

CEPT/CCH/GSM

Recommendation GSM 03.45

TECHNICAL REALIZATION OF FAX GROUP 3 - TRANSPARENT

VERSION: 2.0.0

EDITOR: P. DI TRIA (Italy)

DATE : January 20, 1989

ORIGINAL LANGUAGE: English

NUMBER OF PAGES: 37

LIST OF CONTENTS: 0. SCOPE

1. SERVICE DEFINITION

2. NETWORK ARCHITECTURE

3. REFERENCE CONFIGURATION AT THE MOBILE STATION

4. CONNECTION TYPES

5. USE OF TERMINAL ADAPTATION FUNCTIONS

6. SIGNALLING ASPECTS

7. INTERWORKING TO FIXED NETWORKS

8. SUPPORT OF GROUP 3 ERROR CORRECTION PROCEDURE

ANNEX

BC and HLC coding

APPENDIX

I Abbreviations from CCITT T.30 and T.4

II Procedure examples

0. SCOPE

This Recommendation deals with the procedures allowing the technical realization of the Group 3 facsimile Service within the GSM PLMN using transparent Network support, according to the definition of the Teleservice 61 specified in the GSM Rec. 02.03.

1. SERVICE DEFINITION

The fixed network Group 3 Facsimile service, as basically defined in CCITT Recommendation F.160, is an international telematic service for ISO A4 document transmission between two facsimile stations.

The service specification is comprised of two parts: the control protocol described in CCITT Recommendation T.30, and the document transmission coding described in CCITT Recommendation T.4.

The GSM facsimile Teleservice is intended to allow facsimile connections between group 3 apparatus using:

- a GSM PLMN as a stand alone facility, for mobile to mobile communication;
- a GSM PLMN to gain access to fixed networks PSTN and ISDN, for mobile to/from land communication.

For this Teleservice, the document coding is as CCITT Recommendation T.4 with no modifications. The protocol used is CCITT Recommendation T.30 modified within the PLMN as detailed in this recommendation. The interworking between different networks is based on CCITT Recommendation X.300.

The particular features of this Teleservice are:

- it uses point-point communication;
- the information transfer capability is alternate speech/facsimile;
- both mobile originated and terminated calls are supported;
- the information transfer mode is circuit, duplex, synchronous and symmetric;
- different end-to-end transfer rates are used within the same call to take advantage of the better radio path error rate;

- use of a standard synchronous terminal adaptation function (as per GSM Recommendation 07.03) within the MS.

2. NETWORK ARCHITECTURE

The network architecture applicable to this Teleservice is shown in Fig 1/03.45, below.

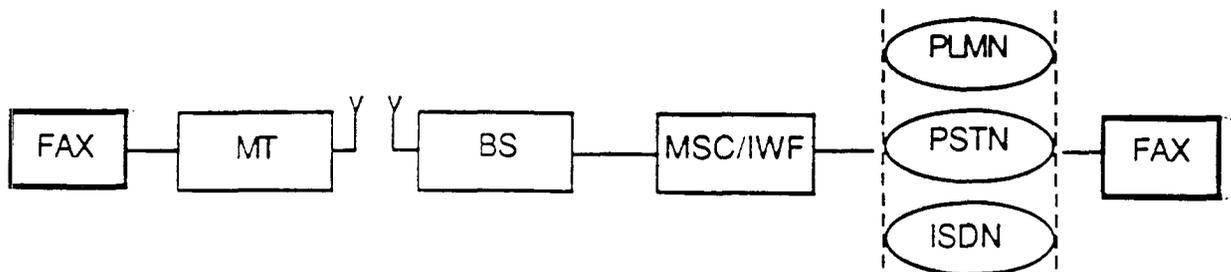


Fig. 1/03.45 Network architecture

This shows the case of mobile to fixed network interworking. For mobile to mobile calls, there would effectively be a loop back within the PLMN, using two IWFs.

3. REFERENCE CONFIGURATION AT THE MOBILE STATION

The mobile reference configurations described in this section are defined as per GSM Recommendation 04.02.

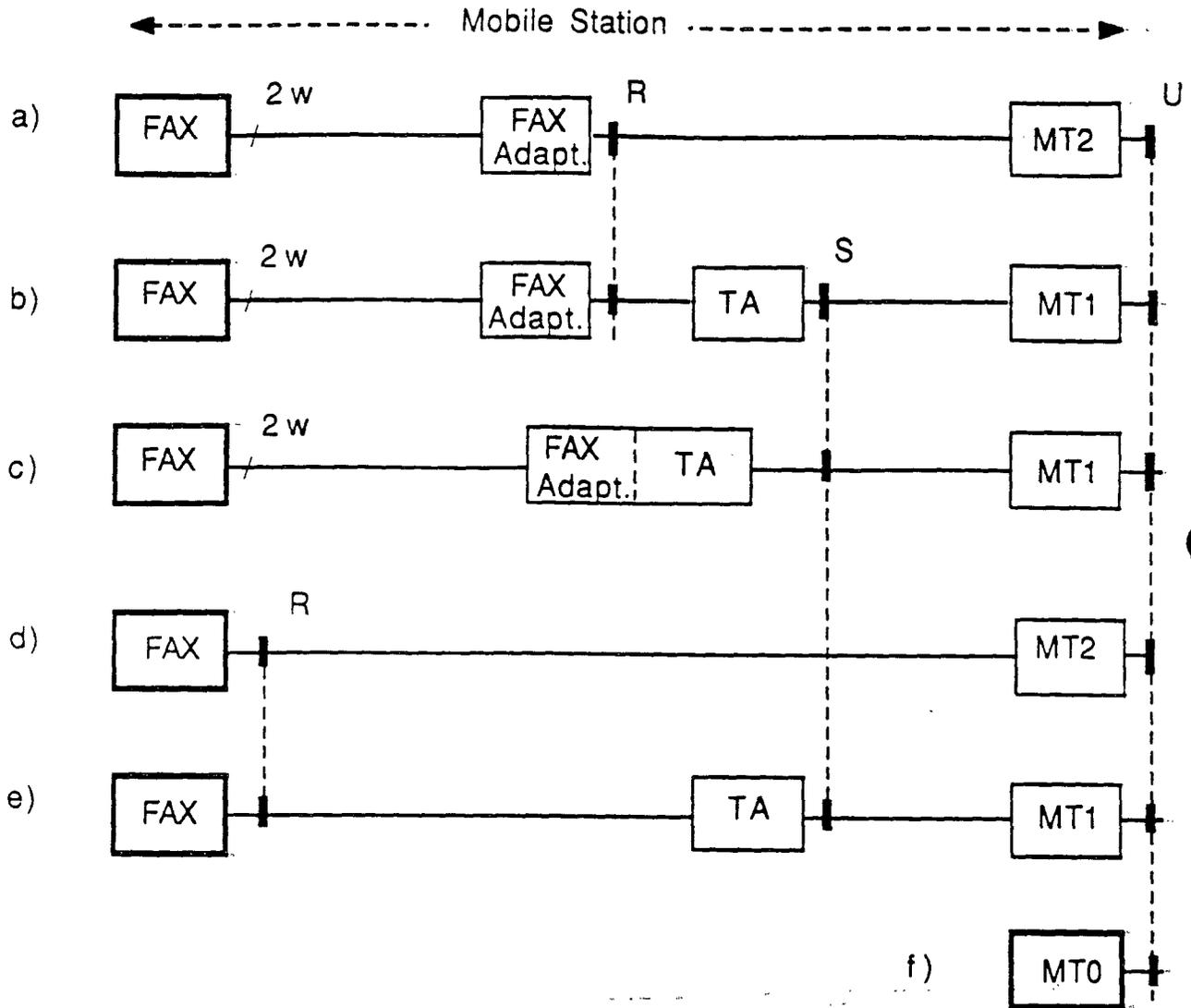


Fig. 2/03.45 Reference configurations

The Teleservice definition in GSM Recommendation 02.03 regards the group 3 facsimile terminal as a 2-wire analogue terminated equipment. In order to connect this to the MT2 a separate "fax Adaptor" device is necessary. This configuration, shown in Fig. 2a/03.45, has to be considered as the standard configuration, so that all the existing Group 3 facsimile apparatus can be connected to the PLMN.

An alternative realisation would be to combine a standard group 3 facsimile machine and the fax adaptor into a specially developed "GSM facsimile machine", directly providing a digital output. Although such a device must appear to the MT2 as identical to

the fax adaptor (i.e. with an identical interface and protocol), it would allow for a significantly smaller and simpler facsimile machine. This configuration is shown in Fig 2d/03.45 and is regarded as a desirable alternative.

In addition of course, it is always possible to realise an MT0, as per Fig 2f/03.45, where both the facsimile and mobile termination functions are considered to be part of one integrated unit.

The remaining configurations concern the use of an S interface and are considered as optional configurations. Their use is for further study.

The particular terminal adaptation functions used are those detailed in GSM Recommendation 07.03 and the interface to the MT2 used is synchronous V24 with an option for support of V25bis procedures for autocalling and autoanswering.

3.1 Fax adaptor functionality

The fax adaptor block, Fig. 3/03.45, is intended to specifically complement the Group 3 facsimile apparatus in order to be able to communicate over a GSM PLMN.

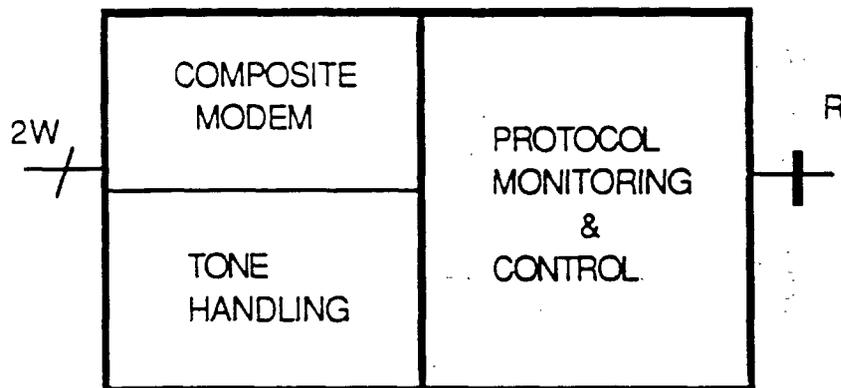


Fig. 3/03.45 fax adaptor scheme

Whether it has to be a function internal to the GSM PLMN, or an external accessory associated with the Group 3 apparatus, is beyond the scope of this Recommendation, and in any case, does not affect at all the working of the procedure as here described.

