RECOMMENDATION ITU-R M.1222

TRANSMISSION OF DATA MESSAGES ON SHARED PRIVATE LAND MOBILE RADIO CHANNELS

(Question ITU-R 213/8)

(1997)

Summary

This Recommendation provides descriptions of channel occupation and access procedures for the transmission of data messages on different categories of private land mobile radio channels. This Recommendation has been developed to standardize the data transmission procedures for users who share an analogue radio channel in order to minimize interference to other users who also operate on the channel.

The ITU Radiocommunication Assembly,

considering

a) that the transmission of information in a data format can significantly improve the communications efficiency for an operator;

b) that transmitting messages in data format can considerably improve the spectral efficiency of a channel;

c) that the use of data transmission to convey messages such as vehicle status and identification is becoming essential for fleet management;

d) that studies have shown that interference to speech users is minimized by regulating channel access for data transmission on speech channels by only permitting manually initiated channel access procedures and by restricting the length of the message;

e) that automatic channel access protocols are required for the transmission of data messages on speech channels by non-related systems in order to minimize interference to voice users;

f) that operators who primarily only use data messaging may wish to transmit longer messages;

g) that automatic channel access protocols are required on data only shared channels in order to minimize interference to other channel users,

recommends

1 for data transmission on two frequency simplex analogue speech dominant channels:

1.1 that for the transmission of data messages on a speech channel both mobiles and base stations should use the channel access protocols defined in Annex 1;

1.2 that the maximum channel occupancy of a single data message should be 650 ms, or 1 000 ms for systems operating with audio squelch control circuitry, e.g. continuous tone controlled signalling system (CTCSS), digitally coded squelch (DCS), selective tone signalling, etc.;

1.3 that only manual initiation of channel access procedures should be permitted in order to prevent automatic polling of mobiles causing interference to speech users;

1.4 that the data message can be either of analogue or digital modulation type;

2 for data transmission on two frequency simplex analogue data dominant channels:

2.1 that for the transmission of data messages by both mobile and base stations the channel access protocol described in Annex 2 should be used;

2.2 that the maximum channel occupancy of a data message on a shared channel primarily intended for data should be limited to 10 s;

2.3 that during a transmission period communication between more than two radio units in a fleet is permitted;

2.4 that speech messages should use the same channel access protocols as data messages;

2.5 that the data message can be either of analogue or digital modulation type;

3 for data transmission on combined speech/data and data only single frequency and two frequency repeater analogue channels:

3.1 that for the transmission of data messages by both mobile and base stations, the channel access protocol described in Annex 3 shall be used;

3.2 that the maximum channel occupancy of a data message shall not exceed 10 s;

3.3 that during a transmission period, communication between more than two radio units in a fleet is permitted;

3.4 that data messages should not account for greater than 0.05% of traffic on combined speech/data channels;

3.5 that the data message can be either of analogue or digital modulation type.

ANNEX 1

Data transmission on two frequency simplex analogue speech channels

1 General

The following sections provide an outline description of the channel access and re-transmission procedures as defined in United Kingdom standard MPT 1379 [MPT, 1994] for the transmission of data messages on two frequency simplex channels. The standard was developed based on the results of a comprehensive study [Greensmith, 1992] assessing data interference to speech messages and simulation of channel access procedures for data messages on a channel.

1.1 Channel occupation time

The maximum channel occupancy of any single data transmission which shall not exceed 650 ms. This is to be measured from the start of the rise-time of the transmitter to the end of its decay-time and might for example consist of 100 ms rise-time, 500 ms used for data transmission and 50 ms transmitter decay-time. For systems permitted to use mobile-to-mobile communication with a CTCSS controlling the base station the maximum channel occupancy of any single data transmission shall not exceed 1 000 ms.

1.2 Channel access procedures

Figures 1 and 2 show the two channel access and re-transmission procedures which are suited to lightly and heavily loaded speech channels and these are described in the following sections. Each transmission (including data as a precursor for a voice message) shall only be initiated by a manual action, e.g. pressing a button.

