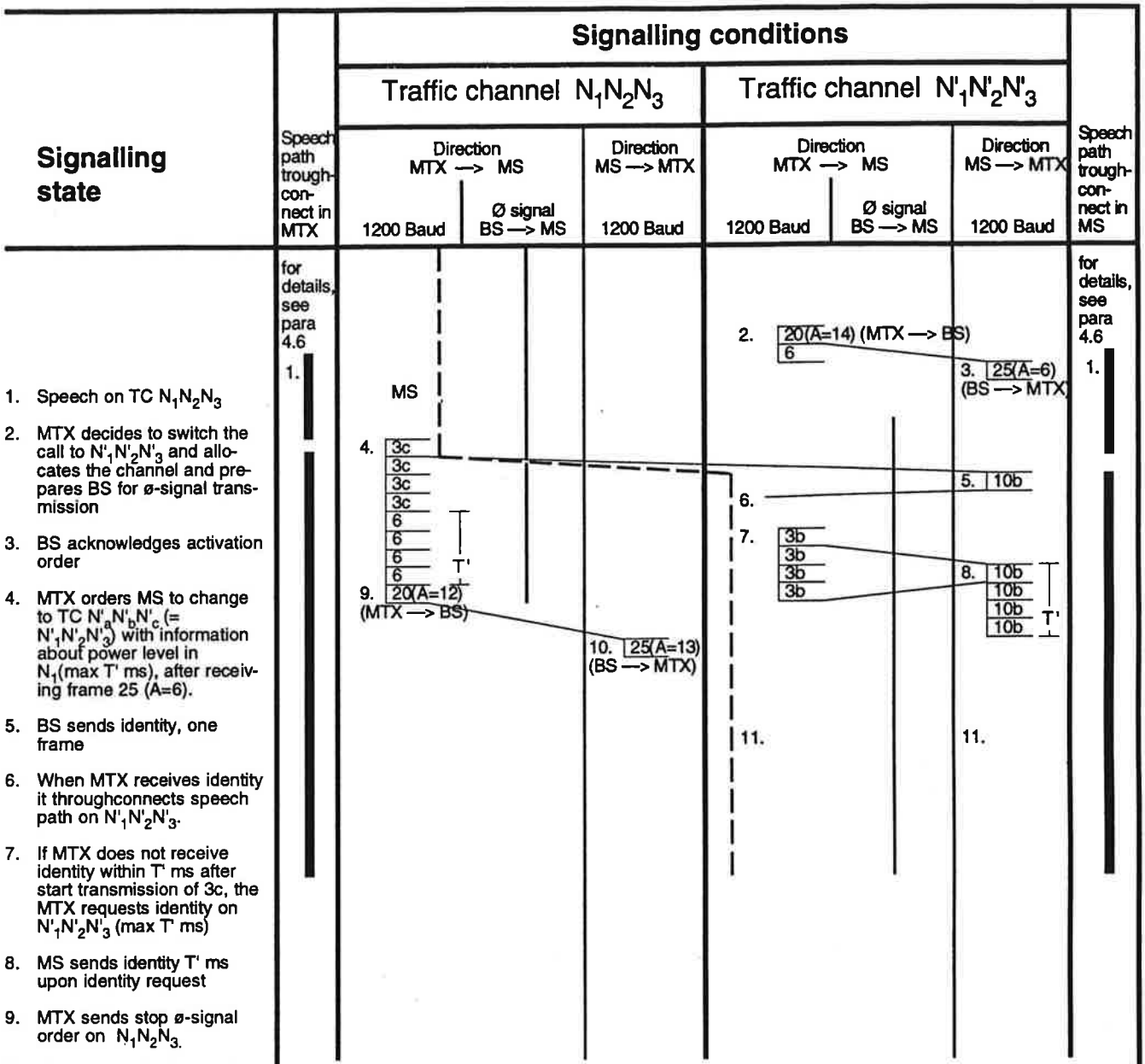
If MS does not receive identity request on the new TC, it will return to the previous TC and throughconnect speech path.

If MTX does not receive identity on the new TC within T ms, it will throughconnect speech path on the previous TC and send forced release on the new TC.

Note that the supervisory signal will control the previous TC in the last case when the speech path is throughconnected.

Note: T = 1107 ms (8 frames)
T' = 553 ms (4 frames)
T'' = 30 ± 2.5 ms
T''' = 277 ms (2 frames)

4.4.1.4.3 Switching call in progress, short procedure. **SCHEME C.2**



1. Speech on TC $N_1N_2N_3$
2. MTX decides to switch the call to $N'_1N'_2N'_3$ and allocates the channel and prepares BS for ø-signal transmission
3. BS acknowledges activation order
4. MTX orders MS to change to TC $N'_aN'_bN'_c$ (= $N'_1N'_2N'_3$) with information about power level in N_1(max T' ms), after receiving frame 25 (A=6).
5. BS sends identity, one frame
6. When MTX receives identity it throughconnects speech path on $N'_1N'_2N'_3$.
7. If MTX does not receive identity within T' ms after start transmission of 3c, the MTX requests identity on $N'_1N'_2N'_3$ (max T' ms)
8. MS sends identity T' ms upon identity request
9. MTX sends stop ø-signal order on $N_1N_2N_3$.
10. Stop ø-signal acknowledgement from BS on $N_1N_2N_3$
11. Speech on $N'_1N'_2N'_3$

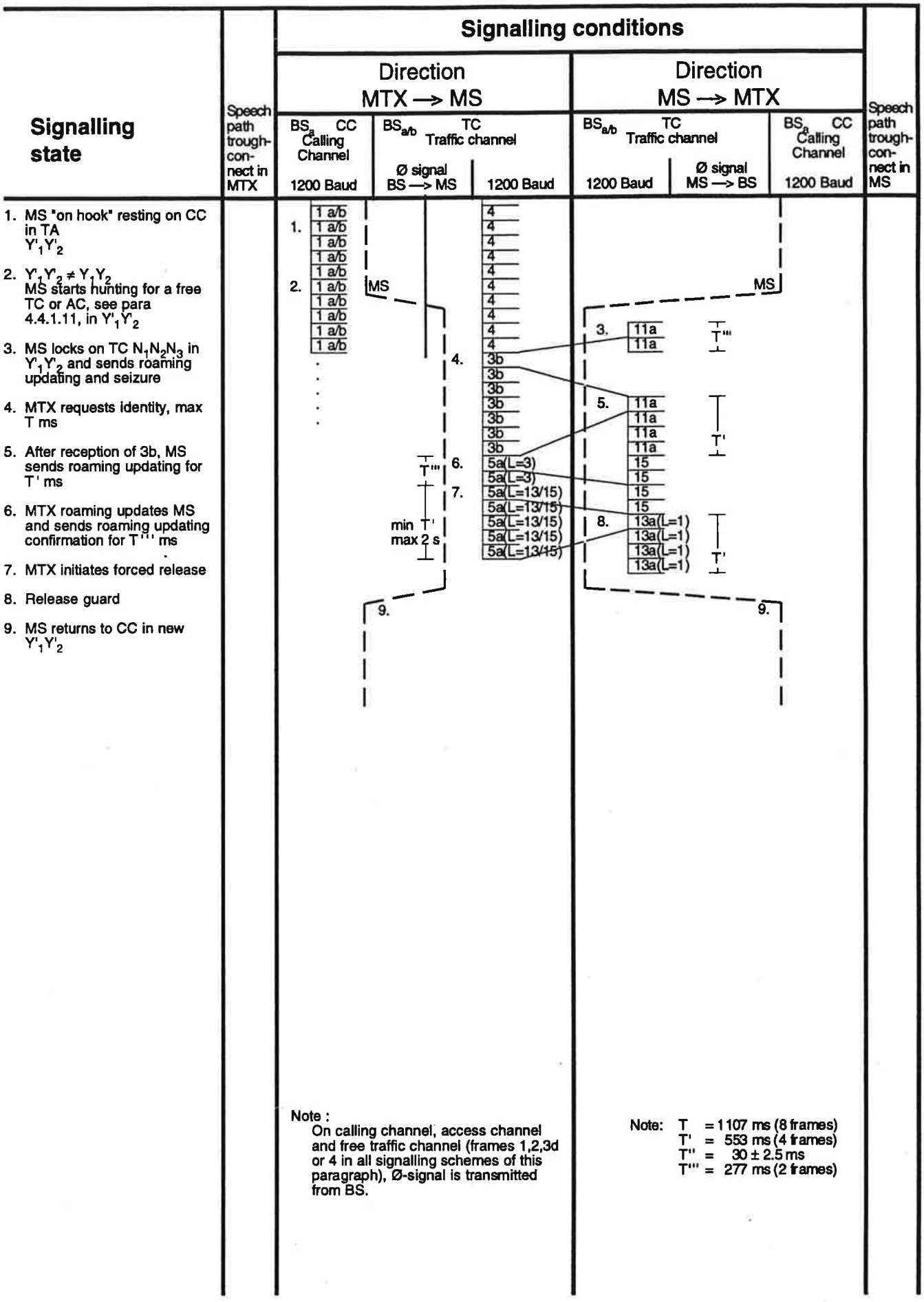
If the MS receives an RF-signal level above a limit A [A=20±4 dB(1µV)EMF] on the new TC it will transmit frame 10 b and throughconnect speech path. If the RF-signal level received in MS is below the limit A the MS shall not transmit frame 10 unless it receives identity request within T ms after received channel order. If identity request is not received within T ms the MS shall return to the previous TC and throughconnect speech path. The received identity request is responded with four identity frames 10b.

If MTX does not receive identity on the new TC within T ' ms after identity request, it will throughconnect speech path on the previous TC and send forced release on the new TC.

Note that the supervisory signal will control the previous TC in the last case when the speech path is throughconnected.