It can be functionally partitioned in two sections:

- an analogue section, dealing with:

- * the modulation and demodulation processes according to CCITT Recommendation V.21, V.27 ter and V.29 as explained in T.4 and T.30;
 - * handling of the signalling on the 2-wire path to the facsimile machine, including autocalling and autoanswer functions where necessary (see section 6).
- a digital section, dealing with:
- * monitoring and where necessary, manipulation of the T.30 protocol as detailed in the rest of this Rec.;
 - * overall control of the adaptor;
 - * connection over the synchronous V24 interface to the MT as described in GSM Recommendation 07.03;
 - * where necessary, autocalling and autoanswering functions according to V25bis.

3.2 GSM Facsimile Machine functionality

The special GSM facsimile machine shown in the MS configuration of Fig 2d/03.45 has a similar functionality to the digital part of the fax adaptor, but without any of the analogue portions.

It appears over the V24 interface as identical to the fax adaptor, i.e. the MT2 needs to have no knowledge of the particular configuration used.

3.3 Clocking

The fax adaptor or GSM facsimile machine will acquire received data bit timing on CT115. The transmitter element timing CT114 shall be synchronized to CT115. Since a synchronous terminal adapter function is used, the clock rate over the V24 interface will always reflect the rate over the radio interface.

4. CONNECTION TYPES

Table 1/03.45 shows the connection elements attributes applicable to this Teleservice, extracted from GSM Recommendation 03.10.

Teleservice in GSM PLMN	Access at Mobile station	Radio Interface Conn. Element	Intermediate Rate RA1 to RA2	BS-MSC/IWF Conn. Element	Protocol Model
Facsimile group 3	Data cct duplex synchronous access alternate speech/data: * 9.6 kbit/s * 4.8 kbit/s * 2.4 kbit/s (*)	Cct mode speech alternating with unstructured unrestricted 3.6, 6.0 or 12.0 Kbit/s on Full Rate transparent	Speech NA 8 kbit/s 16 kbit/s	Cct mode structured 64 Kbit/s alternate speech/unrestricted	(Fig. 6 of 03.10) 5

Table 1/03.45

The Fig. 4/03.45 shows the scheme of a typical GSM PLMN connection for this Teleservice, considering respectively R and S access at Network Termination.

To grant full support to the CCITT Rec. T.30, requiring different transmission speeds, the following strategy shall be implemented:

- PLMN provides for three Access Rate only, that is 9600 bit/s, 4800 bit/s, 2400 bit/s;
- radio channel modification procedures are used for switching between Speech phase and facsimile phase, as well as to select the suitable Access Rate (9600/4800/2400 bit/s) within the facsimile phase, as resulting from the preliminary end-to-end negotiation between the terminals;
- to transport Binary Coded Signaling (BCS) requiring a synchronous 300 bit/s bit-rate, speed conversion will be used at both the PLMN ends, based on a times n multiplexing mechanism (see section 4.2.1), to allow exploitation of the same Message speed;
- local flag stuffing is applied by the fax adaptors towards the terminals, to keep active the data link whenever a procedure delay could timeout typical T.30 timers.

(*) The highest Access Rate actually supported in this Teleservice will be consistent with the highest Transparent Bearer Service provided by the Network Operator, according to the classification ('E3'/'A') fixed in GSM Rec. 02.02.

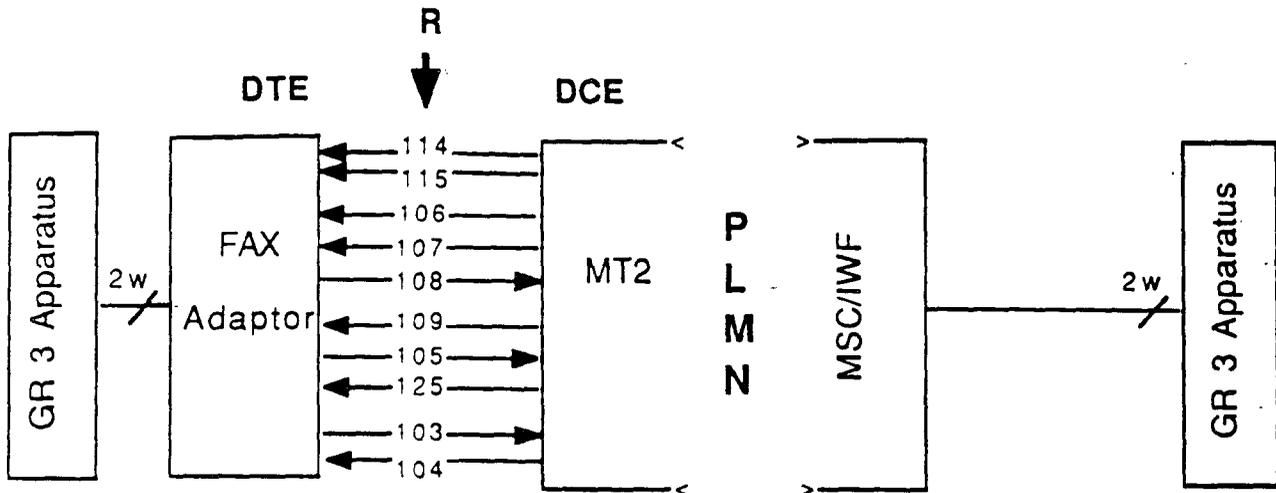


Fig. 4a/03.45 Standard Teleservice connection

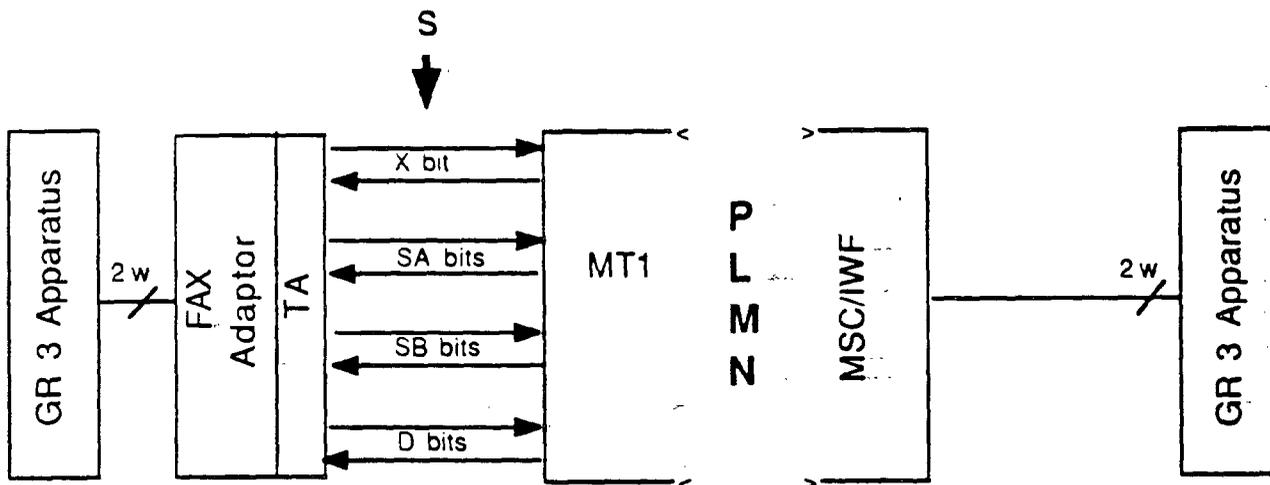


Fig. 4b/03.45 Optional Teleservice connection (F.F.S.)

4.1 Protocol model

The Fig. 5/03.45 depicts the protocol model for this Teleservice, deduced from model 5 of Fig. 6/03.10.

The main point to be underlined is that all the protocol modules specific for this Teleservice are confined in the Fax Adaptation functions at both the MT and IWF ends.

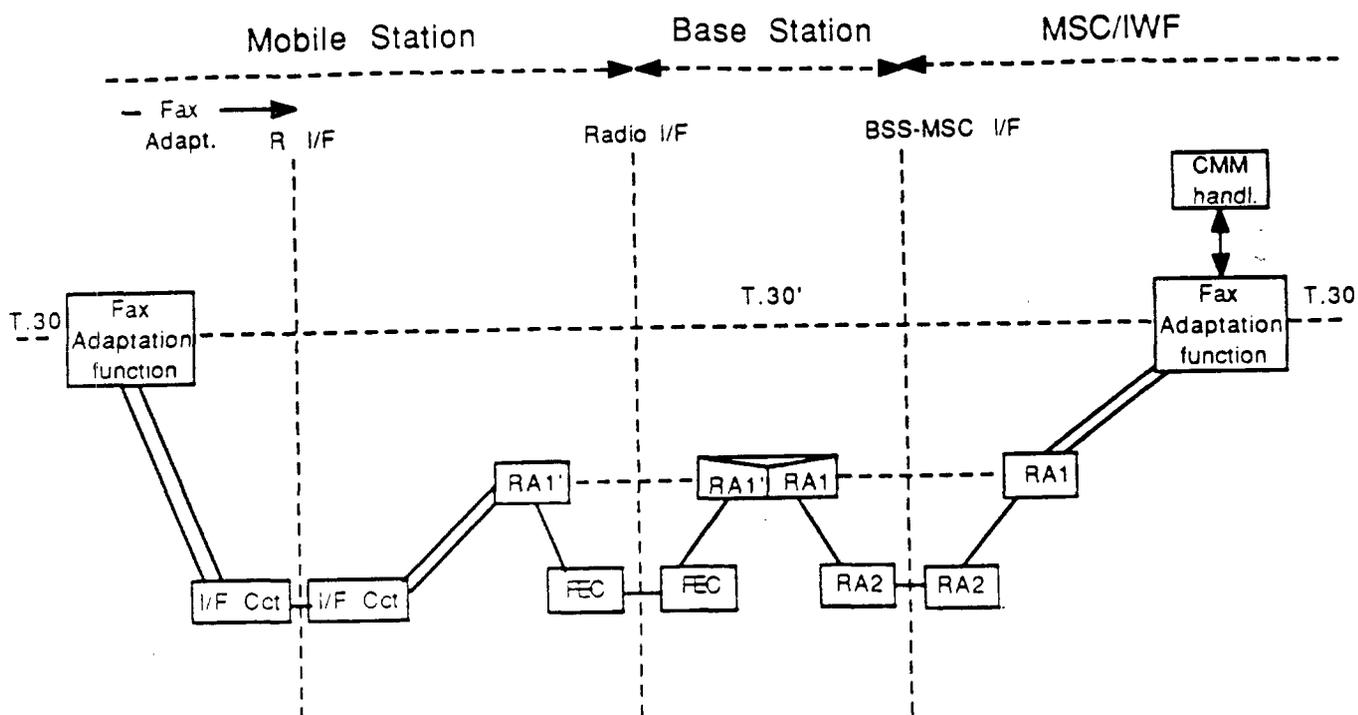


Fig. 5/03.45 Protocol model for transparent support

4.2 Manipulation of T.30 for GSM facsimile Teleservice

The philosophy of this Recommendation is to allow the T.30 protocol to pass transparently wherever possible, through the IWF and the fax adaptor.