FIGURE 1

Flow diagram for channel access and retry procedure option A

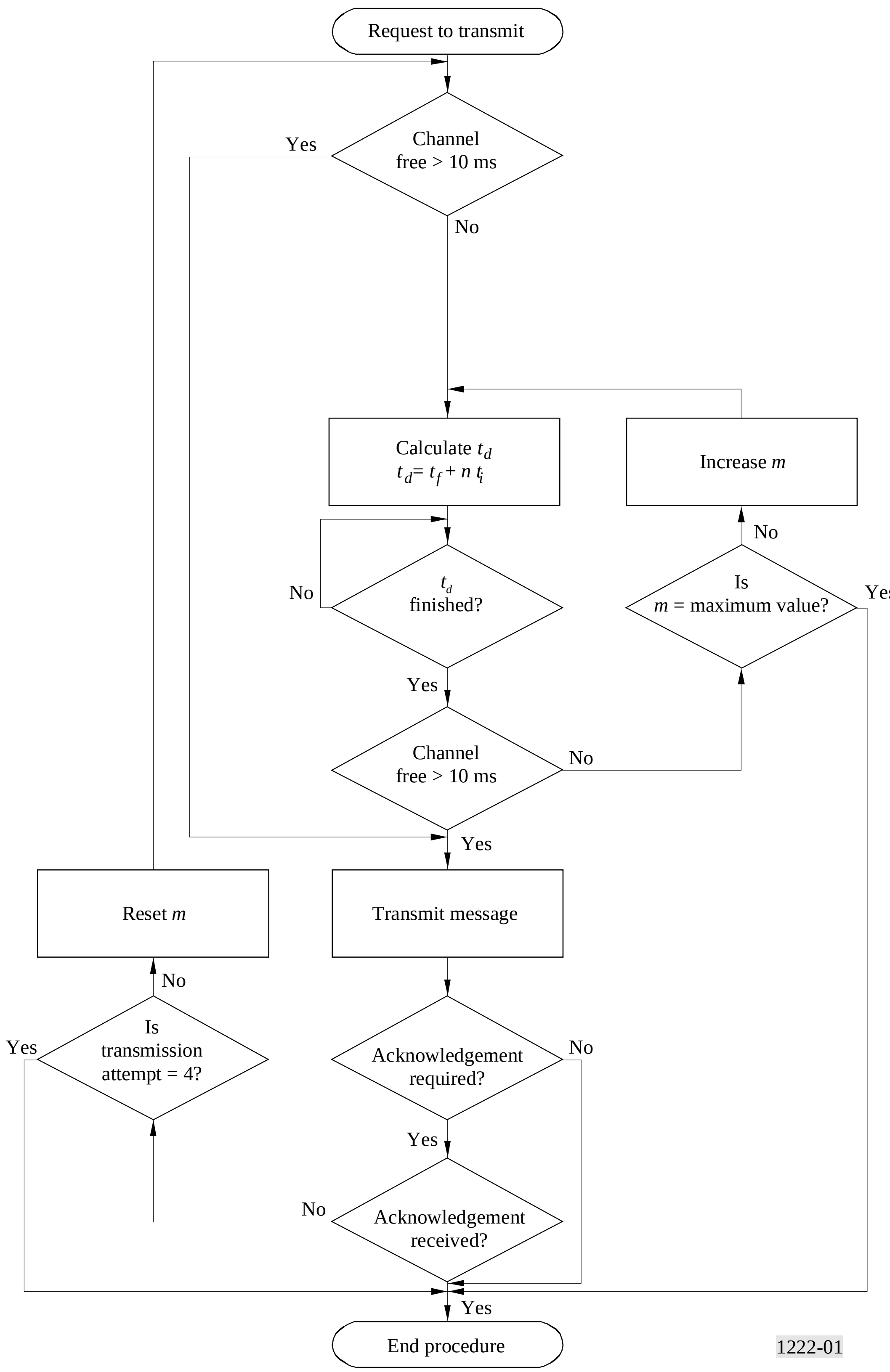
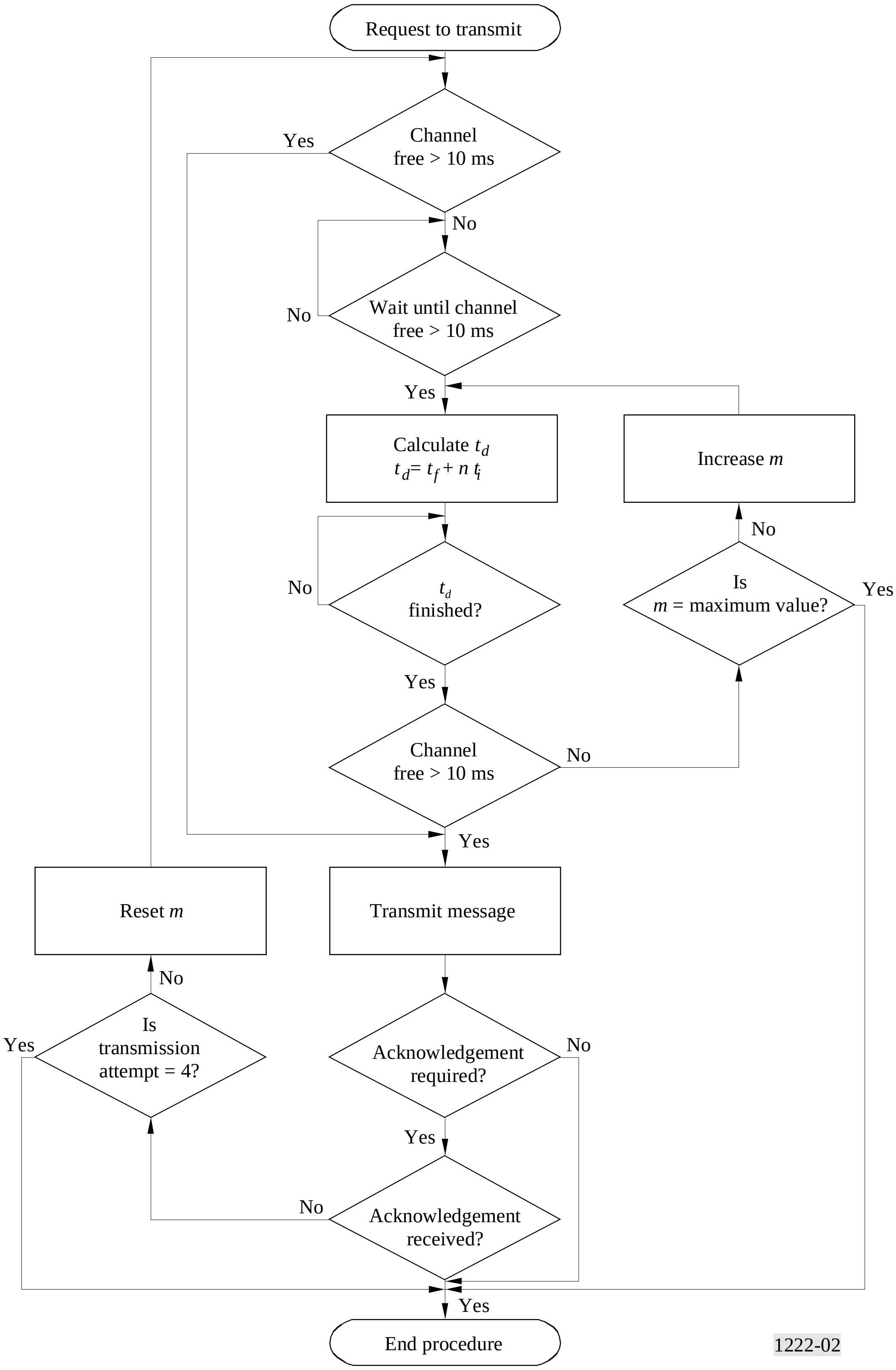


FIGURE 2

Flow diagram for channel access and retry procedure option B



1.2.1 Automatic acknowledgement

An automatic acknowledgement to the message from the receiving transceiver is permitted. The maximum duration of the acknowledgement is 650 ms. This is to be measured from the start of the rise-time of the transmitter to the end of its decay-time and might for example consist of 100 ms rise-time, 500 ms used for data transmission and 50 ms transmitter decay-time. If no response is received in a defined time, automatic retries of the message are permitted using the procedures described below.