Note: T = 1107 ms (8 frames)
T' = 553 ms (4 frames)
T'' = 30 ± 2.5 ms
T''' = 277 ms (2 frames)

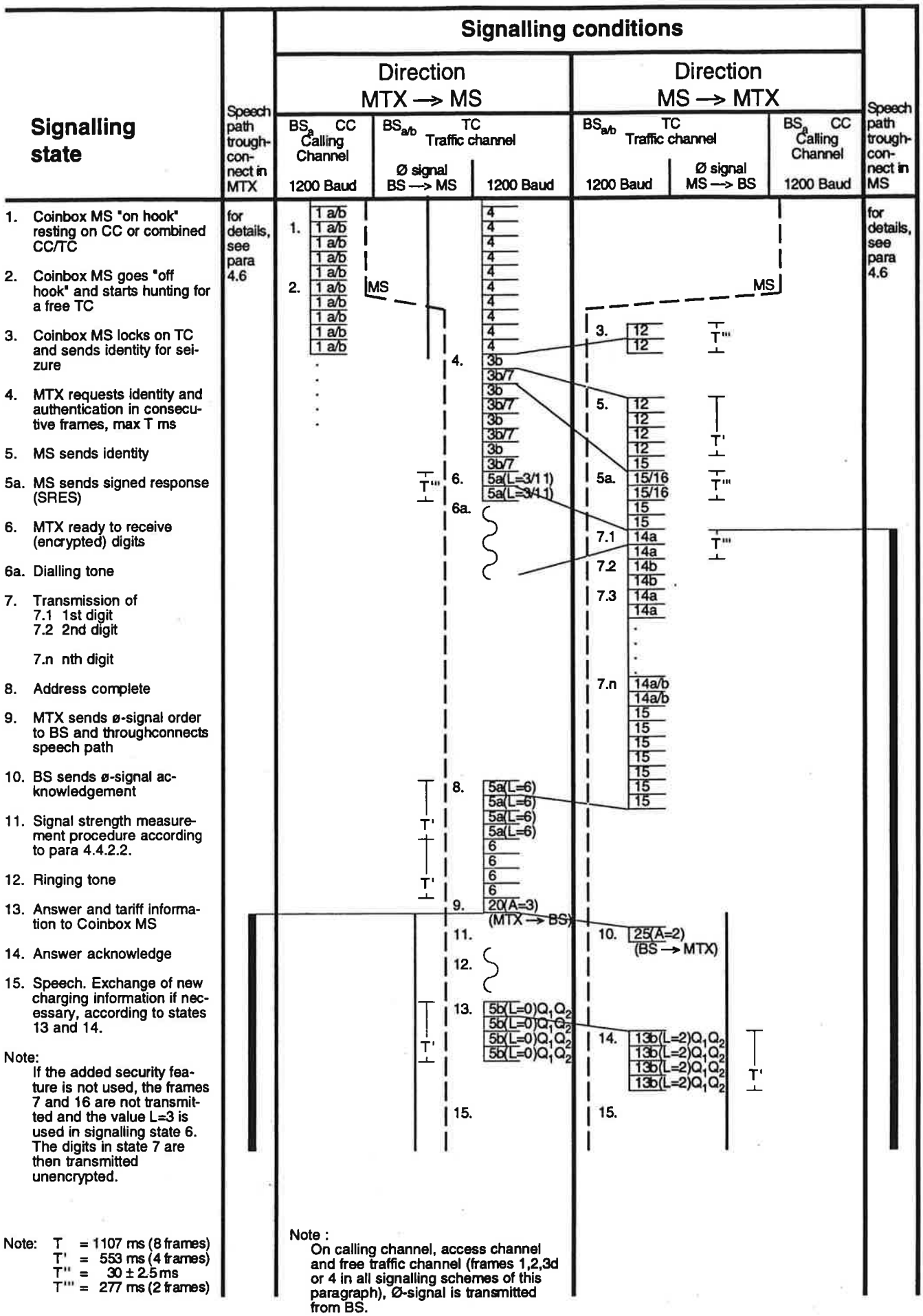
4.4.1.5 Roaming updating procedure
SCHEME D



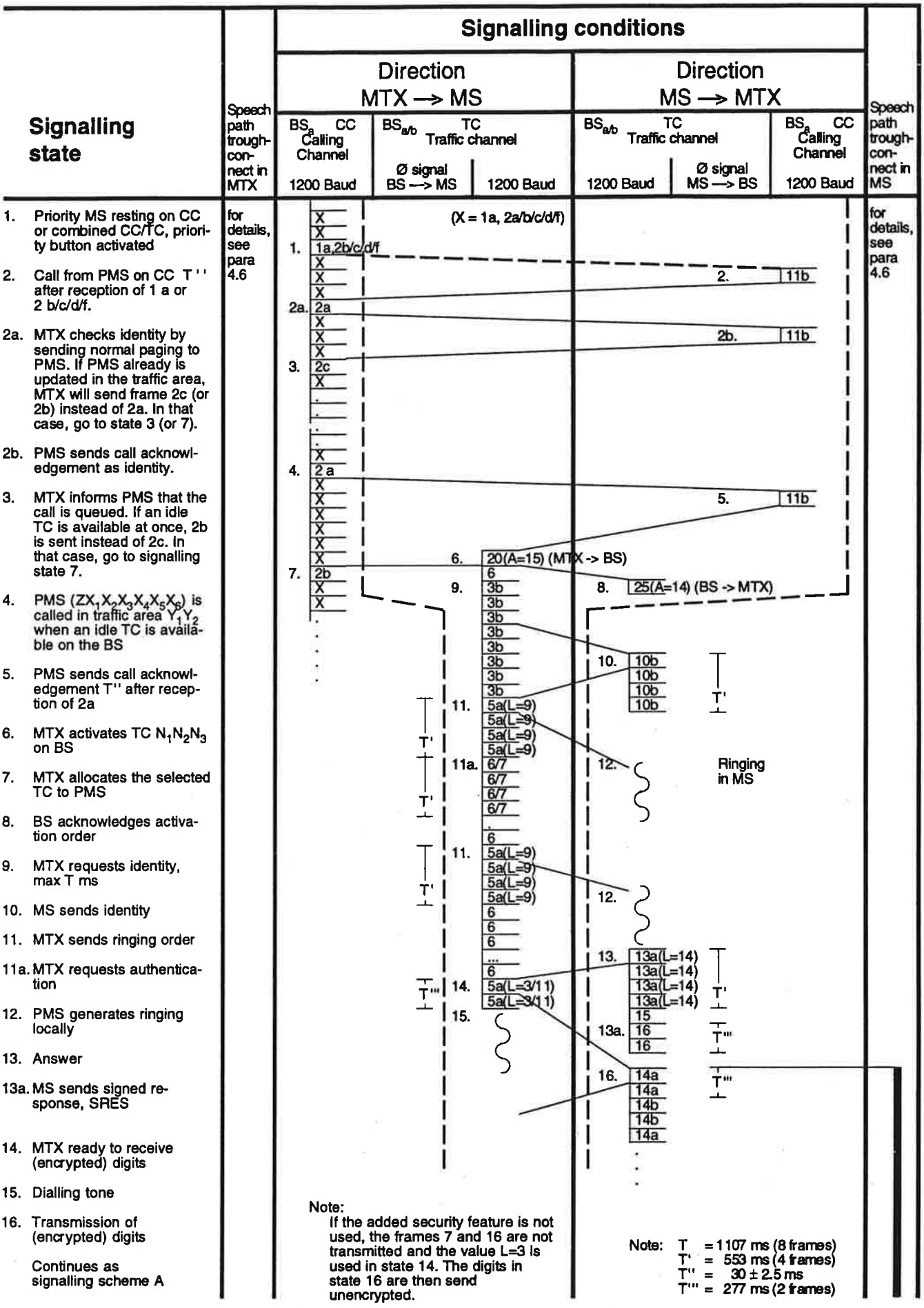
Note :
On calling channel, access channel and free traffic channel (frames 1,2,3d or 4 in all signalling schemes of this paragraph), Ø-signal is transmitted from BS.

Note: T = 1107 ms (8 frames)
T' = 553 ms (4 frames)
T'' = 30 ± 2.5 ms
T''' = 277 ms (2 frames)

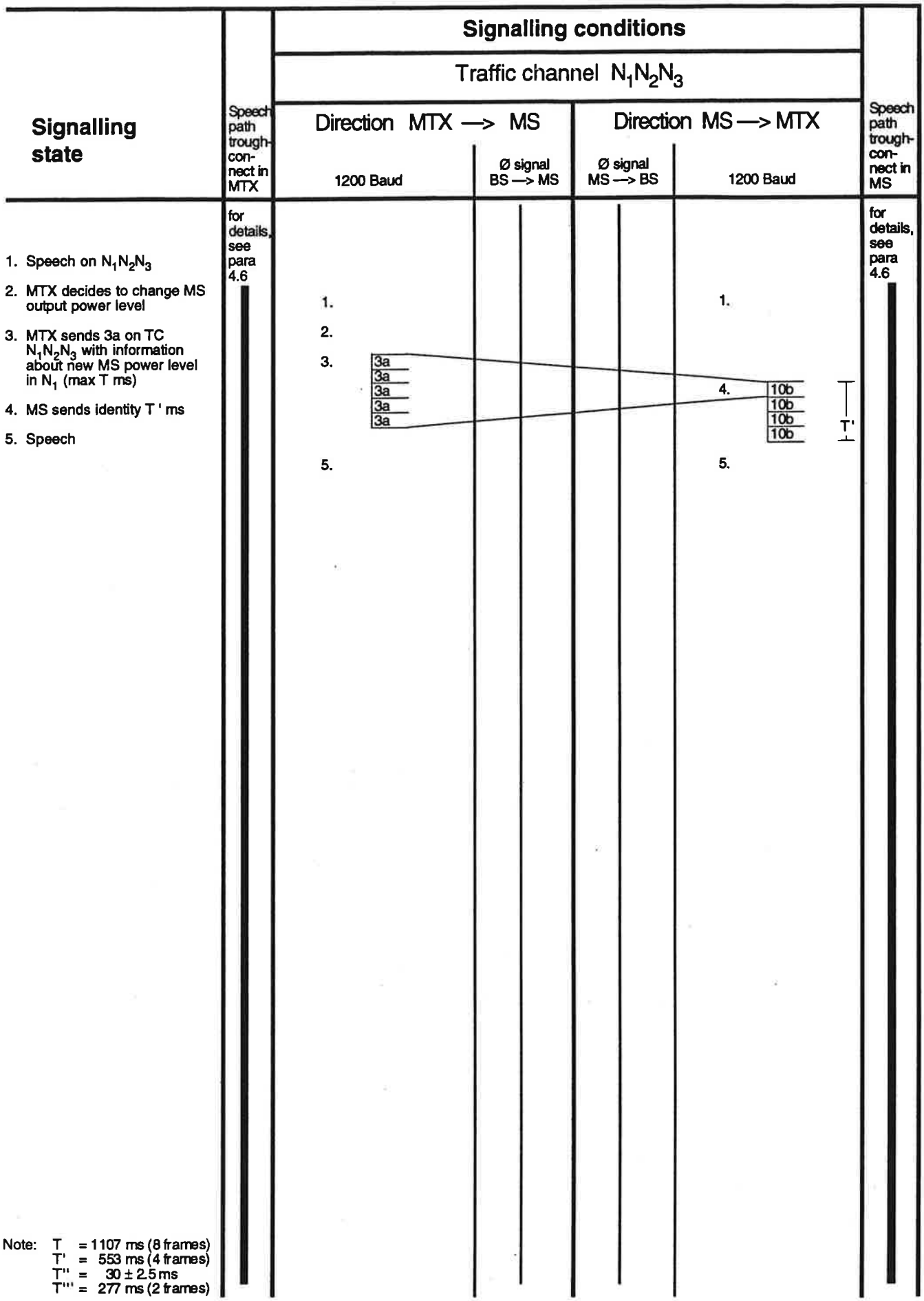
4.4.1.6 Call coinbox MS to mobile telephone exchange