Manipulations are only made to the protocol where necessary to overcome problems resulting from the differences between the PSTN and the GSM system.

Basically, these problems fall into four categories:

- supporting facsimile on a digital connection type;
- bit errors during message transfer;
- the need to change speed to reduce the impact of bit errors during the document transfer portion;
- inability to support some features of T.30.

In order to carry out the necessary manipulation, the IWF and the fax adaptor (fig 2a/03.45) or the GSM digital facsimile machine (fig 2d/03.45) monitor the exchange of frames between the mobile facsimile machine and the machine in the fixed network.

As detailed below, some fields in some frames may need to be changed and in some instances, the T.30 process may have to be interrupted to carry out modification to the radio channel.

4.2.1 Speed conversion for BCS phases

Given the signalling load caused by the Channel Mode Modify procedure, rather than changing the radio channel speed to 300 bit/s to carry the BCS frames, a speed conversion mechanism is exploited at both the PLMN ends, allowing to maintain the Channel rate of the Message phase (9600/4800/2400 bit/s) during BCS phases.

4.2.1.1 Up-conversion to the Radio Channel rate

At the IWF, on correct receipt from the PSTN of a BCS frame, the complete frame (including one leading flag) is repeatedly sent to the MS. The number of repetitions is governed by the current facsimile Message speed.

Similarly, if either the fax adaptor receives a BCS frame from the mobile facsimile machine, or the GSM facsimile machine wishes to transmit a BCS frame, it is repeatedly sent over the V24 interface via the MT2 to the IWF. Again, the number of repetitions is governed by the current facsimile Message speed.

Thus each BCS frame, typically, will be repeated 'n' times, where:

$$n = \frac{\text{Fax Message speed (9600 or 4800 or 2400 bit/s)}}{\text{Standard BCS speed (300 bit/s)}}$$

Actually, to give further protection against burst errors in the PLMN channel, the same frame, by default, will be repeatedly transmitted until new information received from the analogue link has to be transmitted over the radio link, either a new frame or the fax coded information of a new Message phase.

The DCS frame requires a specific procedure, detailed in the following Section 5.2.2.1 in this Recommendation.

As per T.30 (see section 5.3.3/T.30) the HDLC flag sequence will be used to establish bit and frame synchronization.

To this purpose, during the period when no HDLC structured information is available to be sent between the MS and the IWF, the IWF and the fax adaptor (or GSM facsimile machine) will send HDLC flags to each other.

4.2.1.2 Down-conversion from the Radio Channel rate

At the receiving side, as soon as either the IWF or the fax adaptor (or GSM facsimile machine) receives from the radio link an instance of frame with a correct FCS:

- sends the frame over the analogue link, leaded if appropriate by the correct preamble as per T.30;
- following instances of the same frame received from the radio link will be discarded.

The DCS frame requires a specific procedure, detailed in the following Section 5.2.2.1 in this Recommendation.

During the BCS phase, when either the IWF or the fax adaptor have no frames to transmit on the analogue link the V21 holding mark condition (binary ones) is transmitted.

4.2.2 Checkpointing procedure

Although in the majority of cases, the T.30 protocol can take care of lost frames and easily recover, there are some particularly critical points where two consecutive segments in the procedure, without any interposed acknowledgement, require different transmission speeds (BCS speed/Message speed). In these cases, to grant that a correct change-over from one modem type to another takes place at both the PLMN ends, some additional protection is necessary in the GSM environment.

This protection is given by means of a checkpointing procedure, whereby the transfer of the particular frame between the IWF and the MS is ensured by a simple additional protocol.

The mechanism works as follows.

On the transmitting side, when the IWF or the fax adaptor (or GSM facsimile machine) has a message to send over the radio interface which is recognized as needing to be checkpointed:

- sends the whole message repeatedly (including a leading flag in case of BCS frame) until the echoed version is seen on the received path;
- in the meantime the T.30 procedure is suspended, and the information received from the analogue link is buffered;
- upon receiving the correct echo message, resumes the T.30 procedure by sending over the radio path the buffered information.

On the receiving side, when a message known to be subject to the checkpointing procedure is received over the radio path, the message:

- is sent over the analogue link in the normal way (a single instance);
- is echoed back over the radio path repeatedly, replacing the current default message being transmitted.

4.2.3 Compatibility checking

Some features of T.30 cannot be supported in the GSM PLMN environment.

Fax Adaptation function is in charge of dealing with such compatibility checking.

4.2.3.1 Group 1 and Group 2 support

Group 1 and Group 2 equipments are not supported by the Teleservice as described in this Recommendation.

To this purpose, any tonal signalling specific to the above kind of Fax apparatus will be ignored by the Fax adaptation function at MS and IWF.

4.2.3.2 2400 bit/s handshaking

Only standard 300 bit/s Binary Coded Signaling is supported.

To this purpose the bit in DCS frame relevant to "2400 bit/s handshaking" is always forced to "0" status at IWF.

4.2.3.3 Non-standard facilities

It is not possible to support non-standard facilities since some of these contain proprietary methods of changing modem speed, invisible to the IWF and hence impossible to track.

Fields indicating the use of NSF are therefore deleted at the IWF.

4.2.3.4 7200 bit/s Facsimile Document Transfer

It is not possible to support the transfer of T.4 information at 7200 bit/s as this Bearer Service is not provided by a GSM PLMN.

Therefore, the IWF, on receipt of a DCS indicating 7200 bit/s (either from the MS or the fixed network) will not pass the DCS on and will absorb the subsequent TCF. It will then autonomously return an FTT frame.

4.2.4 Speed checking

If a speed lower than 9600 bit/s is chosen in the call set up message (for example if a better error rate is required), the IWF must carry out the following additional procedures:

- Max speed indicated in the call setup message = 4800 bit/s:
 - * if the IWF receives a DIS or DTC indicating (in bits 11 and 12) V.29 only, the call shall be failed;
 - * if V.29 and V27 ter is indicated, this shall be changed to V27ter;
 - * if other values are present, no action need be taken;
- Max speed indicated in setup = 2400 bit/s:
 - * if the IWF receives a DIS or DTC indicating V.29 only, the call shall be failed;
 - * if V.29 and V27ter, or V27 ter alone is indicated this shall be changed to V27ter fallback;
 - * if V27 ter fallback is indicated, no action shall be taken.

It's worth noting that the "9600 bit/s" as max speed indication in the SETUP message, does not preclude the establishment of a Call towards a Fax GR 3 equipment supporting only 4800 and 2400 bit/s as Message speed. As a matter of fact, due to the multiplexing mechanism for BCS phases (Section 4.2.1) the initial Access Rate (9600 bit/s) will affect only the connection part between the called MS and the associated IWF, whilst the appropriate Message speed will be actually negotiated during the initial BCS phase.

4.3 Radio Channel Modification Procedures

There are two reasons why the characteristics of the radio channel may need to be changed during a call.

Firstly, for the swop from speech to data. In this case the In Call Modification procedure as detailed in GSM Recommendation 04.08 is carried out.

Secondly, if a T.30 speed drop back is requested, a channel mode modify procedure as detailed in GSM Recommendation 04.08 is initiated to match the radio channel rate to the facsimile transmission speed to optimize the error rate.

4.3.1 In Call Modification (ICM)

The speech to facsimile change is initiated by MMI at the MT as in other data services. It is not visible to the fax adaptor (GSM facsimile machine).

If during the facsimile call a return to speech is necessary, this is done using a further ICM initiated from the MT MMI, separately from any alerting function within the facsimile machine.

4.3.2 Channel Mode Modify (CMM)

The channel mode modification procedure is only initiated by the IWF. Its purpose is to reduce the radio channel bit rate to that of the facsimile machines in order to provide as low a bit error rate as possible.

The IWF enters the CMM routine upon detecting the DCS frame sent either from the MS or from the PSTN, inside the checkpointing procedure associated to the DCS frame (see Section 5.2.2.1 in this Recommendation).

In the first case, IWF being actually the receiving side in the facsimile document transmission, the CMM procedure is executed just ahead of the closing of checkpointing. That is, IWF monitors the DCS frame and, if the requested rate differs from the existing radio channel rate, then in sequence:

- issues a CMM request to the new rate;
- waits for the acknowledgement of CMM completed;
- returns back the DCS frame, so closing the checkpointing procedure.

In the second case, IWF being actually the transmitting side in the facsimile document transmission, the CMM procedure is executed ahead of the beginning of checkpointing. That is, IWF monitors the DCS frame and, if the requested rate differs from the existing radio channel rate, then in sequence:

- issues a CMM request to the new rate;
- waits for the acknowledgement of CMM completed;
- initiates the DCS checkpointing procedure according to the normal way.