1.2.2 Channel access and retry procedures

Transceivers are permitted to access the channel in two ways as shown in Figs. 1 and 2. Both options permit the transceiver to transmit a message if the channel is observed to be clear of traffic but introduce two distinct distribution mechanisms for transceivers waiting to access a channel that has been observed busy. An operator is free to implement either procedure in order to maximize their channel efficiency.

In the event of an unsuccessful message transmission the re-transmission procedure for each option is as shown in the diagram.

1.2.2.1 Option A (for relatively heavily loaded speech channels)

The transceiver shall only attempt to transmit a message if the channel has been observed by the use of carrier sense clear of traffic for an initial period of at least 10 ms. If the channel is not free the transceiver must wait for a random time delay T_D (defined below). No channel monitoring is performed during time T_D.

Therefore:

$$T_D = T_f + nT_i$$
$$T_f = 250 \text{ ms}$$

The increment time T_i shall be 500 ms ±0.5 ms.

The number n is a random number between 1, 2, ..., m; this means that 1, 2, ..., m is the event field of the random number n. For the first trial, m is set to 4 in the case of a mobile and 2 in the case of a base station.

At the end of T_D the transmitter must observe with carrier sense, that the channel is clear of traffic for a minimum period of 10 ms prior to a transmission attempt. If the channel is observed to be busy at the end of T_D the event field, m, is increased with each trial. For the second trial m is set to 8 (4 for a base station), for the third trial m is set to 13 (8 for a base station), for the fourth trial m is set to 20 (13 for a base station). Therefore the maximum number of transmission attempts is set to 5 (this is made up from the initial access attempt plus four attempts using the delay period T_D).

1.2.2.1.1 Re-transmission procedures

In the event of an unsuccessful transmission attempt (i.e. a message has been transmitted and no response is received) the procedure defined above shall be repeated with m reset to its initial value of 4 in the case of a mobile and 2 in the case of a base station.

The maximum number of re-transmission attempts is set to 3.

1.2.2.2 Option B (for relatively lightly loaded channels)

The transceiver shall only attempt to transmit a message if the channel has been observed by the use of carrier sense clear of traffic for an initial period of at least 10 ms. If the channel is not free the transceiver must wait for the channel to become free. When the channel is observed to become clear using the procedure defined above, the transceiver shall calculate a random time delay T_D (defined below). No channel monitoring is performed during time T_D.

$$T_D = T_f + nT_i$$

The fixed part T_f of the observation time shall be 750 ms.

The increment time T_i shall be 500 ms ±0.5 ms.

The number n is a random number between 1, 2, ..., m; this means that 1, 2, ..., m is the event field of the random number n. For the first trial, m is set to 4 in the case of a mobile and 2 in the case of a base station.

At the end of T_D the transmitter must observe with carrier sense that the channel is clear of traffic for a minimum period of 10 ms seconds prior to a transmission attempt. If the channel is observed to be busy at the end of T_D the event field, m, is increased with each trial. For the second trial m is set to 8 (4 for a base station), for the third trial m is set to 13 (8 for a base station), for the fourth trial m is set to 20 (13 for a base station). Therefore the maximum number of transmission attempts is set to 5 (this is made up from the initial access attempt plus four attempts using the delay period T_D).

1.2.2.2.1 Re-transmission procedures

In the event of an unsuccessful transmission attempt (i.e. a message has been transmitted and no response is received in T_{AC}) the procedure defined above shall be repeated with m reset to its initial value of 4 in the case of a mobile and 2 in the case of a base station.

The maximum number of re-transmission attempts is set to 3.

1.3 Carrier sensing

The carrier sense should be able to detect RF signals with different types of modulation e.g. F3E, G3E, F1D, F2D, G1D. The carrier sense delay shall be less than or equal to 10 ms.

The carrier sense delay is the time which elapses between the application of a carrier to the receiver and the detection of the carrier by that receiver.

Data transmission equipment shall implement one of the following options for carrier sensing:

a) The channel will be regarded as in use during the observation time if the signal-to-noise ratio is greater than the signal-to-noise ratio observed when an RF signal of 2 μV EMF (–107 dBm) is applied directly to the receiver input terminals in the absence of extraneous noise.

b) The channel will be regarded as in use during the observation time if the RF signal on the channel exceeds a level of 2 μV EMF (–107 dBm) as measured at the receiver input terminals.

c) The channel shall be regarded as busy during the observation time if the RF level on the channel exceeds that specified for the frequency band and environment specified in Table 1. These levels are as measured at the receiver input terminals.

TABLE 1

Levels (μV) EMF (dBm) as applied to radio receiver input terminals

Band	Rural		Suburban		Urban	
	μV	(dBm)	μV	(dBm)	μV	(dBm)
Low VHF (68-87.5 MHz)	1	(–113)	5	(–100)	30	(–83)
Mid and high VHF (138-174 MHz)	1	(–113)	2	(–107)	15	(–89)
All UHF	1	(–113)	1	(–113)	4	(–101)

If a transceiver observes a channel to be continuously busy via any one of the mechanisms a), b) laid out in this section for more than 98% of a period of 100 s, the terminal may simply transmit one pending message and if necessary up to four retries.

d) The channel will be regarded as in use during the observation time if the RF level on it exceeds the current threshold value, which consists of two components, a fixed threshold and a variable amount.