4.4.1.7 Call from mobile telephone with priority (PMS)



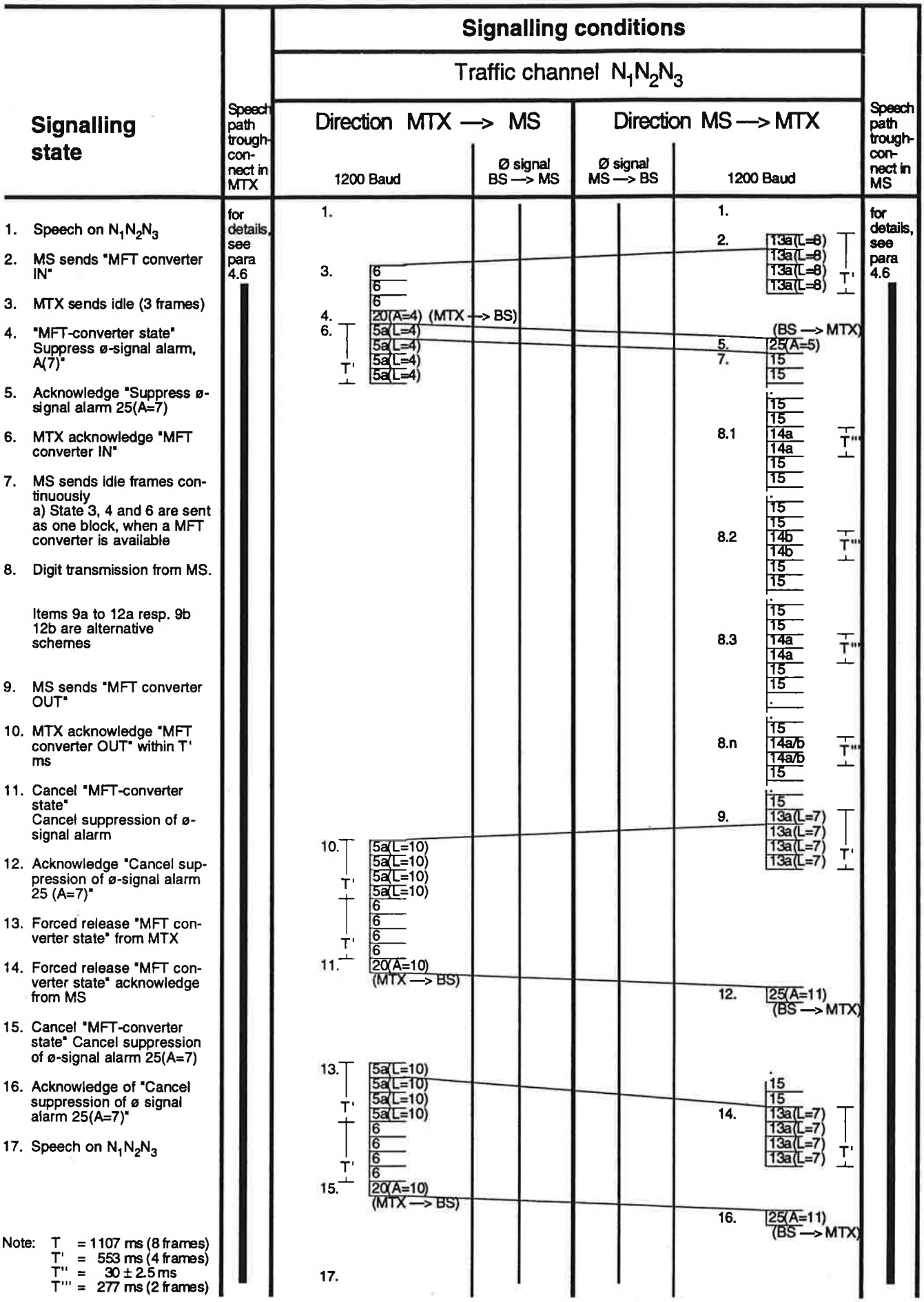
4.4.1.8 Change of MS output power level on same channel



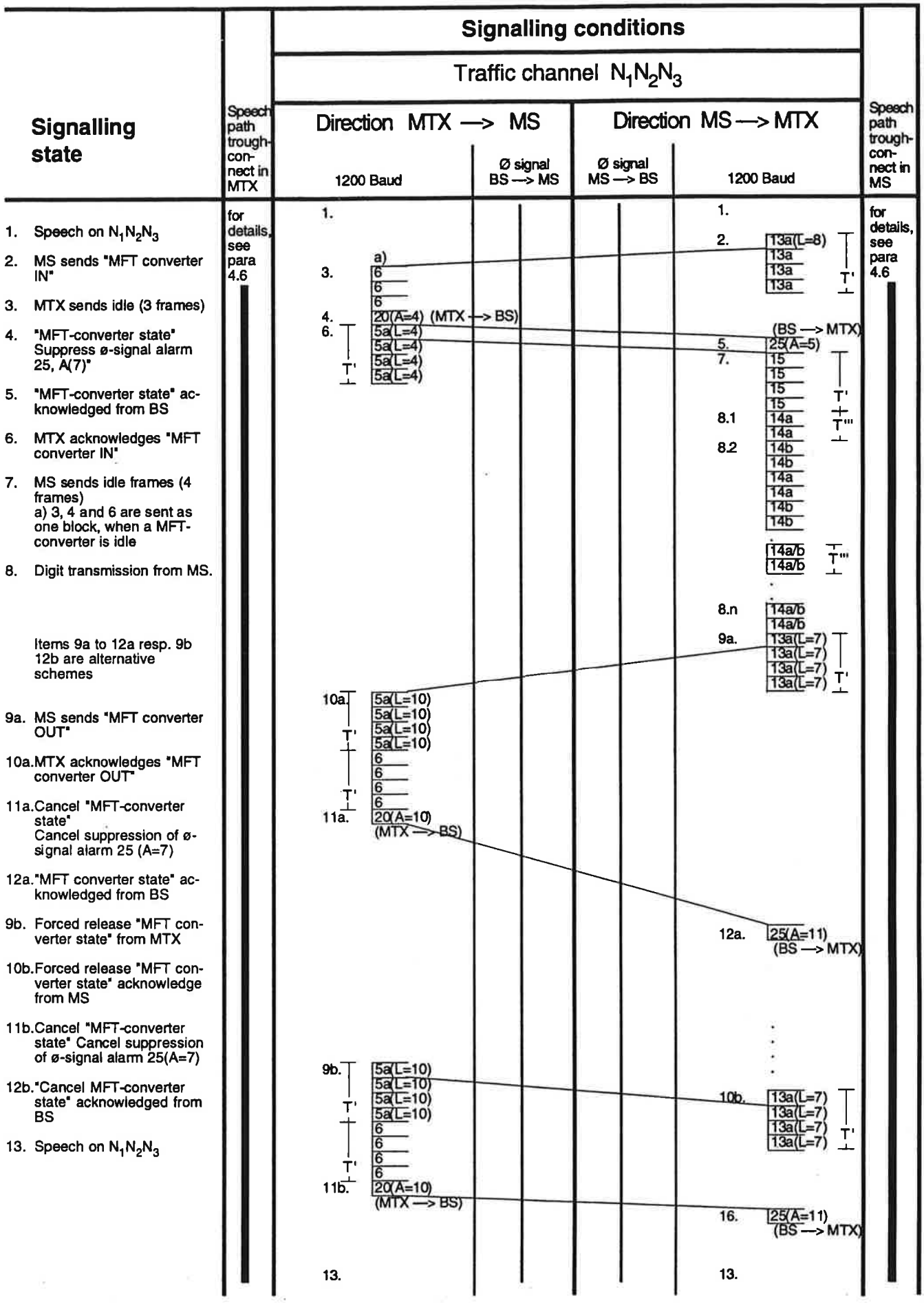
Note: T = 1107 ms (8 frames)
T' = 553 ms (4 frames)
T'' = 30 ± 2.5 ms
T''' = 277 ms (2 frames)

4.4.1.9 Push button data transmission from MS

4.4.1.9.1 Manual transmission

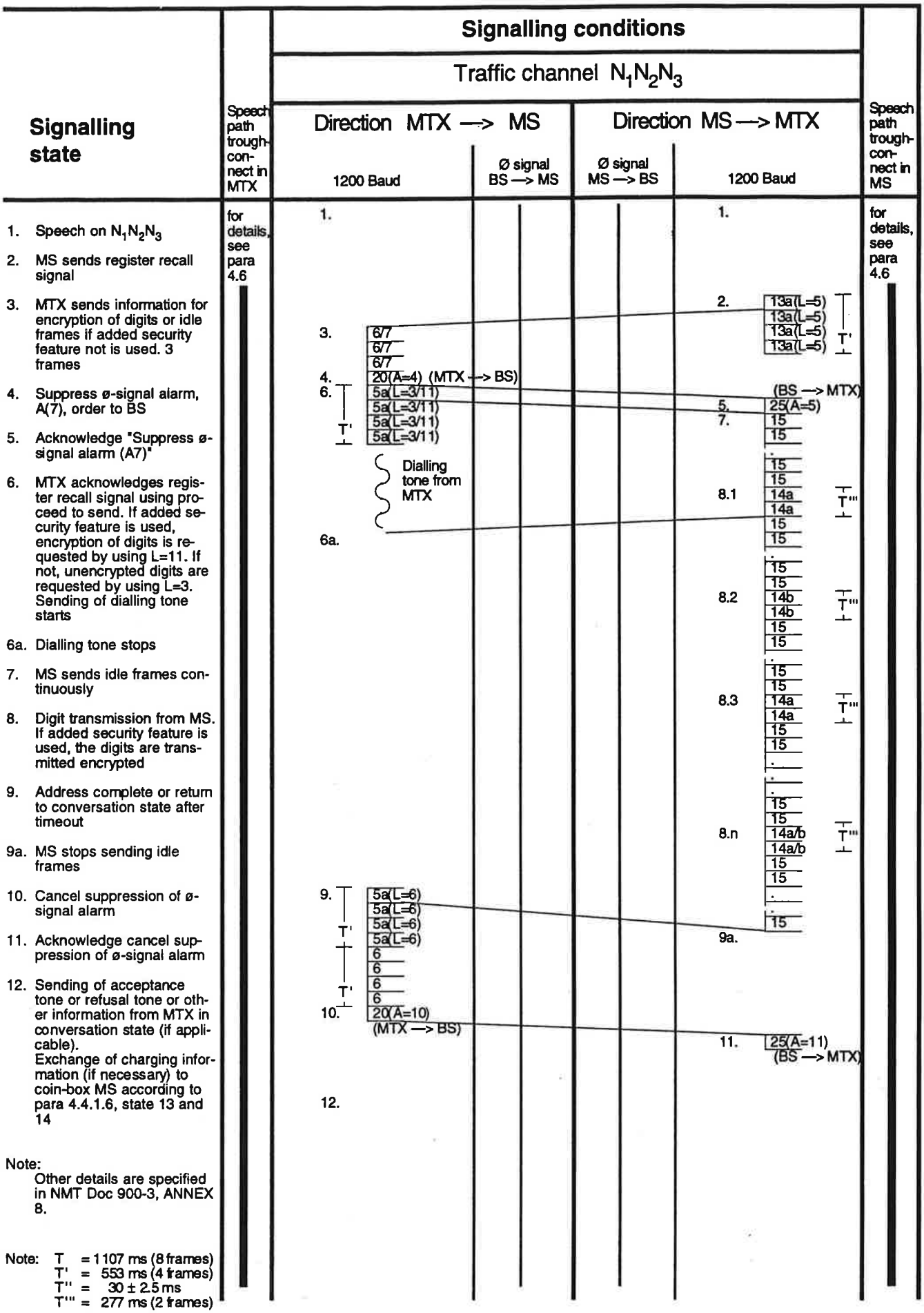


4.4.1.9.2 Automatic transmission, optional mode



4.4.1.10 Register recall procedures

4.4.1.10.1 Subscriber service by register recall and code sending from MS



4.4.1.10.1b Optional use of register recall function, automatic transmission of digits