5. USE OF TERMINAL ADAPTATION FUNCTIONS

According to the Connection types (Fig.5/03.45) there are two classes of TAFs to be considered.

5.1 TAFs defined for synchronous services

Are those described for synchronous transparent bearer capabilities in GSM Rec. 07.03.
The Rate Adaption functions shall comply with the GSM Rec. 04.21
The interchange circuit signaling mapping is in accordance with the GSM Rec.07.03.

5.2 Specific TAFs for facsimile service

Integral part of an end-to-end connection for this Teleservice is the Fax Adaptation function, located at both the PLMN ends and in charge of adapting the T.30 protocol procedure to the GSM PLMN environment, as described in Section 4 of this Recommendation.

The main features relevant to the adaptation function are detailed in the following.
For a better clarification only, in the following a double configuration will be referenced:

- transmitter adaptation function, established at the PLMN side where is located the terminal actually performing document transmission;
- receiver adaptation function, established at the PLMN side where is located the terminal actually receiving the facsimile document.

The proper configuration is settled on both the Network sides by detecting DIS/DTC frame just at the beginning of the B phase in the T.30 protocol procedure.

5.2.1 Message detection

The working principle of this Recommendation is based on detection and control of Key messages in the end-to-end dialogue between the facsimile terminals.

While in BCS, the following frames have to be detected:

- DIS/DTC, to monitor all operational parameters of the transmitting terminal;
- DCS, to realize the actual message transmission speed requested (see Table 2/T.30);
- CFR and MCF, to trigger the Message phase.

- DCN, to initiate the Call release procedure;

During the Message phase (C phase of T.30) a single bit pattern has to be detected, the EOL character (see section 4.1.2/T.4), a unique codeword that can never be found within a valid line of fax coded Data, and used, as per T.4:

- to identify the start of Message phase;
- to control the buffer level;
- to mark the end of Message phase (6 consecutive instances).

5.2.2 BCS phases

The basic mechanism of speed conversion, as described in section 4.2.1 of this Recommendation, applies for all BCS frames.

The DCS frame requires a specific procedure.

5.2.2.1 DCS checkpointing

As the DCS frame (at BCS speed) is directly followed by TCF data at Message speed, to grant a correct change-over from one modem type to another, a checkpointing procedure is executed (Fig. II-1/03.45 and Fig. II-2/03.45), according to the general rules given in section 4.2.2 in this Recommendation.

The transmitter adaptation function, provided the checkpoint is completed (correct DCS received from the remote side), will terminate the transmission of DCS frames by attaching the TCF bitstream received from the local modem, as soon as available.

Otherwise (checkpoint not completed) the TCF frame is buffered, ready for transmission as soon as the the checkpointing is completed.

The receiver adaptation function, upon receipt of a correct instance of DCS frame:

- will send it back repeatedly as default frame;
- will buffer it and discard all DCS frames, following the first one correctly received, until the TCF is recognized (the bitstream following the last HDLC frame pattern).

At that time, while the received TCF data are buffered, the sequence of DCS + TCF will be passed to the analogue link.

The buffer size (see section 5.2.3.1/03.45) is set to store the whole TCF data stream at 9600 bit/s plus DCS frame.

Flag stuffing will be used towards the local terminal to overcome the delay of this procedure, without incurring in the T.30 timeouts.

5.2.3 Message phase

The Message phase (see Fig. II-3/03.45) at both the PLMN ends is triggered by the transit of a frame (either the CFR or the MCF) sent by the receiving terminal to confirm a previous frame from the transmitting terminal, and marking the end of a BCS phase.

The transmitter adaptation function will enter the Message phase as per T.30 standard procedure.

The receiver adaptation function, upon detecting the trigger frame (CFR or MCF), simultaneously:

- will send it repeatedly on the radio link (normally);
- will change Mo-demodulation function to V.27 ter or V.29 CCITT standard and initiate the training at the applicable speed.

Following the training segment, 0s bits will be stuffed towards the facsimile terminal (FILL sequence, see section 4.1.2 of T.4), discarding all the bits received from the radio link, until a EOL character is detected, that will mark the beginning of the real C phase (see Fig. 1/T.4). From this time on, by default, binary ones will be transmitted back over the radio link.

Minor manipulations only will be necessary in the body of message phase.

5.2.3.1 Buffering

Some buffering is required on both the PLMN sides, for compensation against mismatching between PLMN clock speed and local modem clock speed.

In the transmitter adaptation function, when the modem speed is lower, according to T.4 (Section 4.1.3/T.4) a pause may be placed in the message flow by transmitting a FILL sequence (variable string of 0s) between a line of Data and an EOL character.

When the modem speed is higher, as no flow control is provided by T.4 coding, the buffer will store excess data resulting from a fax page transmission.

In the receiver adaptation function, at cross purposes, the same control means will be exploited.

To this purpose, and considering the buffering requirements in BCS phases (see 5.2.2.1/03.45), a buffer size of [16] kByte seems adequate.

5.2.3.2 RTC Sequence checkpointing

The RTC sequence is a string of 6 identical codewords used by T.4 coding procedure to indicate the end of the Message phase.

The codeword (henceforth "EOL codeword") actually is the EOL character for one-dimensional coding, or EOL character plus a tag bit for two-dimensional coding.

To grant a correct progress of the whole procedure, a checkpoint is necessary.

The transmitter adaptation function, upon detecting the end of Message phase (RTC sequence and/or CT109 OFF) will send repeatedly the EOL codeword over the radio link.

While waiting for a replica of the RTC message back from the receiver adaptation function, the ensuing post-message BCS frame will be buffered.

On detecting the RTC message, the T.30 procedure is continued by transmitting the the buffered frame over the radio link.

The receiver adaptation function, upon detecting the RTC message from the radio link:

- after sending the nominal six EOL codewords over the analogue link, will initiate a new BCS phase (with a preliminary preamble);
- will keep sending back EOL codewords towards the radio link (instead of default binary ones) until a correct instance of HDLC frame is received from the same link, interpreted as the real beginning of a new BCS phase.

5.2.4 DISCONNECT procedure

The transmitter adaptation function, upon detection of the DCN frame (see T.30) sent by the local terminal to indicate the end of facsimile transmission, initiates the DISCONNECT procedure.

5.2.5 Timeouts

The overall Fax Adaptation function has no intrinsic timeout, and so relies fully on the timing constraints associated to the end-to-end T.30 procedure.

This means that, no matter of the reference configuration used at the Mobile station, either the "standard" one (Fig. 2a/03.45) or the "GSM Facsimile Machine" (Fig. 2d/03.45), the progress of the Call for this Teleservice will be merely subject to the T.30 typical timing protections, settled externally (physically and/or functionally) with respect to the procedure as above described.

6. SIGNALING ASPECTS

GSM recommendation 07.03 identifies the bearer capability requirements to be supported by the terminal adaptation function in the MT (see Annex for BC and HLC coding). The specific signalling requirements are those for "speech" and "group 3 facsimile". The MT indicates in the call set up request the first requirement e.g. speech, by sending this as the first bearer capability. For an "autocalling" facsimile request, the group 3 facsimile bearer capability is sent as the first bearer capability.

6.1 Transport of Tonal Signals

Because the CCITT defined service uses modems, there are some signals received from the analogue link at the IWF and (where used) the fax adaptor which do not have a direct binary representation. These signals cannot therefore be passed across the radio interface in the same way as the T.30 and T.4 information.

These signals are the modem Called (CED) and Calling (CNG) tones sent at the start of the call.

These are treated as described in 6.1.1 and 6.1.2 below.

6.1.1 Mobile Terminated Call

The PSTN Facsimile apparatus may be manually or automatically calling.

6.1.1.1 Speech than Fax

Refer to the diagram in Fig. II-5/03.45.

In order to make the transition from the speech phase to the facsimile phase, the MODIFY command must be initiated.

On completion of the synchronization process over the radio interface, the modem at the IWF will be automatically selected, and send CED to the PSTN Fax apparatus. Also CT107 shall be turned on by the MT.

In the case where a Fax Adaptor is used, the Fax Adaptor will be connected to line on receipt of CT107. The Fax apparatus will be connected to line by manual intervention, which will cause the Fax Adaptor to turn on CT108.2 towards the MT.

In the case where a GSM facsimile machine is used, CT108.2 will be turned on directly as a result of manual intervention.

The analogue links at both the PSTN side and Mobile side (where a Fax Adaptor is used) will be established in accordance with the appropriate V. series Recommendation.

Note that CT109 and CT106 at the R interface of the MT must be turned on within 9 seconds of DIS being sent from the mobile Fax apparatus.

6.1.1.2 Auto answer

Refer to the diagram in Fig. II-6/03.45.
A call received from the PSTN will cause the MT to turn on CT125 at the R interface.
In the case where a GSM facsimile machine is used, V.25 bis auto answer process is handled directly by turning on CT108.2.
In the case where a Fax Adaptor is used, CT125 will cause ring current to be sent to the mobile Fax apparatus. The Fax Adaptor will turn on CT108.2 when the mobile Fax Apparatus answers the call.

On receipt of CT108.2, the MT will answer the call and initiate the synchronization process over the radio interface. On completion of the synchronization process over the radio interface, the modem at IWF will be automatically selected and send CED to PSTN Fax apparatus. Also CT107 shall be turned on by the MT.

In the case where a Fax Adaptor is used, the Fax adaptor will connect to line on receipt of CT107.

The analogue links at both the PSTN side and Mobile side (where a Fax Adaptor is used) will be established in accordance with the appropriate V. series Recommendation.

Note that CT109 and CT106 at the R interface of MT must be turned on within 9 seconds of DIS being sent from the mobile Fax apparatus.

6.1.2 Mobile Originated call

The PSTN facsimile apparatus may be manually or automatically answered.

6.1.2.1 Speech than Fax

Refer to the diagram in Fig. II-7/03.45.
In order to make the transition from the speech phase to the facsimile phase, the MODIFY command must be initiated, which will result in a synchronization phase over the radio interface.

In the case where a Fax Adaptor is used, the mobile Fax apparatus must be connected to line by manual intervention at this stage, and will cause the Fax Adaptor to turn on CT108.2 towards the MT.