The fixed values are shown in Table 1 and the variable amounts may take any number up to +12 dB, though it is recommended that this should be in discrete steps not larger than 6 dB. No lower limit is specified.

Whenever a transceiver is turned on, resets or access a new channel, the variable part of the threshold will be zero. If, after monitoring for a long duration (exceeding 100 s) a channel appears to be busy for a period of 98% of the time or more, then the transceiver may reset the variable threshold by one step of up to 6 dB and once more monitor. The threshold may again be increased after a further 100 s of monitoring if the channel appears to be busy for at least 98% of the time.

Provided that channel appears to be busy for more than 80% of time (as observed over a duration of at least 100 s) then the increased value of the variable part of the threshold shall endure. However, if the channel appears to be busy for less than 80% of such a period then the variable part of the threshold shall be reduced by a step of at least 6 dB, for a period of at least 100 s monitoring at the lower total threshold level.

1.4 Emergency data transmissions

The channel access procedure set out above need not be followed for data transmission for the purpose of indicating the existence of an emergency condition. It is expected that equipment will have some special feature to initiate emergency data transmissions which is separate from the normal mode of transmitting data that adheres to the access protocol. It is recommended that the emergency signal should upon reception generate some form of alarm condition at the recipient and be terminated when an acknowledgement is received. The sending unit may not continuously retry the emergency data message if there is no acknowledgement for more than 30 s.

REFERENCES

GREENSMITH, D. [1992] The study of data transmission in the Private Mobile Radio Bands. Radiocommunications Agency, United Kingdom.

MPT 1379 [August, 1994] Channel access procedures for digital radio equipment operating in the Land Mobile Radio Bands. Radiocommunications Agency, United Kingdom.

ANNEX 2

Data transmission on two frequency simplex analogue data channels

1 General

The following sections describe the channel access and re-transmission procedures as defined in United Kingdom standard MPT 1379 [MPT, 1994] for the transmission of data messages on two frequency simplex channels. The standard was developed based on the results of a comprehensive study [Greensmith, 1992] assessing data interference to speech messages and simulation of channel access procedures for data messages on a channel. The following sections provide an outline description of the standard.

This access protocol applies to two frequency simplex operation and includes two frequency duplex mode and the mobile units in the simplex mode. This access protocol is applicable for:

– multiple, private data only users which do not share a common central control facility, but may share a common two frequency radio channel;

– multiple private mixed analogue speech and data users which do not share a common central control facility, but may share a common two frequency, radio channel;

– within the limits set out in this Annex, each group of users may use its own communication protocol.

The access protocol provides access to independent users with equal priority.

1.1 Channel access procedure

The access protocol shall be used for each occupation of the RF channel for sharing data/data and for sharing speech/data with automatic channel access.

When a request to transmit a message has been made the transceiver shall determine whether or not the channel is and has been idle for a certain period (the observation time) by means of carrier sensing. The observation time consists of a fixed part of a randomly selected part. When the channel still appears to be idle at the end of the observation time, the transmitter is initiated.

The transceiver shall determine whether or not the channel is and has been idle for a certain period, the observation time t_0, by means of carrier sensing. The observation time t_0 consists of a fixed part t_f and a randomly selected part t_r.

If the channel is occupied during part of the observation time (excepting brief observation of not more than 100 ms), the process shall be repeated.

If the channel still appears to be idle during the observation time, the transmitter shall be initiated and powered up. The channel can then be seized for the duration of one time interval.

If no response is received (owing, for example, to simultaneous channel access by several users), the channel shall be detected as free during the observation time t_0 prior to a repetition of a transmission.

Within one time interval, radio traffic may take place:

– from a base station to one or several mobiles;

– from a mobile to a base station;

– between mobiles.

To ensure that no other user can access the channel during a time interval, the reversion time t_c between transmission of a message and corresponding acknowledgement and reply, shall not exceed 100 ms. The reversion time t_c is the time between the switch off of one transmitter and the switch on of the other, as measured at 50% of the rated carrier power.

1.1.1 Observation time

The observation time shall start within 10 ms after each time that the RF channel has become idle. It will also start at power on.

The observation time t_0 is the sum of t_f and the random part $t_r = n\,t_i$.

$$t_0 = t_f + n\,t_i$$

The fixed part, t_f of the observation time shall be 300 ms.

The increment time t_i shall be 50 ms ±0.5 ms.

The number n is a random number between 1, 2, ..., m; this means that 1, 2, ..., m is the event field of the random number n. The random number n shall be determined by use of a random generator with a uniform distribution. To achieve short delays during low traffic, the observation time should be short, i.e. m should be a small integer.

A short random part of the observation time however, increases the probability of several users simultaneously accessing the channel for a time interval. In the event of an unsuccessful transmission attempt, the channel shall be detected as free during a new t_0 before a repetition of the transmission takes place. The event field (1, 2, ..., m) is doubled with each trial. In this way, channel congestion can be reduced even with short initial observation times.

For the first trial, m is set to 4 in the case of a mobile and 2 in the case of a base station.

For the second trial, m is set to 8, etc. until m = 64. In the case of a base station these values are halved to 4, 8, 16 and 32.

1.1.2 Duration of channel occupation (time interval)

1.2.1.1 Transmissions of data packets exceeding 650 ms

The maximum time interval during which packets of data can be sent by the initiating transmitter to the addressed parties is called t_t. To ensure that only the initiating transmitter monitors the time interval, acknowledgements and replies may exceed the time interval t_t by the time dt_t. This determines the duration of the windows. Equipment designed to comply with this protocol shall provide for the following ranges:

t_t = 10 s

dt_t = 1 s.