Signalling state

1. Speech on $N_1N_2N_3$
2. MS sends register recall signal
3. MTX sends information for enchryption of digits or idle frames if added security feature not is used. 3 frames
4. Supress ø-signal alarm, A(7), order to BS
5. Acknowledge supress ø-signal alarm A(7)
6. MTX acknowledge register recall signal using proceed to send. If added security feature is used, enchryption of digits is requested by using L=11. If not, unenchrypted digits are requested by using L=3. Sending of dialling tone starts

6a. Dialling tone stops

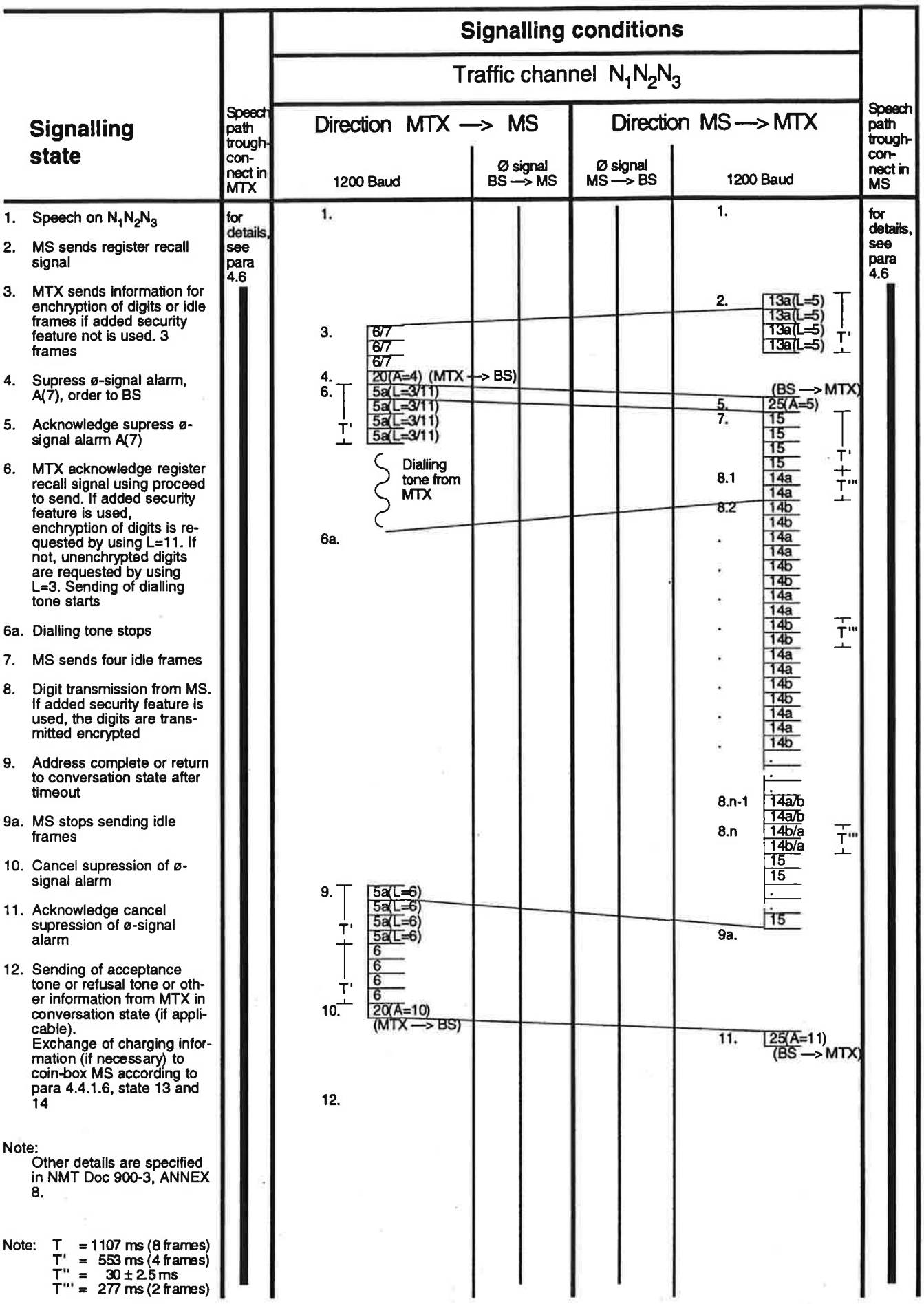
7. MS sends four idle frames
8. Digit transmission from MS. If added security feature is used, the digits are transmitted encrypted
9. Address complete or return to conversation state after timeout

9a. MS stops sending idle frames

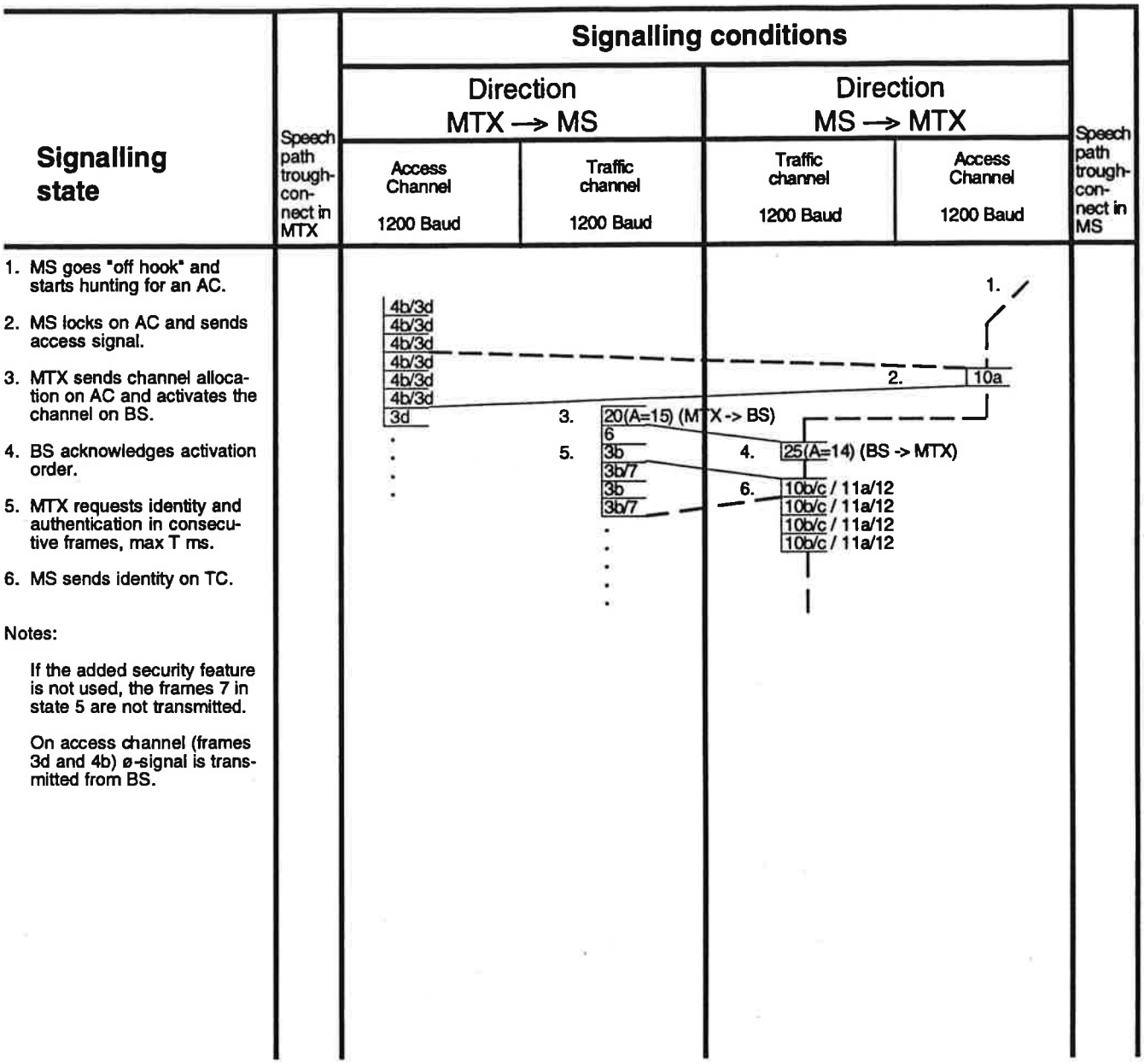
10. Cancel supression of ø-signal alarm
11. Acknowledge cancel supression of ø-signal alarm
12. Sending of acceptance tone or refusal tone or other information from MTX in conversation state (if applicable).
    Exchange of charging information (if necessary) to coin-box MS according to para 4.4.1.6, state 13 and 14

Note:
Other details are specified in NMT Doc 900-3, ANNEX 8.

Note: T = 1107 ms (8 frames)
T' = 553 ms (4 frames)
T'' = 30 ± 2.5 ms
T''' = 277 ms (2 frames)



4.4.1.11 Access on access channel



Note: T = 1107 ms (8 frames)
T' = 553 ms (4 frames)
T'' = 30 ± 2.5 ms
T''' = 277 ms (2 frames)

After signalling state 6 the procedure continues as after signalling state 5 in schemes A,D and "call coin-box" (paragraph 4.4.1.6) or after signalling state 9 in scheme B1.

In signalling state 3 identity request (frame 3b) may be sent. The scheme is then continued from signalling state 5 (access channel is used as traffic channel).

4.4.2 Signalling procedures between MTX and BS

4.4.2.1 Signalling on each channel

Signalling state	Signalling conditions	
	Direction MTX —> BS	Direction BS —> MTX
1. Start BS transmitter		
2. "Start transmitter" acknowledged from BS	1. 20 (A=15)	2. 25 (A=14) x)
3. Send ø-signal	3. 20 (A=3)	4. 25 (A=2) x)
4. "Start ø-signal" acknowledged from BS.	5. 20 (A=14)	6. 25 (A=6) x)
5. Start BS transmitter, send ø-signal	7. 20 (A=4)	8. 25 (A=5)
6. "Start BS transmitter, send ø-signal" acknowledged from BS.	9. 20 (A=10)	10. 25 (A=11)
7. Suppress ø-signal alarm (frame 25(A=7) from BS		11. 25 (A=7)
8. "Suppress ø-signal alarm" acknowledged from BS		12. 15 25 (A=8)
9. Cancel suppression ø-signal alarm in BS	13. 20 (A=12)	14. 25 (A=13)
10. "Cancel suppression ø-signal alarm in BS" acknowledged from BS.	15. 20 (A=0)	16. 25 (A=1) x)
11. Ø-signal alarm from BS (1:st limit)	17. 20 (A=2)	18. 25 (A=3) x)
12. Ø-signal alarm from BS (2:nd limit)	19. 20 (A=5)	
13. Stop sending of ø-signal		
14. "Stop ø-signal" acknowledged from BS		
15. "Idle radio channel"		
16. "Idle radio channel" acknowledged from BS		
17. General channel reset		
18. "General channel reset" acknowledged from BS		
19. Loop line in BS		

x) No reception of frame 25 within T' ms after frame 20 indicates BS or line fault.