In the case where a GSM facsimile machine is used, CT108.2 shall be turned on when the GSM facsimile apparatus is connected to line by manual intervention.

On completion of the synchronization process over the radio interface, the modem at IWF will be automatically selected and send CED to PSTN Fax apparatus. Also CT107 shall be turned on by MT.
In the case where a Fax Adaptor is used, the receipt of CT107 shall cause the Fax Adaptor to connect to line.

The analogue links at both the PSTN side and Mobile side (where a Fax Adaptor is used) will be established in accordance with the appropriate V. series Recommendation.

Note that, in the case where a Fax Adaptor is used, the analogue link at the mobile station must be fully established no later than 9 seconds after receipt of CT106 by the Fax adaptor from the MT.

6.1.2.2 Auto calling

Refer to the diagram in Fig. II-8/03.45.
The autocalling procedure of V.25 bis is initiated over the V.24 interface. This is done either directly from the GSM facsimile machine or, in the case where a Fax Adaptor is used, by loop disconnect or DTMF dialling information between the mobile Fax apparatus and the Fax Adaptor.

When the call is answered, a synchronization phase will take place over the radio interface.

On completion of the synchronization process over the radio interface, the modem at IWF will be automatically selected and send CED to PSTN Fax apparatus. Also CT107 shall be turned on by MT.
In the case where a Fax Adaptor is used, the receipt of CT107 shall cause the Fax Adaptor to connect to line.

The analogue links at both the PSTN side and Mobile side (where a Fax Adaptor is used) will be established in accordance with the appropriate V. series Recommendation.

Note that, in the case where a Fax Adaptor is used, the analogue link at the mobile station must be fully established no later than 9 seconds after receipt of CT106 by the Fax adaptor from the MT.

6.1.2.3 Manual calling

Refer to the diagram in Fig. II-9/03.45.
When the call is answered a synchronization phase will take place over the radio interface.

In the case where a Fax Adaptor is used, the mobile Fax apparatus must be connected to line by manual intervention at this stage, and will cause the Fax Adaptor to turn on CT108.2 towards the MT.
In the case where a GSM facsimile machine is used, CT108.2 shall be turned on when the GSM facsimile apparatus is

connected to line by manual intervention.

On completion of the synchronization process over the radio interface, the modem at IWF will be automatically selected and send CED to PSTN Fax apparatus. Also CT107 shall be turned on by MT.

In the case where a Fax Adaptor is used, the receipt of CT107 shall cause the Fax Adaptor to connect to line.

The analogue links at both the PSTN side and Mobile side (where a Fax Adaptor is used) will be established in accordance with the appropriate V. series Recommendation.

Note that, in the case where a Fax Adaptor is used, the analogue link at the mobile station must be fully established no later than 9 seconds after receipt of CT106 by the Fax adaptor from the MT.

7. INTERWORKING TO FIXED NETWORKS

PSTN and ISDN only are considered, both used as transit network to complement the PLMN in the end-to-end connection between GR 3 facsimile apparatus, Fig. 6/03.45.

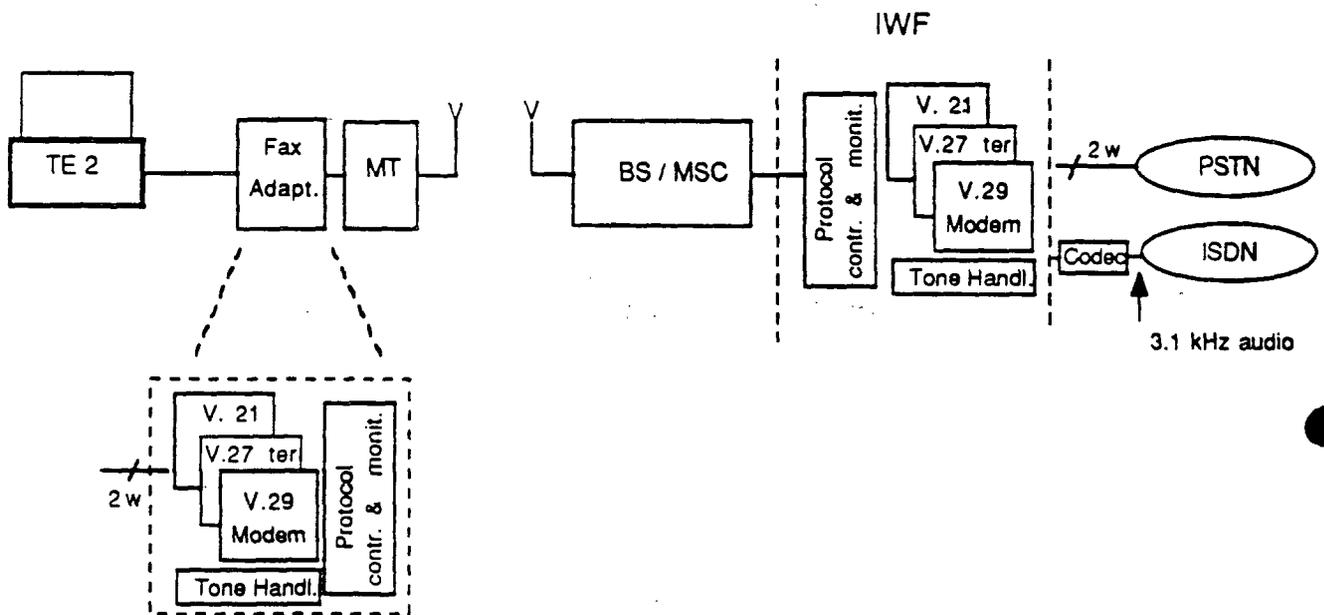


Fig. 6/03.45 Network interworking

7.1 Interworking to PSTN

As the standard access of Group 3 facsimile terminals for this Teleservice is a 2-wire analogue interface, all the technical requirements for network interworking to PSTN are identical in principle to those encountered for the terminal connection to the MT.

The key functional block is the fax adaptor described in Section 4 of this Recommendation.

As far as network interworking is concerned, the main function to be performed by such block is the correct managing of a composite modem, in accordance with the requirements of CCITT Rec. T.30:

- V.21 synchronous mode, as standard facility for all BCS phases;
- V.27 ter for message speeds of 4800 and 2400 bit/s;
- V29 for 9600 bit/s message speed.

The mechanism for selecting the right modem is the following:

- the actual message speed is obtained by detecting the DCS frame (see Table 2/T.30) while in BCS phase;
- on entering the Message phase, there is an interchange between the V.21 modem and the actual modem agreed upon between the terminals for message transmission;
- on exiting the Message phase (RTC checkpointing) the V.21 modem is selected again.

Times for settling the modems will be in accordance with the requirements of Rec. T.30.

7.2 Interworking to ISDN

The use of 3.1 kHz bearer capability of ISDN allows for an interworking of PLMN very similar in practice to the scheme for PSTN, Fig. 6/03.45.

The fax adaptor function is in conformance with the description given in Sections 4 and 7.1 of this Recommendation.

8. SUPPORT OF GROUP 3 ERROR CORRECTION PROCEDURE

The optional error correction procedure, as defined in CCITT T.4 and T.30 Recommendations may be fully supported, provided some specific features are included in the Fax Adaptation procedure.

These features are relevant to :

- additional HDLC frames to be detected;
- handling of the Message phase.
- modification of the Channel rate (CMM request);

The overall framework as described in Section 4 of this Recommendation applies.

The Error Correction mode is entered upon detection of the relevant bits in the DIS/DTC frame (*).

8.1 Frame detection

During the BCS phases, besides the frames enlisted in Section 5.2.1/03.45, some HDLC frames typical of T.30 Error Correction Mode have to be monitored:

- CTC/EOR, fixing the retransmission strategy by the Fax transmitting terminal;
- CTR/ERR, acting as confirmation message and so closing a BCS phase before a new Message phase;
- PPR, as above, but after the fourth consecutive PPR request, the BCS phase continues (with either a CTC or EOR).

8.2 Message phase

As the fax coded data are structured in HDLC frames, the handling of this procedure segment will exploit such formatting.

The Message phase (see Fig. II-4/03.45) at both the PLMN ends is triggered by the transit of a confirmation frame (CFR or MCF or PPR) sent by the receiving terminal and marking the end of a BCS phase.

If four consecutive PPR are counted within the same "partial page", the BCS phase continues.

(*) If not supporting this mode, the Fax Adaptation function in the IWF will strip these bits, forcing the standard T.30 procedure.

The transmitter adaptation function will enter the Message phase as per T.30 standard procedure.

The receiver adaptation function, upon detecting the trigger frame, at the same time:

- will send it repeatedly on the radio link (normally);
- will change Mo-demodulation function to V.27 ter or V.29 CCITT standard and initiate the training at the applicable speed.

Following the training segment, HDLC flags will be stuffed towards the facsimile terminal, discarding all the data received from the radio link, until a FCD frame is detected, that will mark the beginning of the real C phase. From this time on, by default, HDLC flags will be transmitted back over the radio link.

The same buffering approach as for standard T.30 procedure (see Section 5.2.3.1/03.45) will be exploited to overcome the mismatching in clock speed between PLMN and the local modem.

8.2.1 RCP checkpointing

Three RCP frames are used by T.4 coding procedure to indicate the end of the Message phase for any "partial page".

To grant a correct progress of the whole procedure, a checkpoint is necessary.

The transmitter adaptation function, upon detecting the end of Message phase (a single RCP frame and/or CT109 OFF) will send repeatedly the RCP frame over the radio link. While waiting for an echo of the message back from the receiver adaptation function, the ensuing post-message BCS frame will be buffered. On detecting a single RCP frame, the T.30 procedure is continued by transmitting the the buffered BCS frame over the radio link.

The receiver adaptation function, upon detecting the RCP frame from the radio link:

- after sending the nominal three RCP frames over the analogue link, will initiate a new BCS phase (with a preliminary preamble);
- will keep sending back RCP frames towards the radio link (instead of the default HDLC flags) until a correct instance of BCS frame is received from the same link, interpreted as the real beginning of a new BCS phase.