1.2.1.2 Transmission of data packets not exceeding 650 ms

On data dominant channels additional short data bursts of a duration of at least 100 ms and not exceeding 650 ms can be transmitted using a different procedure to that described above. The observation time (with carrier sense) before such emissions shall be equal to the random part stated above (the fixed part of the observation time shall be zero).

If a re-transmission or another burst is to be transmitted, this procedure may only be repeated after 2 s.

1.3 Voice messages

This protocol gives equal probability of access for a data transaction or a speech transaction. A transceiver seeking to initiate a speech transaction must undertake all of the monitoring procedures described for data transmission.

The maximum duration of a voice transaction on a channel shall be 60 s. Any number of mobiles from the user’s own fleet may make voice transmissions or reception during this interval without needing to repeat the access protocol described above, so long as the dwell time from one voice transmission to the next within the interval is such that the channel is never left idle for more than the time equal to the fixed part of the observation time defined above.

When a data message or series of data messages within a time interval have been successfully transmitted on the channel, the initiating transceiver of that message shall increase its fixed monitoring time t_f to a duration of 1 s for a period of 10 s after acknowledgement. Only after this 10 s period is the transceiver allowed to reset t_f to the value set in § 1.1.1. This section does not apply to the procedures for messages less than 650 ms.

When a voice message or series of voice messages within a time interval have been successfully transmitted on the channel, the initiating transceiver of that message shall increase its fixed monitoring time t_f to a duration of 1 s for a period of 10 s after acknowledgement. Only after this 10 s period is the transceiver allowed to reset t_f to the value set above.

Figures 3 to 6 illustrate the protocol as described above.

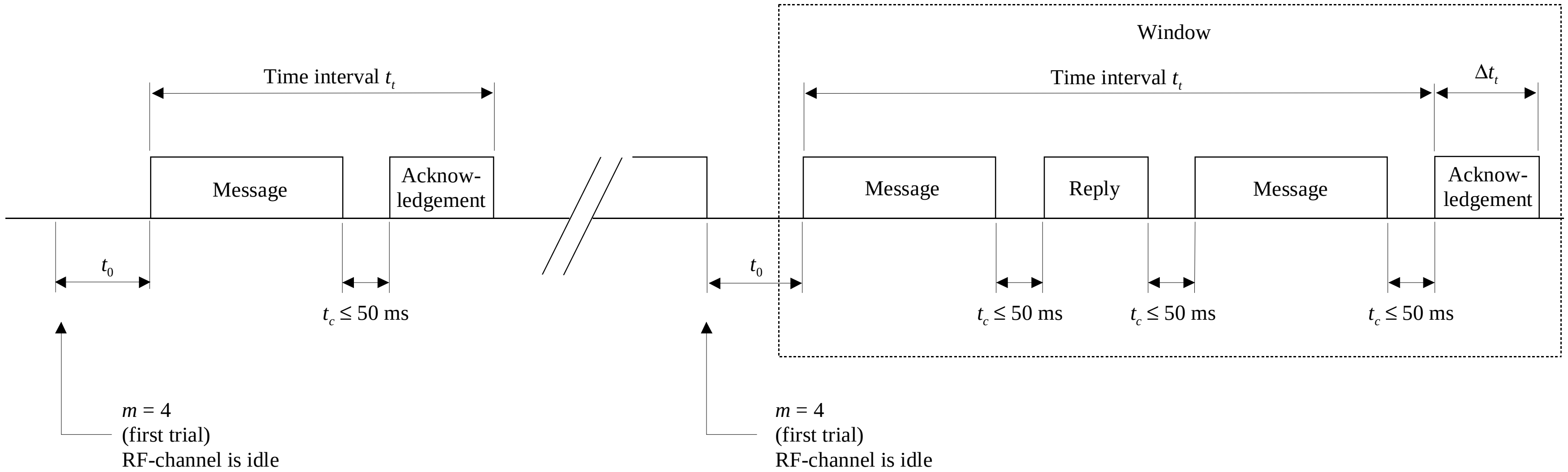
1.4 Carrier sensing

The carrier sense should be able to detect RF signals with different types of modulation e.g. F3E, G3E, F1D, F2D, G1D. The carrier sense delay shall be less than or equal to 10 ms.

The carrier sense delay is the time which elapses between the application of a carrier to the receiver and the detection of the carrier by that receiver.