Note: BS starts sending acknowledge within 62 ms after reception of frame 20.
Some of the signalling states described above are normally included in other signalling procedures.

4.4.2.2 Signal strength measurements
(On data channel, idle channel, free marked TC, or the TC actually in use)

Signalling state	Signalling conditions	
	Direction MTX —> BS	Direction BS —> MTX
1. Signal strength measurement order 2. BS starts sending measurement result within T''' after reception of 21 b/c	1. 21 b/c 21 b/c 21 b/c	2. 26 26 26

Note: T = 1107 ms (8 frames)
T' = 553 ms (4 frames)
T'' = 30 ± 2.5 ms
T''' = 277 ms (2 frames)

Note: Several measurements orders may be given in sequence, as indicated above.

4.4.2.3 BS management, maintenance and alarm

Signalling state	Signalling conditions	
	Direction MTX —> BS	Direction BS —> MTX
1. Alarm reset	1. 22 (V_1=1)	
2. "Alarm reset" acknowledged from BS		2. 27 (V_1=2)
3. SU/SR alarm reset	3. 22 (V_1=2)	
4. "SU/SR alarm reset" acknowledged from BS.		4. 27 (V_1=3)
5. Suppress RF receiver blocking alarm	5. 22 (V_1=3)	
6. "Suppress RF receiver blocking alarm" acknowledged from BS.		6. 27 (V_1=4)
7. Self test	7. 22 (V_1=4)	
8. "Self test" acknowledged from BS		8. 27 (V_1=5)
9. Self test completed		9. 27 (V_1=6) x)
10. Self test failed		or 10. 15 x) 28 (V_1=10,V_2=15,V_3=2)
11. RF test loop in	11. 22 (V_1=6)	
12. "RF test loop in" acknowledged from BS		12. 27 (V_1=7)
13. RF test loop out	13. 22 (V_1=9)	
14. "RF test loop out" acknowledged from BS		14. 27 (V_1=10)
15. BS-alarm		15. 15 xx) 28

Note: T = 1107 ms (8 frames)
T' = 553 ms (4 frames)
T'' = 30 ± 2.5 ms
T''' = 277 ms (2 frames)

Note: BS starts sending acknowledge within 62 ms after reception of frame 20.

x) In the "Self test" BS sends the result (state 9 or 10) within 5 sec.

xx) Frame 15 is sent for synchronization purposes

4.5 SUPERVISORY SIGNAL BS — MS — BS

As supervisory signal (ø-signal) on the radio path, a tone is used. The frequency of this tone is selected among four possible frequencies (3955, 3985, 4015 and 4045 Hz) in such a way that it differs to two nearby base stations having the same radio frequencies. The signal is inserted into the speech channel at the base station upon reception of a command from the MTX. In the mobile station, the ø-signal is separated from the speech signal and re-inserted into the speech channel in the direction towards the base station, where it is filtered out and evaluated. The level of the signal is such that a peak deviation of 300 Hz is obtained in both directions.

The evaluation of the ø-signal at the base station is performed on the basis of the signal-to-noise ratio (S/N) for the supervisory tone within its frequency band and on the basis of time.

The information forwarded to MTX is one out of the 2 possible messages below.

a) Received ø-signal below 1:st limit but not below 2:nd limit

b) Received ø-signal below 2:nd limit

The two messages are also called "ø-signal alarms". Message a) starts signal strength measurement procedure and message b) starts clearing procedure.

The signal strength measurement alarms, which are performed on each channel at the BS, are transmitted to the MTX in the same way.

Optional signal strength measurement alarms, which are performed at each channel at the BS, are transmitted to the MTX in the same way.

4.6 1200 BAUD SIGNALLING EQUIPMENT

For the exchange of message between MTX, BS and MS binary signalling is used. Modulation method is baseband 1200 BAUD FFSK within the speech channel. The necessary equipment at MTX has the following function blocks (fig.4.6.1): encoder, modulator, equalizer, demodulator and decoder. The BS and MS have the same equipment functionally as the MTX except for the equalizer.

The various blocks are specified below. During conversation state, the 1200 bit/s signalling may be used for end to end user data transfer as specified in Doc 900-3, ANNEX 21.

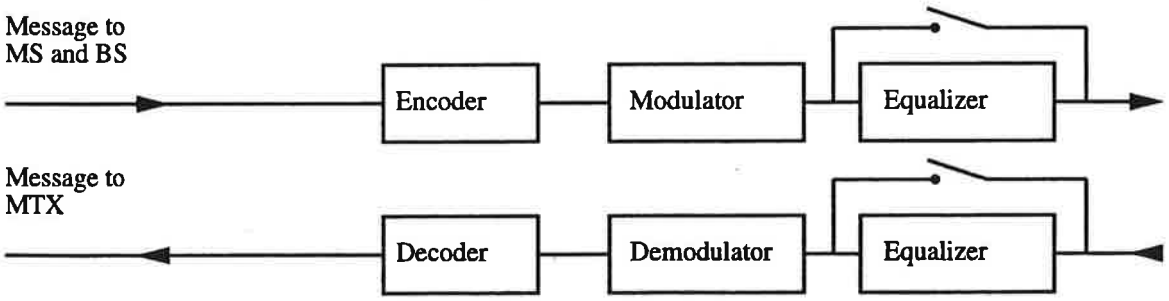


Fig. 4.6.1 Functional block diagram of the 1200 Baud signalling equipment at MTX

4.6.1 Reference data transmitter and receiver

The reference data transmitter and receiver fulfil the error rate performance in para 4.6.7. In the frequency band 600-2400 Hz the group delay distortion is less than 100 µs and the shape of the spectrum of the transmitted signal deviates from the theoretical by less than 1 dB.

4.6.2 Encoder

In order to combat errors on the radio path due to fading and interference, an error-correcting code is used. The errors appear in bursts and therefore the chosen code is burst error correcting. The type of code is convolutional. The correcting capability of the code is 6 bits when there are at least 19 "errorfree" bits between the bursts. The encoder output bits Y_i are obtained from the encoder input bits X_i according to the following formulas.

$$Y_{2i-1} = \left\{ \begin{array}{ll} \overline{X_i} & \text{for } i = 1 \text{ to } 3 \\ \overline{X_i \oplus X_{i-3}} & \text{for } i = 4 \text{ to } 64 \\ \overline{X_{i-3}} & \text{for } i = 65 \text{ to } 67 \\ 1 & \text{for } i = 68 \text{ to } 70 \end{array} \right\} \text{ parity check bits}$$

$$Y_{2i} = \left\{ \begin{array}{ll} 0 & \text{for } i = 1 \text{ to } 6 \\ X_{i-6} & \text{for } i = 7 \text{ to } 70 \end{array} \right\} \quad \text{information bits}$$

⊕ denotes addition modulo-2. Thus for every information bit two output bits are obtained, one delayed information bit and one parity check bit. The length of the encoded message is 140 bits.

The messages are transmitted in frames which consists of three parts (fig.4.6.2): bit synchronization (15 bits), frame synchronization (11 bits) and the encoded message (140 bits). The first sync bit of the second frame starts at the first bit position after the end of the previous frame i.e. the bit stream is transmitted continuously.

bit sync.	frame sync.	encoded message
15 bits	11 bits	140 bits
101010101010101	11100010010	

Fig. 4.6.2 Frame disposition

The bits in a frame are transmitted in the order from left to right.
The bit pattern for the bit synchronization is 101010101010101 and for the frame synchronization 11100010010.

The bit sequences for bit and frame synchronization are intended to facilitate initial synchronization. During a transmission consisting of several frames the encoded messages contain enough information to check whether synchronization is maintained also when the specific frame synchronization sequence has been lost due to transmission errors.

To illustrate the encoding procedure an example is given.

Frame number 1a Free calling channel indication.

$N_1N_2N_3$ P(12) Y_1Y_2 $H_1H_2H_3H_4H_5H_6H_7H_8H_9H_{10}$

N_1= 1 representing binary	0001
N_2= 3	0011
N_3= 5	0101
P(12)= 12	1100
Y_1 = 6	0110
Y_2 = 4	0100
H_1-H_{10} = 0	0000

$X = X_1, X_2, X_3, X_4, X_5, X_6, X_7, \ldots\ldots\ldots X_{63}, X_{64}$

= 0001001101011100 00

According to the formulas above the encoded message will be

$Y = Y_1, Y_2, Y_3, \ldots\ldots\ldots\ldots Y_{140}$

Y_1	= 1;	Y_2	= 0;	Y_{11}	= 1;	Y_{12}	= 0
Y_3	= 1;	Y_4	= 0;	Y_{13}	= 1;	Y_{14}	= 0
Y_5	= 1;	Y_6	= 0;	Y_{15}	= 0;	Y_{16}	= 0
Y_7	= 0;	Y_8	= 0;	Y_{17}	= 1;	Y_{18}	= 0
Y_9	= 1;	Y_{10}	= 0;	Y_{19}	= 1;	Y_{20}	= 1
Y_{133}	= 1;	Y_{134}	= 0;	Y_{137}	= 1;	Y_{138}	= 0
Y_{135}	= 1;	Y_{136}	= 0;	Y_{139}	= 1;	Y_{140}	= 0

The bits in the full frame 1.a are thus
10101010101010111110001001010101000101010001011 10101010

4.6.3 Modulator

The modulation rate is 1200 ± 0,1 Baud. The modulation method is FFSK with the tone frequencies 1200 Hz and 1800 Hz for the logical "one" and "zero" respectively. The bit frequency and the modulation tone frequencies shall be derived from the same source. The shift from one frequency to the other shall be continuous in phase. The line diagram for the signal from the modulator shall thus be as shown in the figure 4.6.3.

The level from the modulator in the MTX including transmitting filters if so equipped is : 13 ± 0.25 dBm0. The output level of the modulator in the BS is -10 ± 1.5 dBm0. The performance requirement of the modulator including transmitting filter, expressed as maximum increase at required S/N ratio for an error rate of 10^{-4} measured with a reference receiver is 0.5 dB compared with a reference data transmitter.