8.3 Additional CMM request

While in BCS the CTC frame has to be detected, due to the possible (not mandatory) implication of changing the transmission speed to a fallback bit-rate.

The CMM request towards the PLMN (when appropriate) is issued at the IWF side, by exploiting the bit-rate indication in the CTC frame, similar to the indication in DCS frame.

Upon detecting the CTC frame, either sent by the PSTN or by the MS, provided the transmission speed indication is different from the existing Channel rate, before passing on this frame, the adaptation function will fully execute the CMM procedure.

Annex

Radio Channel Requirement	Full rate channel
Coding Standard	GSM standard
Transfer Mode	Circuit mode
Information Transfer Capability	Facsimile Group 3
Structure	Unstructured
Duplex Mode	Full duplex
Configuration	Point-to-point
Establishment	Demand
Rate Adaption	V.110/X30 rate adaption
Signalling Access Protocol	
Synch/Asynch	Synchronous
Number of Data Bits	8 bits
User Rate	9.6 Kbit/s, 4.8 kbit/s, 2.4 kbit/s
Intermediate Rate	16 kbit/s, 8 kbit/s
Network Independent Clock on Tx	
Network Independent Clock on Rx	
Number of Stop Bits	
Connection Element	Transparent
Modem Type	None
User Information Layer 2 Protocol	

Table A-1/03.45 Bearer Capability Information Element

High Layer Characteristics Identification	Facsimile Group 2/3 (Recommendation T.62)
---	--

Table A-2/03.45 High Layer Compatibility

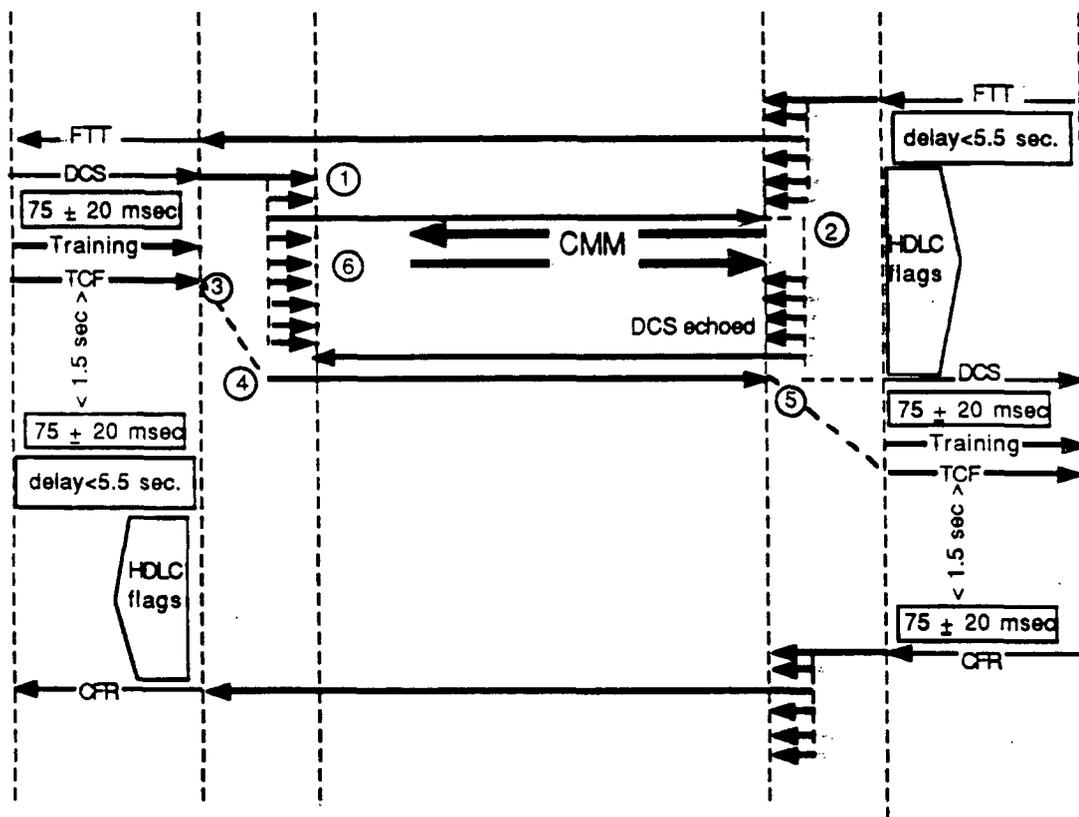
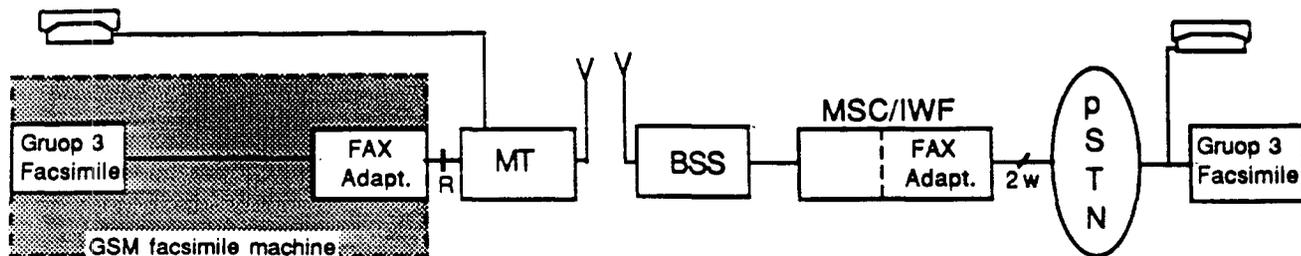
Appendix I

Abbreviations from CCITT T.30

Abbreviation	Function	Signal format	T.30 Standard	T.30 Err. Corr.
CED	Called station identification	2100 Hz	X	X
CFR	Confirmation to receive	X010 0001	X	X
CRP	Command repeat	X101 1000	X	X
CIG	Calling subscriber identification	1000 1000	X	X
CNG	Calling tone	1100 Hz	X	X
CSI	Called subscriber identification	0000 0010	X	X
CTC	Continue to correct	X100 1000		X
CTR	Response to continue to to correct	X010 0011		X
DCN	Disconnect	X101 1111	X	X
DCS	Digital command signal	X100 0001	X	X
DIS	Digital identification signal	0000 0001	X	X
DTC	Digital transmit command	1000 0001	X	X
EOM	End of message	X111 0001	X	
EOP	End of procedure	X111 0100	X	
EOR	End of retransmission	X111 0011		X
ERR	Response to end of retransmission	X011 1000		X
FCD	Facsimile coded data	0110 0000		X
FCF	Facsimile control field	--	X	X
FCS	Frame checking sequence	16 bit	X	X
FIF	Facsimile information field	--	X	X
FTT	Failure to train	X010 0010	X	X
MCF	Message confirmation	X011 0001	X	X
MPS	Multi-page signal	X111 0010	X	
NSC	Non-standard facilities command	1000 0100	X	X
NSF	Non-standard facilities	0000 0100	X	X
NSS	Non-standard set-up	X100 0100	X	X
PIN	Procedural interrupt negative	X011 0100	X	X
PIP	Procedural interrupt positive	X011 0101	X	X
PIS	Procedure interrupt signal	462 Hz	X	X
PPR	Partial page request	X011 1101		X
PPS	Partial page signal	X111 1101		X
PRI	Procedure interrupt	X111 XXXX	X	
RCP	Return to control for partial page	0110 0001		X
RNR	Receive not ready	X011 0111		X
RR	Receive ready	X111 0110		X
RTN	Retrain negative	X011 0010	X	X
RTP	Retrain positive	X011 0011	X	X
TCF	Training check frame	0... 1.5s	X	X
TSI	Transmitting subscriber identification	X100 0010	X	X

Abbreviations from CCITT T.4

EOL	End of line	0000 0000 0001
RTC	Return to control	6 * EOL



- ① DCS checkpointing initiated
- ② Upon detecting a DCS frame requiring a different message speed, the CMM procedure is executed before closing DCS checkpointing.
- ③ TCF data are buffered, while waiting for DCS checkpointing complete.
- ④ Upon completion of DCS checkpointing (DCS frame echoed) TCF data are sent over the radio link.
- ⑤ Upon detecting TCF data (no more HDLC frame patterns) DCS+TCF is passed.
- ⑥ Clock speed changes