FIGURE 3

Access protocol sharing data/data



Sharing data/data; users operating independently

Observation time $t_0 = t_f + n\, t_i$; $t_f = 60$ ms; $t_i = 50$ ms

n: random number between 1, 2, ..., m

$t_t = 1, ..., 10$ s, step size 100 ms

$\Delta t_t = 0, 1, ..., 10$ s, step size 100 ms

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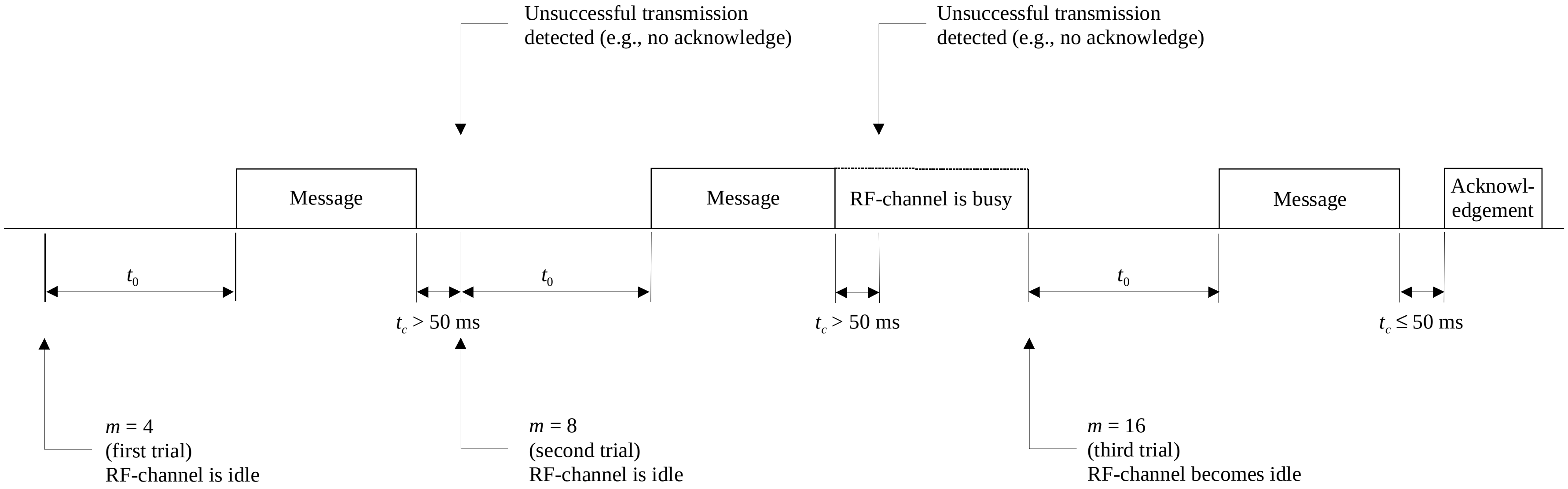
FIGURE 4

Access protocol: unsuccessful transmission



Sharing data/data; users operating independently

Example with an unsuccessful transmission

Observation time $t_0 = t_f + nt_i$; t_f = 60 ms; t_i = 50 ms

n: random number between 1, 2, ..., m

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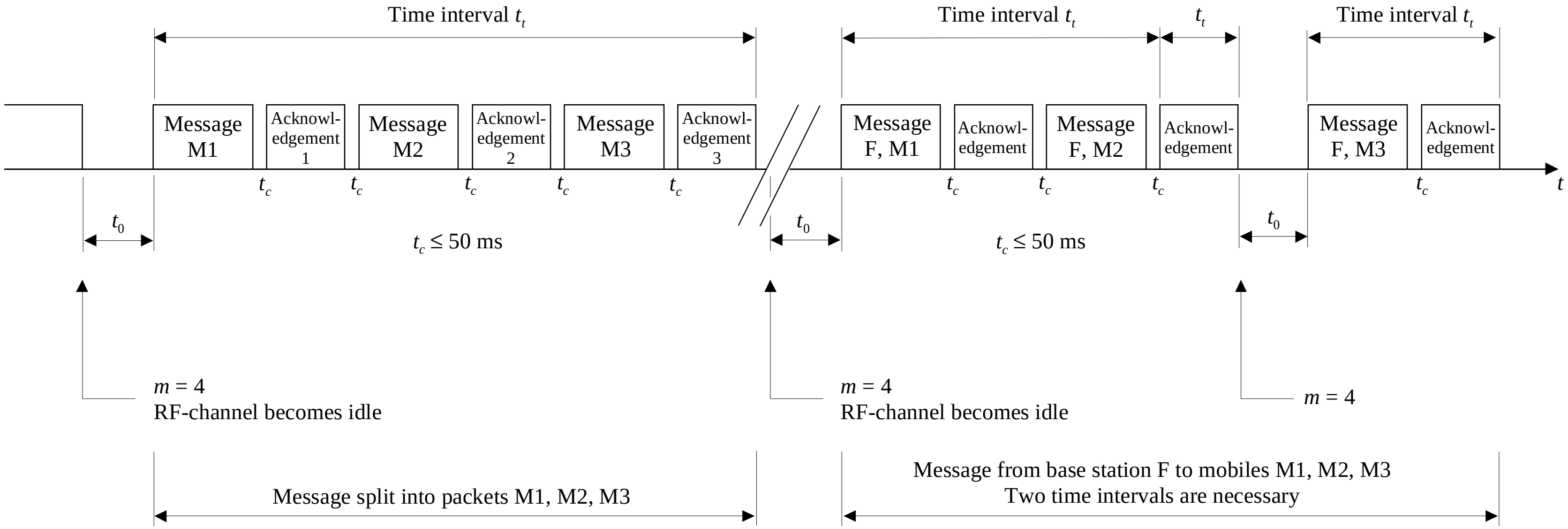
FIGURE 5