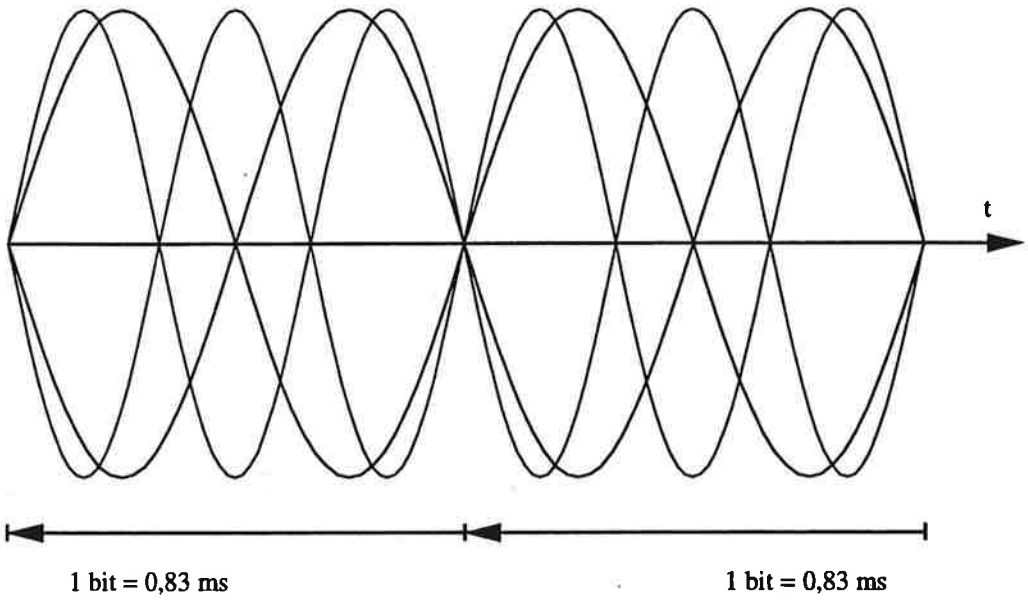


Fig. 4.6.3 Line diagram for the FFSK signal

4.6.4 Transmitting filter

The spectrum S(F) of the signal from the modulator as a function of the frequency is shown in figure 4.6.4 below. Above 3400 Hz the total power shall be below -30 dB relative to the power of the transmitted data signal. A transmitting filter may be used for reduction of spectrum components outside the necessary band (600-2400Hz).

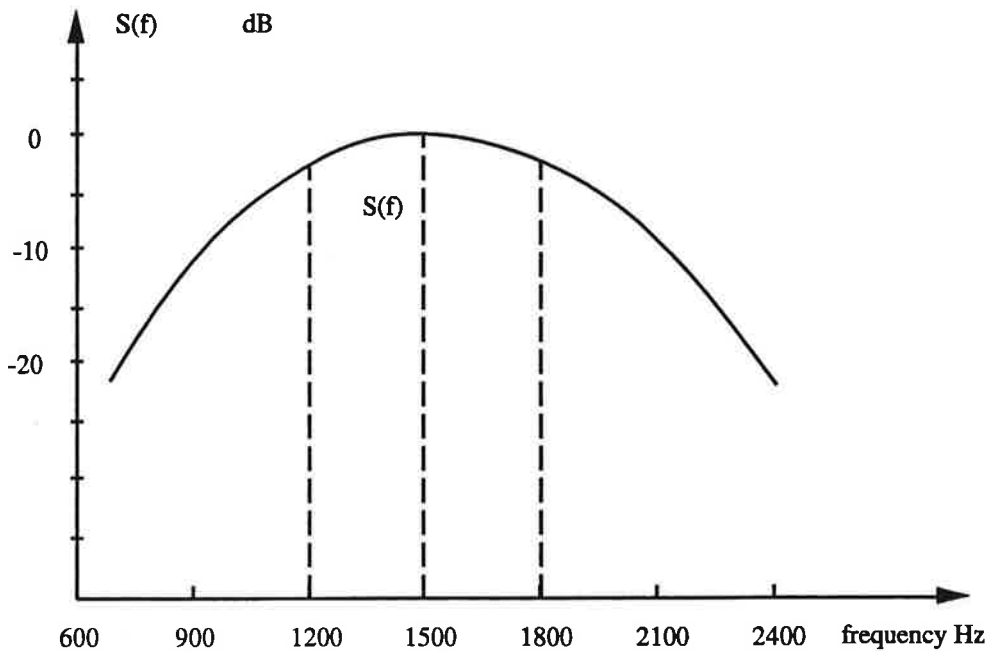


Fig. 4.6.4 Spectrum S(f) of the FFSK signal

4.6.5 Equalizer

The path between the MTX and the BS consists normally of one or more links in carrier systems and/or a physical line. To decrease the problems created by group delay distortion on this path equalizers are necessary. The equipment at the MTX therefore includes a "plug in" standard equalizer with a characteristic as shown in the figure 4.6.5 ±100 µs. Such an equalizer is foreseen in both the transmitting path and receiving path of the MTX.

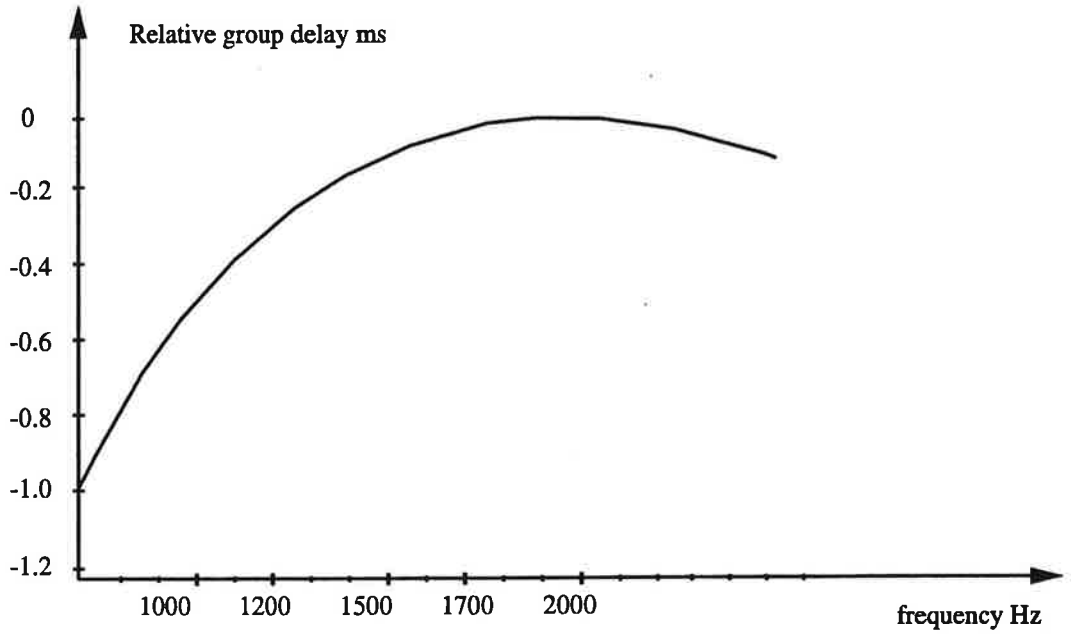


Fig. 4.6.5 Relative group delay of equalizer

4.6.6 Receiving filter

In order to improve the signal to noise ratio before demodulation a receiving filter may be required. This filter shall be designed in such a way that the requirements in para 4.6.7. are met.

4.6.7 Demodulator and signal level detector

The performance requirements of the signal receiving equipment when connected to a reference data transmitter is that the error rate shall be lower or equal to what is indicated by the curve in fig. 4.6.7. This requirement shall also be fulfilled for a shift ±5 Hz of the frequencies (due to frequency errors in carrier frequency systems) for logical "one" and "zero" for MTX input signal levels in the range

-10^{+3}_{-6} dBm0. For BS the input signal level is -13^{+3}_{-6} dBm0

The modems in BS and MTX shall be equipped with a signal level detector. The function of this detector is to prevent the decoder from reacting upon signals below a level of -34 ± 3 dBm0. The detector shall permit decoding and the modem shall operate if FFSK modulated signals above the threshold level are detected. The error rate may be higher than specified in fig. 4.6.7 if the received level is outside the levels specified in the first paragraph.

The call probability shall be at least 95 % at a SINAD rate of 20 dB (FFSK signalling and gaussian noise), tested on the line input to the MTX. A complete scheme B, call MTX to MS, shall be used. The test shall be verified by using a radio receiver with a sensitivity of -2 dB (1 µV) E.M.F.

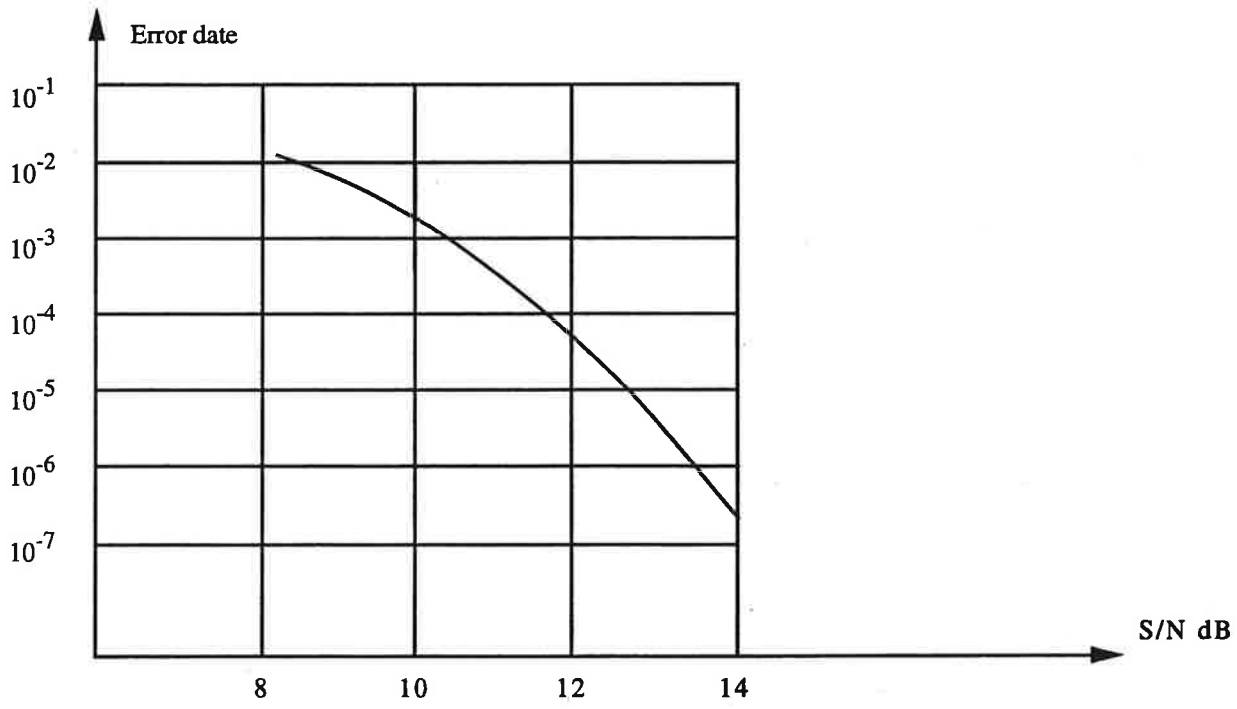


Fig. 4.6.7 Error rate versus signal to noise ratio at input from line (S/N) measured in bit rate bandwidth (1200 Hz) for noise with an even distribution at least from 300 to 3400 Hz.