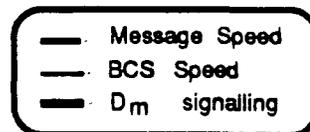
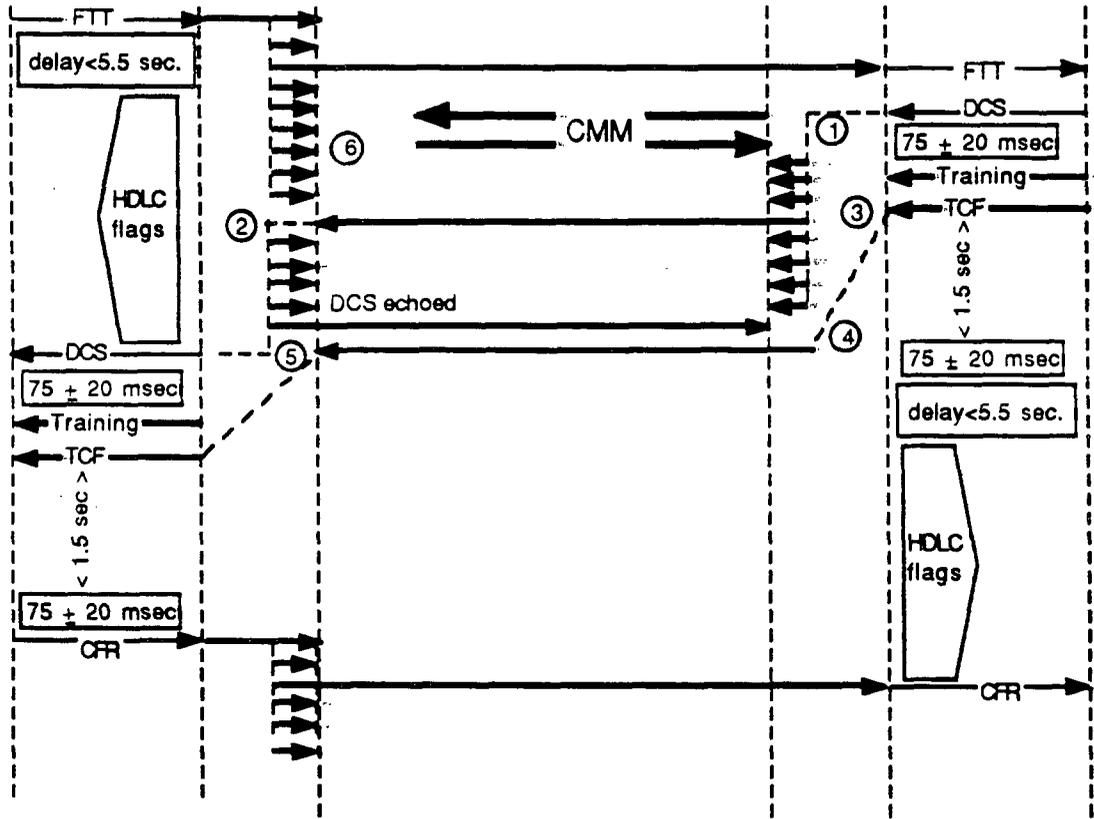
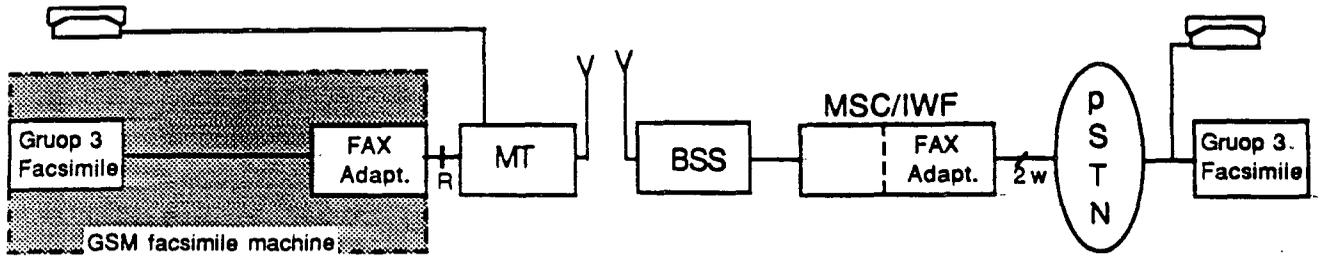


Fig. II-1/03.45

- Mobile originated facsimile transmission -
DCS checkpointing including CMM procedure



- ① Upon detecting a DCS frame requiring a different message speed, the CMM procedure is executed before initiating DCS checkpointing.
- ② Closing checkpointing loop.
- ③ TCF data are buffered, while waiting for DCS checkpointing complete.
- ④ Upon completion of DCS checkpointing (DCS frame echoed) TCF data are sent over the radio link.
- ⑤ Upon detecting TCF data (no more HDLC frame patterns) DCS+TCF is passed.
- ⑥ Clock speed changes

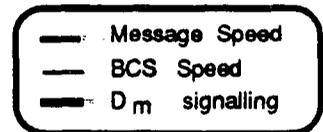
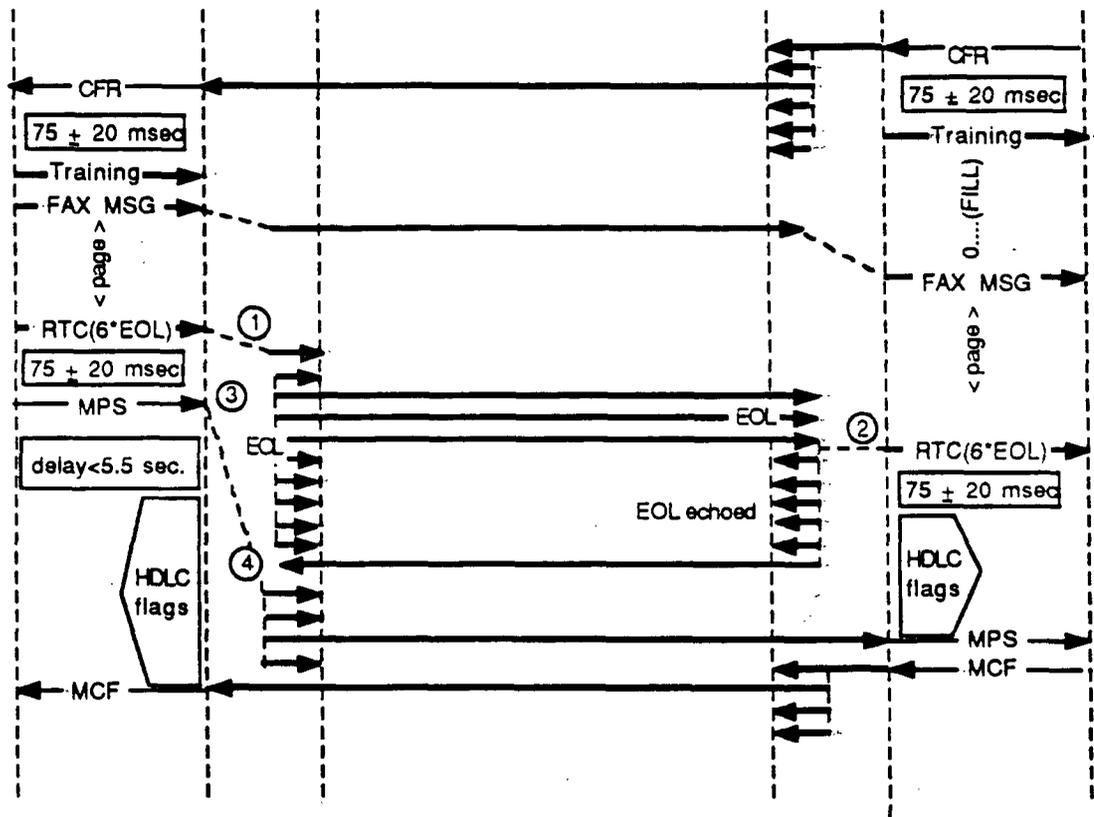
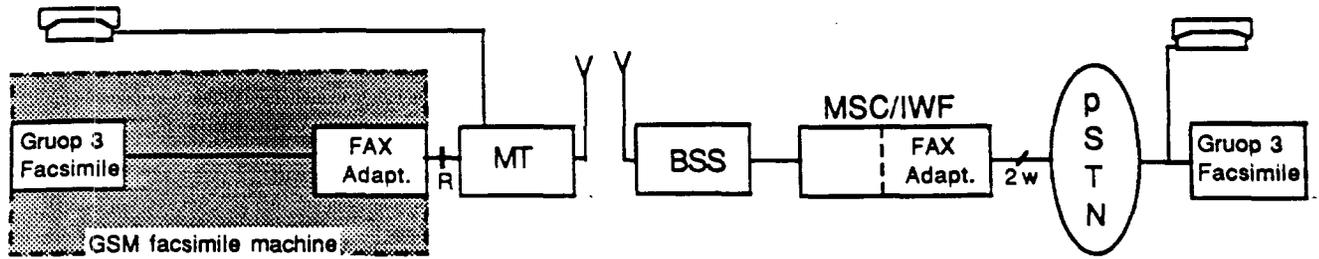


Fig. II-2/03.45

- Mobile terminated facsimile transmission -
DCS checkpointing including CMM procedure



- ① Upon detecting the end of Message phase (RTC sequence and/or CT109) EOL codewords are sent continuously.
- ② When a whole RTC sequence has been received, the new BCS phase is initiated towards the analogue link, and EOLs looped back.
- ③ BCS frames received during RTC checkpointing are buffered.
- ④ On completion of the RTC checkpointing (6 EOLs echoed) the T.30 post-message dialogue is restored.

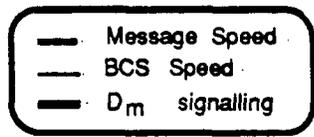
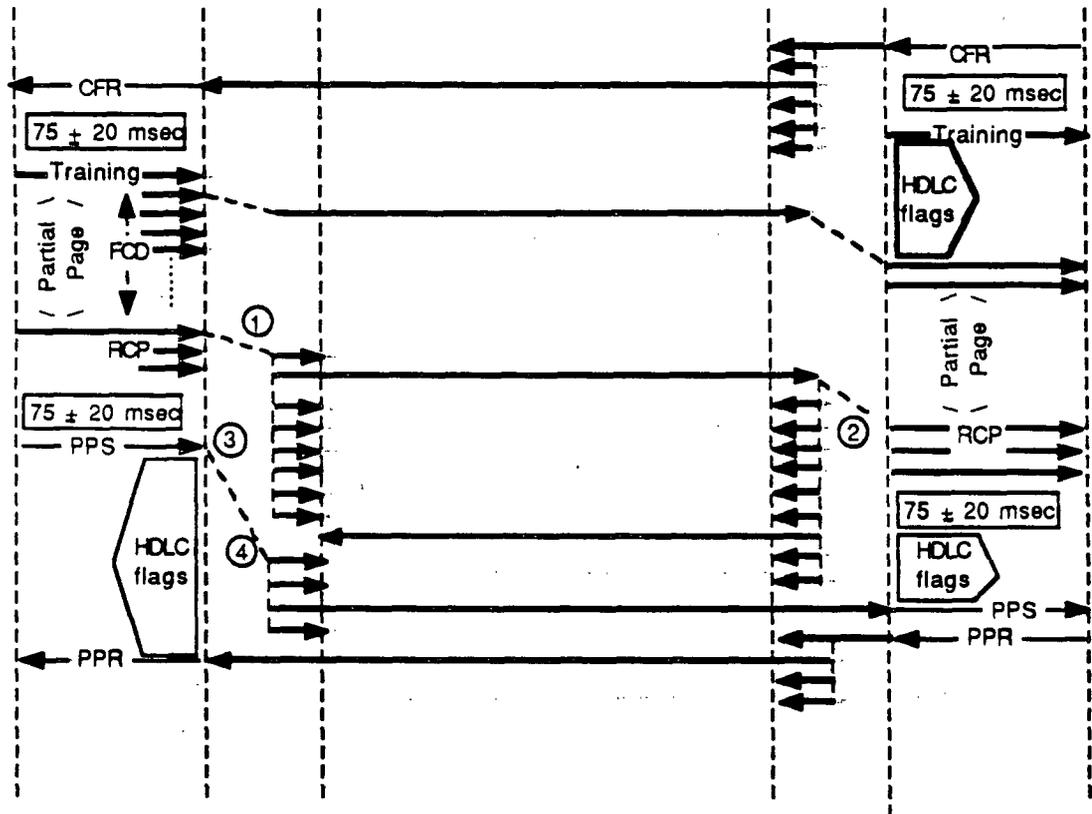
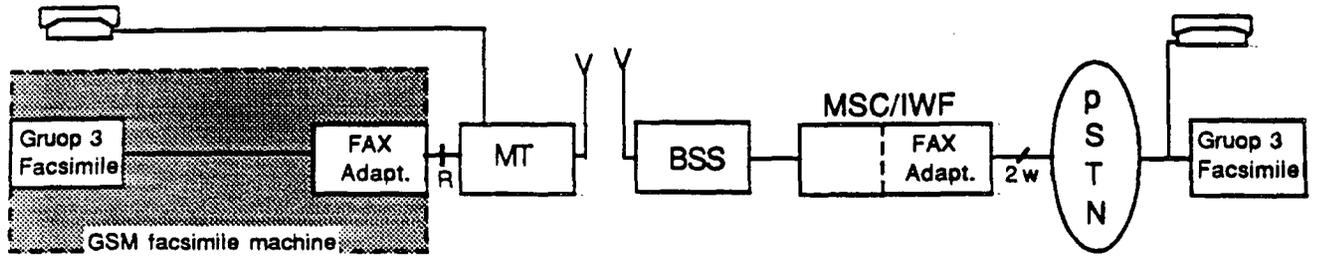