Access protocol sharing data/data



Sharing data/data; users operating independently

Observation time $t_0 = t_f + nt_i$; $t_f = 60$ ms; $t_i = 50$ ms

n: random number between 1, 2, ..., m

$t_t = 1, \ldots 10$ s, step size 100 ms

$\Delta t_t = 0, 1, \ldots 10$ s, step size 100 ms

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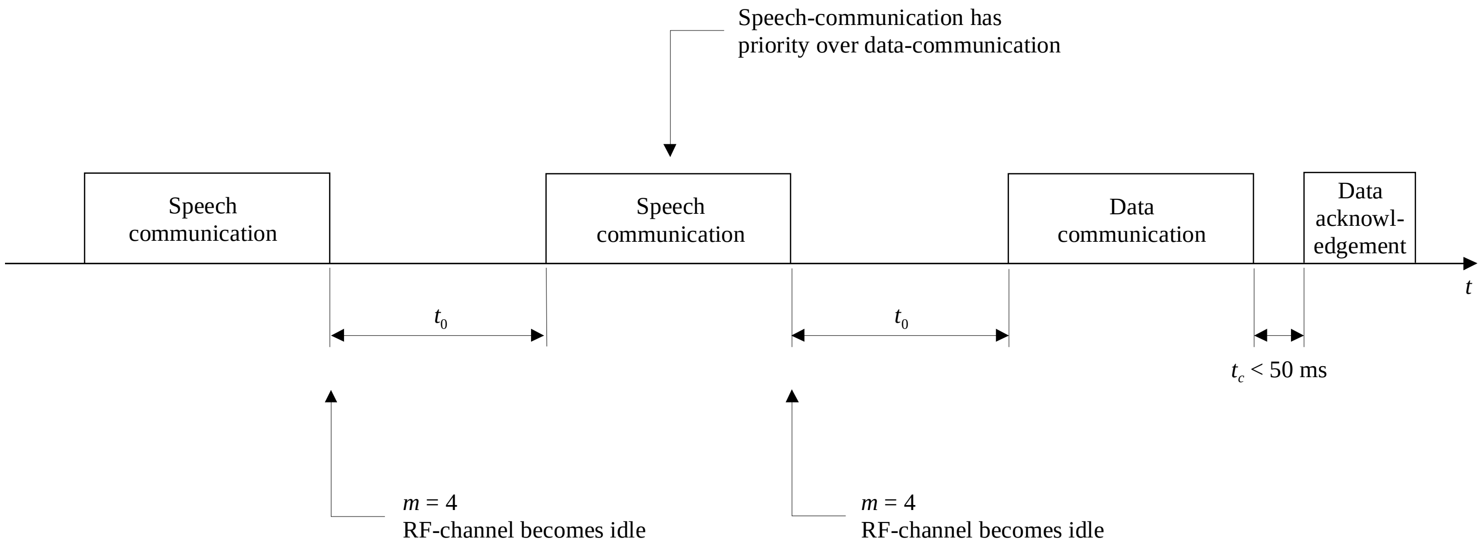
FIGURE 6

Sharing speech/data



If the RF-channel is busy during the observation time the observation process shall be repeated

Sharing speech/data; users operating independently

Observation time $t_0 = t_f + nt_i$; t_f = 60 ms; t_i = 50 ms

n: random number between 1, 2, ..., m

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Data transmission equipment shall implement one of the following options for carrier sensing:

a) the channel will be regarded as in use during the observation time if the signal-to-noise ratio is greater than the signal-to-noise ratio observed when an RF signal of 2 μV EMF (–107 dBm) is applied directly to the receiver input terminals in the absence of extraneous noise;

b) the channel shall be regarded as busy during the observation time if the RF level on the channel exceeds that specified for the frequency band and environment specified in Table 2. These levels are as measured at the receiver input terminals.

TABLE 2

Levels (μV) EMF (dBm) as applied to radio receiver input terminals

Band	Rural		Suburban		Urban	
	μV	(dBm)	μV	(dBm)	μV	(dBm)
Low VHF (68-87.5 MHz)	1	(–113)	5	(–100)	30	(–83)
Mid and high VHF (138-174 MHz)	1	(–113)	2	(–107)	15	(–89)
All UHF	1	(–113)	1	(–113)	4	(–101)

If a terminal observes a channel to be continuously busy via any one of the mechanisms a), b) laid out in this section for more than 97% of a period of 50 s, the terminal may simply transmit one pending message and if necessary up to four retries.

c) The channel will be regarded as in use during the observation time if the RF level on it exceeds the current threshold value, which consists of two components, a fixed threshold and a variable amount.

The fixed values are shown in Table 1 and the variable amounts may take any number up to +12 dB, though it is recommended that this should be in discrete steps not larger than 6 dB. No lower limit is specified.

Whenever a transceiver is turned on, resets or accesses a new channel, the variable part of the threshold will be zero. If, after monitoring for a long duration (exceeding 50 s) a channel appears to be busy for a period of 97% of the time or more, then the transceiver may reset the variable threshold by one step of up to 6 dB and once more monitor. The threshold may again be increased after a further 100 s of monitoring if the channel appears to be busy for at least 98% of the time.

Provided that channel appears to be busy for more than 80% of time (as observed over a duration of at least 50 s) then the increased value of the variable part of the threshold shall endure. However, if the channel appears to be busy for less than 80% of such a period then the variable part of the threshold shall be reduced by a step of at least 6 dB, for a period of at least 50 s monitoring at the lower total threshold level.

REFERENCES

GREENSMITH, D. [1992] The study of data transmission in the Private Mobile Radio Bands. Radiocommunications Agency, United Kingdom.

MPT 1379 [August, 1994] Channel access procedures for digital radio equipment operating in the Land Mobile Radio Bands. Radiocommunications Agency, United Kingdom.

ANNEX 3

Data transmission on analogue single frequency and two frequency repeater channels

1 General

The following sections describe the channel access protocol and re-transmission procedures as defined in European Telecommunications Standard ETS 300 471 [ETSI, 1995] for the transmission of data on combined speech/data and data only single frequency and two frequency repeater channels.

ETS 300 471 applies to equipment designed to operate within the professional mobile radio service and to the associated frequency planning. It also applies to equipment for the transmission of data on shared channels.

ETS 300 471 specifies an access protocol and occupation rules for data communications on radio channels shared by different users. It may be used for data communications over channels originally intended for speech use. It gives freedom for the use of any bit rate, any constant envelope modulation or any type of protocol which fulfils its normative parameters, to access a shared radio channel.

The access protocol specified also permits the sharing of speech and data communication.

The access protocol contained in ETS 300 471 applies to single frequency simplex operation (and two frequency repeater operations with the repeater in duplex mode and the mobile units in simplex mode). The protocol is applicable for:

– multiple data only users, independent from each other, which do not share a common central control facility, but may share a common single or two frequency radio channel;

– multiple mixed analogue speech and data users, independent from each other, which do not share a common central control facility, but may share a common single, or two frequency, radio channel and where speech is to have priority over data transmissions.