4.6.8 Decoder and splitting

After reception of frame synchronization the bit stream is functionally divided into one stream containing information bits and another containing parity check bits. "New" parity check bits are calculated from the information bits and compared with the received parity check bits. Errors, if any, are localized and corrected in accordance with the capability of the code.

After reception of frame synchronization before any error correction it is checked whether the subsequent six information bits all have the value 0.

- If so in the MTX the line to the telephone network is splitted within 10-20 ms. The reconnection time in the MTX shall be 160 ±10ms after the last frame sync.

- If so in the MS the audio output is muted. Reconnection of the audio path is delayed (160 ms) after reception of the last framesync.

  In the BS no splitting takes place in the direction MTX —> BS —> MS.

The decoding continues even if the six first information bits differ from the value 0.

4.6.9 Muting of speech path

When the 1200 Baud signalling equipment in the MTX is sending, or a dialling tone is sent from the MTX, the audio signal through the MTX towards the BS is muted.

In the MS the audio path is muted towards the MTX when the MS modem is sending.

In the BS the radio receiver is muted towards the MTX when the BS is signalling to the MTX.

4.7 ACCEPTANCE OF SIGNALS

This paragraph describes how the analysis of received frames is to be carried out in the MTX, BS and MS and how they shall behave upon receiving frames containing errors.

The analysis is constructed to draw use of the redundancy in the signalling schemes and the structure of the frames.

The requirements concerning detection of 1200 baud signalling and where the signalling information starts, are specified in detail in paragraph 4.6. Paragraph 4.6 also specifies the requirements set to reception of frame synchronization.

4.7.1 False frame synchronization

Any number of false frame synchronization words within a frame shall be handled. The occurrence of false frame synchronization words shall not cause frames to be lost.

However there exist a minor possibility that decoding of a frame after synchronization to a false synchronization word, will produce meaningful information. In such situations the above stated requirement need not to be fulfilled.

4.7.2 Mobile in standby condition

Before locking to a channel the MS checks that $N_1N_2N_3$ P Y_1Y_2 of the received frame 1a/1a'/1a"/1b is correctly received. Frames 2a to 2f are accepted as frames 1a/1a'/1a"/1b according to the acceptance criteria below, when identity Z $X_1X_2X_3X_4X_5X_6$ does not match with the own identity of the MS. The criteria to continue to be locked at the channel is that $N_1N_2N_3$ P Y_1Y_2 is received regularly. However, two frames can be lost between two correct frames.

On the calling channel, the MS is primarily looking for the identity match in Z $X_1X_2X_3X_4X_5X_6$ (i.e. a call to the MS).

In standby condition the MS shall also decode the additional information $H_1H_2...H_{10}$ if H_1 = 0 or H_1 = 14. The additional information concerning channel band information need not be checked continuously. The check must be made at least once a minute and when the channel is changed.

The received new information shall be memorised. New information is accepted, if it has been received twice. Between these two frames there may be other frames which do not contain same type of information.

4.7.3 Acceptance of signals after entering a particular signalling scheme

Generally, frames that cannot be interpreted by the logic, shall be ignored. This applies also to frames that have no meaning in an actual signalling sequence.

A frame consists of 140 bits in the encoded message. However, on CC from MS/BS to MTX also a shortened frame consisting of at least 114 bits exists. A decision on the frame content shall be taken as soon sufficient information is available.

In signalling sequences where identical frames are known to be repeated a number of times, the MTX and MS shall act upon the first of them that can be interpreted by the logic. That is, the MTX and MS shall not confirm the received signal by checking further frames.

The prefix shall always be correctly received in order to accept a frame.

The following paragraphs specifies the additional acceptance requirements for each frame used in the different signalling schemes

4.7.4 Acceptance of frames received by MS from MTX

4.7.4.1 Frame 1a

$N_1N_2N_3P(11/12/13)Y_1Y_2H_1H_2H_3H_4H_5H_6H_7H_8H_9H_{10}$

The criteria for locking to a calling channel are stated in para 4.7.2. The additional information $H_1.....H_{10}$ is accepted if the content is meaningful according to para 4.3.3.13 and 4.3.3.14.

4.7.4.2 Frame 1b

$N_1N_2N_3P(4)Y_1Y_2H_1H_2H_3H_4H_5H_6H_7H_8H_9H_{10}$

The frame is accepted as a free-marked traffic channel if prefix and Y_1Y_2 are correctly received, and $H_8H_9H_{10}$ is one of the following fictitious channel numbers 0, 1011, 1012, 1013 or 1014.

4.7.4.3 Frame 2a

$N_1N_2N_3P(11/12/13)Y_1Y_2ZX_1X_2X_3X_4X_5X_6H_8H_9H_{10}$

The frame is accepted if prefix and identity $ZX_1...X_6$ are correct, and $H_8H_9H_{10}$ is one of the following fictitious channel numbers 0, 1011, 1012, 1013 or 1014.

4.7.4.4 Frame 2b

$N_1N_2N_3P(11/12/13)Y_1Y_2ZX_1X_2X_3X_4X_5X_6N_aN_bN_c$

The frame is accepted if prefix and identity $ZX_1...X_6$ are correctly received and $N_aN_bN_c$ is a valid channel number.

4.7.4.5 Frame 2c

$N_1N_2N_3P(11/12/13)Y_1Y_2ZX_1X_2X_3X_4X_5X_6H_8H_9H_{10}$

The frame is accepted if prefix and identity $ZX_1...X_6$ are correctly received and $H_8H_9H_{10}$ is equal to (fictitious) channel number 1009.

4.7.4.6 Frame 2d

$N_1N_2N_3P(11/12/13)Y_1Y_2ZX_1X_2X_3X_4X_5X_6H_8H_9H_{10}$

The frame is accepted if prefix and identity $ZX_1...X_6$ are correctly received and $H_8H_9H_{10}$ is equal to (fictitious) channel number 1010.

4.7.4.7 Frame 2e

$N_1N_2N_3P(4)Y_1Y_2ZX_1X_2X_3X_4X_5X_6H_8H_9H_{10}$

See para 4.7.4.3 (frame 2a)

4.7.4.8 Frame 2f

$N_1N_2N_3P(11/12/13)Y_1Y_2ZX_1X_2X_3X_4X_5X_6H_8H_9H_{10}$

The frame is accepted if prefix and identity $ZX_1...X_6$ are correctly received and $H_8H_9H_{10}$ is equal to (fictitious) channel number 1008.

4.7.4.9 Frame 3a

$N_1N_2N_3P(5)Y_1Y_2ZX_1X_2X_3X_4X_5X_6N_aN_bN_c$

See para 4.7.4.4 (frame 2b)

4.7.4.10 Frame 3b

$N_1N_2N_3P(5)Y_1Y_2ZX_1X_2X_3X_4X_5X_6H_8H_9H_{10}$

See para 4.7.4.3 (frame 2a)

4.7.4.11 Frame 3c

$N_1'N_2'N_3'$ P(9) Y_1Y_2 $Z\ X_1X_2X_3X_4X_5X_6$ $N_aN_bN_c$

The frame is accepted if prefix and identity $Z\ X_1...\ X_6$ are correctly received, and channel number in $N_aN_bN_c$ and $N_1'N_2'N_3'$ together with the first bit in Y_1 are equal.

4.7.4.12 Frame 3d

$N_1N_2N_3$ P(7) Y_1Y_2 $Z\ X_1X_2X_3X_4X_5X_6$ $N_aN_bN_c$

See para 4.7.4.4 (frame 2b). The frame is accepted as access channel indication if $Z\ X_1X_2X_3X_4X_5X_6$ does not match with the own identity of the MS.

See para 4.7.4.4 (frame 2b)

4.7.4.13 Frame 4

$N_1N_2N_3P(3)Y_1Y_2JJJJJJJH_8H_9H_{10}$

See para 4.7.4.2 (frame 1b)

4.7.4.14 Frame 4b

$N_1N_2N_3P(7)Y_1Y_2JJJJJJJH_8H_9H_{10}$

The frame is accepted if prefix and Y_1Y_2 are correctly received and $H_8H_9H_{10}$ is one of the following fictitious channel numbers 0, 1011, 1012, 1013 or 1014.

4.7.4.15 Frame 5a

$N_1N_2N_3P(6)Y_1Y_2ZX_1X_2X_3X_4X_5X_6L(n)L(n)L(n)$

The frame is accepted if prefix and identity $ZX_1...X_6$ are correctly received and at least two of the three characters L(n) are equal and meaningful.

4.7.4.16 Frame 5b

$N_1N_2N_3P(6)Y_1Y_2ZX_1X_2X_3X_4X_5X_6L(0)Q_1Q_2$

The frame is accepted if prefix, identity $ZX_1...X_6$ and L(0) are correctly received.

4.7.4.17 Frame 7

$N_1N_2N_3P(8)Y_1Y_2C_1C_2C_3C_4C_5C_6C_7JJJ.$

The frame is accepted if prefix, channel number, Y_1Y_2 and JJJ are correctly received. In register recall procedures, frame 7 shall be accepted independant of the received area code Y_2, but Y_1 has to be correctly received.

4.7.5 Acceptance of frames received by MTX from MS

4.7.5.1 Frame 10a

$N_1N_2N_3P(1)ZX_1X_2X_3X_4X_5X_6T(JJJJ)$

The frame is accepted if prefix, identity $ZX_1...X_6$ and T are correctly received. As a seizure frame on access channel parameter values t_1t_2=00 (binary) in T are always considered to be correct.

4.7.5.2 Frame 10b

$N_1N_2N_3P(1)ZX_1X_2X_3X_4X_5X_6TY_2K_1K_2K_3$

a) As seizure signal the frame is accepted if $N_1N_2N_3$, prefix, identity $ZX_1...X_6$ and TY_2 are correctly received.

b) As a response to identity request the frame is accepted if prefix, identity and $K_1K_2K_3$ are correctly received.

4.7.5.3 Frame 10c

$N_1N_2N_3P(6)ZX_1X_2X_3X_4X_5X_6TY_2K_1K_2K_3$

See para 4.7.5.2a (frame 10b)

4.7.5.4 Frame 10d

$N_1N_2N_3P(10)ZX_1X_2X_3X_4X_5X_6T(JJJJ)$

See para 4.7.5.1 (frame 10a)

4.7.5.5 Frame 11a

$N_1N_2N_3P(14)ZX_1X_2X_3X_4X_5X_6TY_2K_1K_2K_3$

See para 4.7.5.2 (frame 10b)

4.7.5.6 Frame 11b

$N_1N_2N_3$ P(15) $Z\ X_1X_2X_3X_4X_5X_6$ T J(JJJ)

See para 4.7.5.1 (frame 10a)

4.7.5.7 Frame 12

$N_1N_2N_3P(11)ZX_1X_2X_3X_4X_5X_6TY_2K_1K_2K_3$

See para 4.7.5.2 (frame 10b)

4.7.5.8 Frame 13a

$N_1N_2N_3P(8)ZX_1X_2X_3X_4X_5X_6L(n)L(n)L(n)L(n)L(n)$

The frame is accepted if prefix, identity $ZX_1...X_6$ are correctly received and at least three of the characters L(n) are equal and meaningful.

4.7.5.9 Frame 13b

$N_1N_2N_3P(8)ZX_1X_2X_3X_4X_5X_6L(2)L(2)L(2)Q_1Q_2$

The frame is accepted if prefix, identity $ZX_1...X_6$ are correctly received and two of the three L(2) are equal to 2. Q_1Q_2 must be identical to the values transmitted to the MS.

4.7.5.10 Frames 14a and 14b

$N_1N_2N_3P(7)ZX_1X_2X_3X_4X_5X_6S(0/15)S(0/15)S(n)S(n)S(n)$

The frame is accepted if the following conditions are satisfied:

a) Prefix is correctly received
b) $N_1N_2N_3$

or

$ZX_1X_2X_3X_4X_5X_6$

or

six out of the ten characters $N_1N_2N_3ZX_1X_2X_3X_4X_5X_6$ are correctly received.

c) S(0)S(0) (orS(15)S(15)) are correctly received

d) S(n)S(n)S(n) are equal

Further a new digit frame is only accepted when S(0)S(0)/S(15)S(15) have changed relative to the previous digit. The first digit to be accepted shall contain S(0)S(0).

4.7.5.11 Frame 16

$N_1N_2N_3$ P(12) $R_1R_2R_3R_4R_1R_2R_3R_4R_1R_2R_3R_4$

The frame is accepted if prefix is correct and two of the three $R_1R_2R_3R_4$-groups are equal and correctly received.

4.7.6 Acceptance of frames received by BS from MTX

4.7.6.1 Frame 20

$N_1N_2N_3$	P(15)	Y_1Y_2	Z(15)	JJJ	A(0,1,2,4-13)	JJJJJ
$N_1N_2N_3$	P(15)	Y_1Y_2	Z(15)	JJJ	A(3)	$f_Ø f_Ø f_Ø f_Ø f_Ø$
$N_1N_2N_3$	P(15)	Y_1Y_2	Z(15)	JJJ	A(14)	$I_L I_L I_H f_Ø f_Ø$
$N_1N_2N_3$	P(15)	Y_1Y_2	Z(15)	JJJ	A(15)	$I_L I_L I_H$JJ

or [OPTIONAL] for A is 3 or 14

$N_1N_2N_3$	P(15)	Y_1Y_2	Z(15)	JJJ	A(3)	J $F_1F_2F_1F_2$
$N_1N_2N_3$	P(15)	Y_1Y_2	Z(15)	JJJ	A(14)	$I_L I_L I_H F_1F_2$

The frame is accepted if prefix and Z(15) JJJ are correctly received.
$f_Ø$ is valid if A is 3 or 14 and the last two $f_Ø$ are equal and meaningful.
I_L is valid if A is 14 or 15 and if the two I_L are equal and meaningful.
I_H is valid if A is 14 or 15 and if the I_H is meaningful.
F_1F_2 [OPTIONAL] is valid if A is 3 or 14 and the last F_1F_2 is meaningful.

4.7.6.2 Frame 21b

$N_1N_2N_3$	P(3)	Y_1Y_2	Z(15)	JJJ	V(15)	J $f_Ø$	$N_aN_bN_c$

or [OPTIONAL]

$N_1N_2N_3$	P(3)	Y_1Y_2	Z(15)	JJJ	V(15)	F_1F_2	$N_aN_bN_c$

The frame is accepted if prefix, Z(15) JJJ and V(15) are correctly received. $f_Ø$ or F_1F_2 is valid if $f_Ø$ or F_1F_2 is meaningful.

4.7.6.3 Frame 21c

$N_1N_2N_3$	P(5)	Y_1Y_2	Z(15)	JJJ	V(15)	J $f_Ø$	$N_aN_bN_c$

or [OPTIONAL]

$N_1N_2N_3$	P(5)	Y_1Y_2	Z(15)	JJJ	V(15)	F_1F_2	$N_aN_bN_c$

The frame is accepted if prefix, Z(15) JJJ and V(15) are correctly received. $f_Ø$ or F_1F_2 [OPTIONAL] is valid if $f_Ø$ or F_1F_2 is meaningful.

4.7.6.4 Frame 22

$N_1N_2N_3$	P(14)	Y_1Y_2	Z(15)	JJJ	$V_1V_2V_3V_4V_5V_6$

The frame is accepted if P(14) and Z(15) JJJ are correctly received.

4.7.6.5 Frames 1, 2, 3d and 4

The frames are accepted if $N_1N_2N_3$ and prefix P(11), P(12), P(13), P(4), P(3) or P(7) respectively are correctly received.

4.7.7 Acceptance of frames received by MTX from BS

$N_1=N_2=N_3=0$ (empty channel register) shall be accepted as correct information in the frames below.

4.7.7.1 Frame 25

$N_1N_2N_3$	P(9)	Z(15)	JJ	A(2,6)	JJJ	$f_{\emptyset}I_HI_L$	JJ	
$N_1N_2N_3$	P(9)	Z(15)	JJ	A(14)	JJJ	JI_HI_L	JJ	
$N_1N_2N_3$	P(9)	Z(15)	JJ	A(0,1, 3-5,7-13,15)	JJJ	JJJ	JJ	

or [OPTIONAL] for A = 2,6 and 7,8

$N_1N_2N_3$	P(9)	Z(15)	JJ	A(2,6)	JJ	$F_1F_2I_HI_L$	JJ
$N_1N_2N_3$	P(9)	Z(15)	JJ	A(7,8)	JJJ	CCC	JJ

The frame is accepted if $N_1N_2N_3$, prefix, Z(15) and A(n) are correctly received. When A is 2 or 6 also $f_{\emptyset}/F_1F_2$, I_H and I_L must be correctly received. When A is 14 also I_H and I_L must be correctly received. When [OPTIONAL] A is 7 or 8 also at least two out of three values of C must be equal.

4.7.7.2 Frame 26

$N_1N_2N_3$ P(2) Z(15) J $f_{\emptyset}$ $N_aN_bN_c$ $R(n_1)R(n_2)R(n_1)R(n_2)R(n_1)R(n_2)$

or [OPTIONAL]

$N_1N_2N_3$ P(2) Z(15) F_1F_2 $N_aN_bN_c$ $R(n_1)R(n_2)R(n_1)R(n_2)R(n_1)R(n_2)$

The frame is accepted if $N_1N_2N_3$, prefix, Z(15), $f_{\emptyset}/F_1F_2$ and $N_aN_bN_c$ are correctly received, and two out of the three pairs of $R(n_1)R(n_2)$ are identical. Measurement is valid if $f_{\emptyset}/F_1F_2$ is the same as sent in frame 21 or if $f_{\emptyset}/F_1F_2$ = 0/00.

4.7.7.3 Frame 27

$N_1N_2N_3$P(4)Z(15)JJV$_1$V$_2$V$_3$V$_4$ JJJJJ

The frame is accepted if $N_1N_2N_3$, prefix and Z(15) are correctly received.

4.7.7.4 Frame 28

$N_1N_2N_3$ P(13) Z(15) JJ $V_1V_2V_3V_4$ JJJJJ

The frame is accepted if $N_1N_2N_3$, prefix and Z(15) are correctly received, and $V_1V_2V_3$ is one of the combinations listed in paragraph 4.3.3.9, starting from V_1(10) V_2(15) V_3(0) and ending to V_1(10) V_2(8) V_3(15). V4 shall not be included in the acceptance criteria.

4.7.8 Acceptance criteria on a handover request channel (HC) [OPTIONAL]

The BS shall not accept frames specified for signalling between BS and SSE (frames 50, 51, 52, 54 and 55) if they are received at HC/HC's which are connected directly to the MTX.

4.7.8.1 Acceptance criteria of frames received by BS from MTX.

Frame 46 is accepted if the following conditions are fulfilled:

- $B_1B_2B_3$ and P(2) are correctly received.
- two out of three "C" cause shall be equal and correspond to the cause value in the handover request alarm which was sent up to 240±5 ms earlier.
- TCno shall correspond with the TCno in the handover request alarm which was sent up to 240±5 ms earlier.
- status A(7) is correctly received

Frame 20 is accepted if prefix, Z(15) and A(0, 2 or 5) are correctly received.

Frame 22 is accepted if prefix, Z(15) and V_1(1 or 4) are correctly received.

4.7.8.2 Acceptance criteria of frames received by BS from SSE.

Frame 51 is accepted if $B_1B_2B_3$ and P(1) are correctly received and the value of U_1U_2 is valid. The acceptance criteria of the activation information is specified in NMT Doc 900-1 paragraph 4.7.6.1.

Frame 55 is accepted if $B_1B_2B_3$ and P(8) are correctly received. The Check information is valid if two of three C_h is equal and valid. The acknowledge is valid if the check information, C_h, is the same as in the frame 54 which was sent up to 240±5.0 ms earlier.

Frame 46 is accepted if the following conditions are fulfilled:

- $B_1B_2B_3$ and P(2) are correctly received.
- two out of three "C" cause shall be equal and correspond to the cause value in the handover request alarm which was sent up to 240±5 ms earlier.

- TCno shall correspond with the TCno in the handover request alarm which was sent up to 240±5 ms earlier.

- status A(7,8) is correctly received

4.7.8.3 Acceptance criteria of frames received by SSE from BS

Frame 28 is accepted if $B_1B_2B_3$ and P(13) are correctly received.

Frame 41 is accepted if $B_1B_2B_3$ and P(3) are correctly received and A is 7.

Frame 50 is accepted if $B_1B_2B_3$ and P(12) are correctly received and the value of U_1U_2 is valid.

Frame 52 is accepted if $B_1B_2B_3$ and P(6) are correctly received and the value of U_1U_2 is valid.

Frame 54 is accepted if $B_1B_2B_3$ and P(15) are correctly received. The check information is valid if two or three C_h is equal and valid.

4.7.8.4 Acceptance criteria of frames received by SSE from MTX

Frame 47 is accepted if $B_1B_2B_3$ and P(3) are correctly received. The acknowledge is valid if the information in the frame corresponds with the handover offer message (frame 42 or 42b) which was sent up to 240±5.0 ms earlier.

The acceptance criteria of frame 20 and 22 are specified in paragraph 4.7.8.1.

4.7.8.5 Acceptance criteria of frames received by MTX from BS/SSE

Frame 41 is accepted if $B_1B_2B_3$ and P(3) are correctly received. The procedure is performed if $N_aN_bN_c$ is used on the actual base station and if A is 7 or 8. C is used if two of three C are meaningful, else C=0 is used.

Frame 42 is accepted if $B_1B_2B_3$ and P(5) are correctly received and JJJJ is equal to 000X. G is accepted if both G are equal and meaningful. If not, G=0 is used. F_1F_2 is used if it is meaningful.

Frame 42b is accepted if $B_1B_2B_3$ and P(5) are correctly received and actual BS ($B_aB_bB_c$)is not 000. (The three last positions are ignored). G is accepted if both G are equal and meaningful. If not, G=0 is used. The procedure is performed if the combination of $B_aB_bB_c$ and $N_aN_bN_c$ is meaningful. Else the message is ignored.