The access protocol is not applicable for data users with common central control facilities or for trunked systems operating on dedicated non-shared channels.

In the case of analogue transmissions, the corresponding access protocol is known as the “radio-discipline” of the users.

Within the limits set out in ETS 300 471, each group of users may use its own communication protocol.

1.1 Access protocol

The access protocol shall be used for each occupation of the RF channel for sharing data/data and for sharing speech/data with automatic channel access.

1.2 Principles

The equipment shall determine whether or not the channel is and has been idle for a certain period (the observation time) by means of carrier sensing.

The observation time consists of a fixed part and a randomly selected part. When the channel still appears to be idle at the end of the observation time, the transmitter is initiated and shall be powered up within a specified time.

The maximum duration of the emission is limited to 10 s or less.

1.3 Procedure

The equipment shall determine whether or not the channel is and has been idle for the duration of the observation time, by means of carrier sensing (see § 1.4). The observation time t_0 consists of a fixed part t_f and a randomly selected part t_r.

If the channel is occupied during part of the observation time, the process shall be repeated (without changing *m* (see § 1.5)).

If the channel still appears to be idle during the observation time, the transmitter shall be initiated and powered up within the specified attack time. The channel can then be seized for the duration of one time interval. The maximum length t_t of this interval depends on the frequency sharing category (data/speech, data/data).

If a re-transmission is required (due, for example, to a "collision", i.e. a simultaneous channel access by several users), the observation process shall be repeated and the channel shall be detected as free prior to a repetition of a transmission.

Within one time interval, radio traffic may take place:

– from a base station to one or several mobiles,

– from a mobile to a base station,

– between mobiles.

To ensure that no other user can access the channel during a time interval, the reversion time t_c between transmission of a message and corresponding acknowledgement and reply, shall not exceed 50 ms. The reversion time t_c, is the time between the switch off of one transmitter and the switch on of the other, as measured at 50% of the rated carrier power.

1.4 Carrier sensing

Carrier sensing is the detection of RF power in the receive channel that exceeds a given threshold.

The carrier sense shall be able to detect RF signals with different types of modulation (e.g. F3E, G3E, F1D, F2D, G1D).

The channel shall be regarded as in use during the observation time (see § 1.5) if the level of the RF signal on the channel exceeds a threshold level as defined in Table 3.

TABLE 3

Threshold levels

Band (MHz)	Threshold level (dBμV) EMF
30-137	12
137-300	6
> 300	0

The carrier sense delay shall be no more than 10 ms.

1.5 Observation time

The observation time shall start within 10 ms after each time that the RF channel has become idle. It will also start at power on.

The observation time t_0 is the sum of the fixed part t_f and the random part $t_r = n\,t_i$:

$$t_0 = t_f + n\,t_i$$

The fixed part, t_f, of the observation time shall be:

– on pure data channels: 60 ms ±1 ms;

– on combined speech/data channels: 2 000 ms ±1 ms.

The increment time t_i shall be 50 ms ±0.1 ms.

The number n is a random integer number from 1 to m ($1 \le n \le m$); this means that 1 to m is the event field of the random number n. The random number n shall be determined by use of a random generator with a uniform distribution.

To achieve short delays during low traffic, the observation time should be short, i.e. m should be small. Therefore in the access protocol, m shall be set to 4 for the first trial.

A short random part of the observation time however, increases the probability of several users simultaneously accessing the channel for a time interval.

Therefore, when a re-transmission is required (e.g. in the case of no acknowledge, see Fig. 4), the observation process shall be repeated and the channel shall be detected as free during a new t_0 before a repetition of the transmission takes place. The event field (1 to m) shall be doubled with each trial. In this way, channel congestion can be reduced even with short initial observation times. For the second trial (transmission of the same message) m shall be set to 8, etc. until $m = 64$.

1.6 Initiation of the transmitter

If the channel has not been occupied since the start of the observation time, then the transmitter can be initiated. The time, which elapses between the end of the observation time and the moment that the carrier power from the transmitter has reached a level of 1 dB below the steady state power, shall not exceed 25 ms.

1.7 Duration of the RF channel occupation (time interval)

1.7.1 Transmissions of data packets exceeding 300 ms

The time interval during which packets of data can be sent by the initiating transmitter to the addressed parties is called t_t. To ensure that only the initiating transmitter monitors the time interval, acknowledgements and replies may exceed the time interval t_t by the time Δt_t. This determines the duration of a set of interrelated transmissions resulting from the action of the initiating transmitter. Equipment designed to comply with the access protocol shall provide for the following ranges and step sizes:

t_t = 1, ..., 10 s step size 100 ms;

Δt_t = 0, 1, ..., 10 s step size 100 ms.

The actual value of t_t and Δt_t may be set by the appropriate administration.

The total time interval during which a packet of data can be sent, as expressed in this section may be a condition to the issue of a licence by the appropriate administration.

1.7.2 Transmissions of data packets not exceeding 300 ms (speech/data channels)

On mixed speech/data channels additional short data bursts of a duration not exceeding 300 ms can be transmitted. The start of the observation time is regulated by § 1.5. The observation time (with carrier sense) before such transmissions shall be equal to the random part stated in § 1.5, but in this particular case the value of n shall be set to an integer number from 2 to m (the fixed part of the observation time shall be 0).

If a re-transmission is necessary or if another burst is to be transmitted, this procedure may only be repeated after 2 s (fixed part of the observation time).

1.8 Examples

Figures 3 to 6 illustrate the protocol described above.

REFERENCES

ETSI [December, 1995] ETS 300 471 – Radio Equipment and Systems (RES); Land Mobile Service; Access protocol, occupation rules and corresponding technical characteristics of radio equipment for the transmission of data on shared channels. European Telecommunications Standards Institute, Sophia Antipolis, F-06291, Valbonne Cedex, France.