Fig. II-3/03.45
Message phase and RTC checkpointing



- ① Upon detecting the end of Message phase (RCP frame and/or CT109) RCP frames are sent continuously.
- ② When a single RCP frame has been received, 3 RCPs are passed. After that, the new BCS phase is initiated towards the analogue link. RCPs are looped back.
- ③ BCS frames received during RCP checkpointing are buffered.
- ④ On completion of the RCP checkpointing (single RCP echoed) the T.30 post-message dialogue is restored.

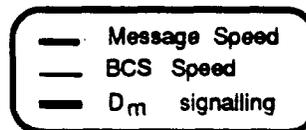
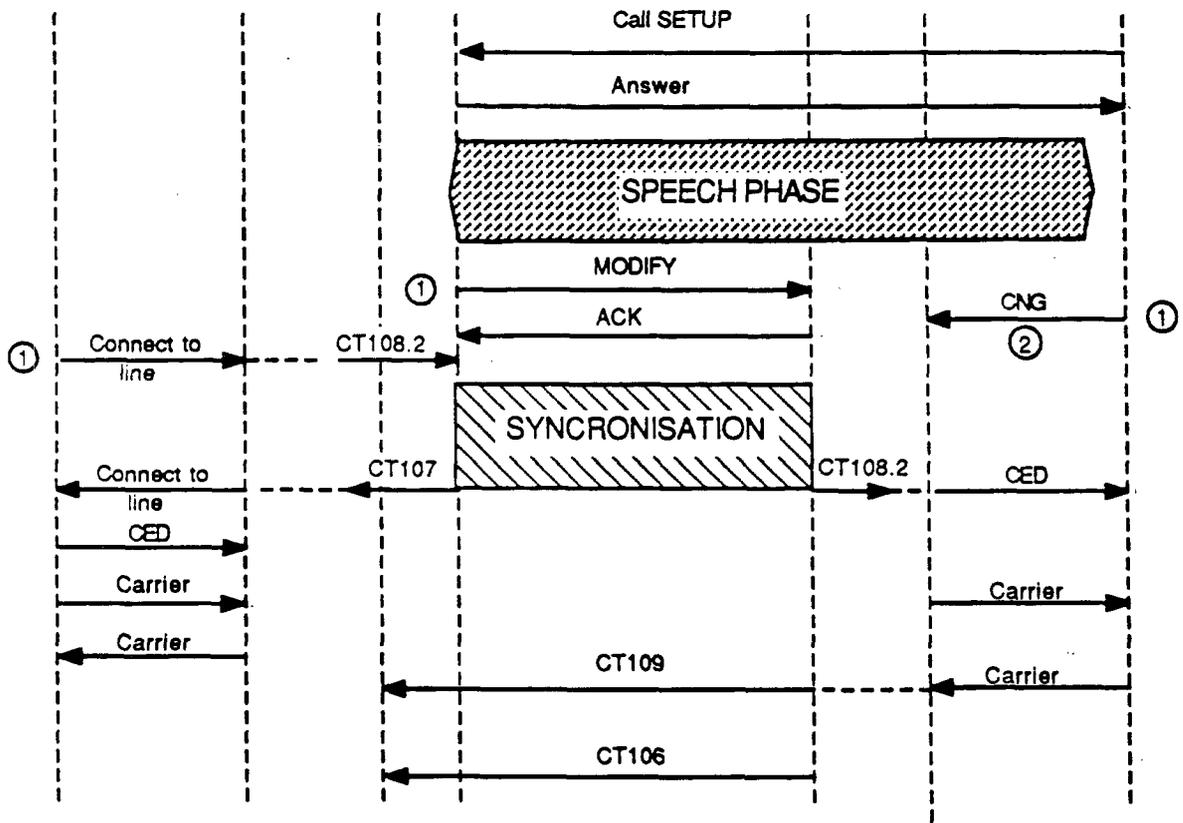
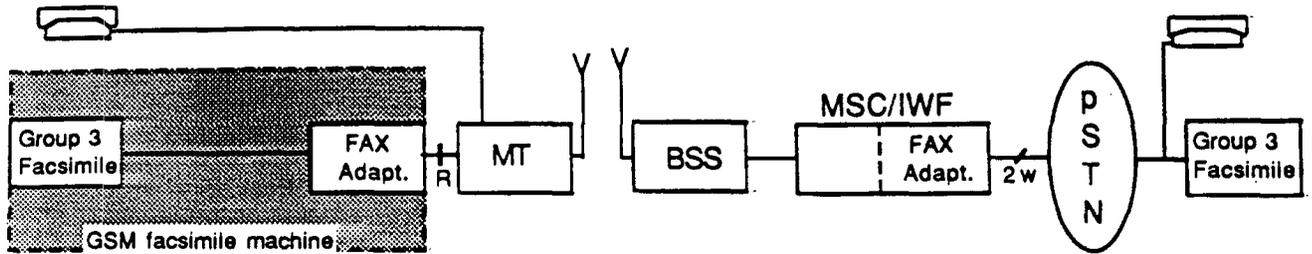
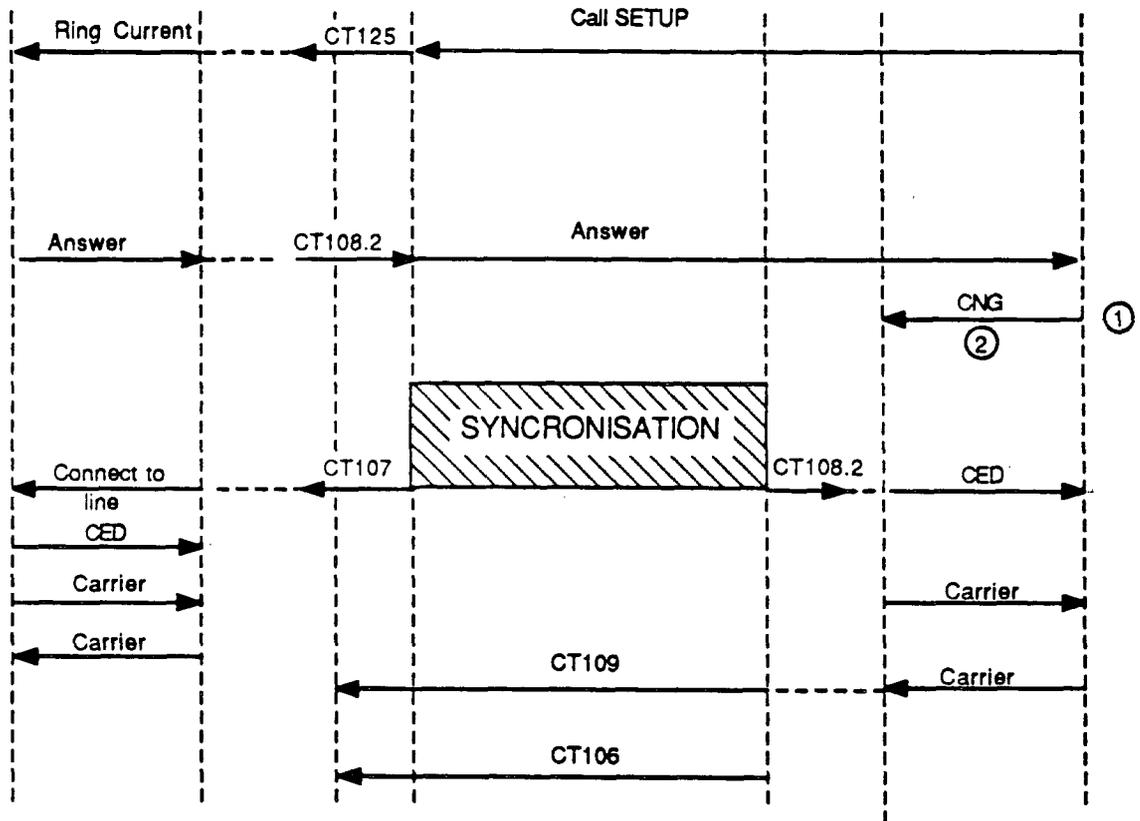
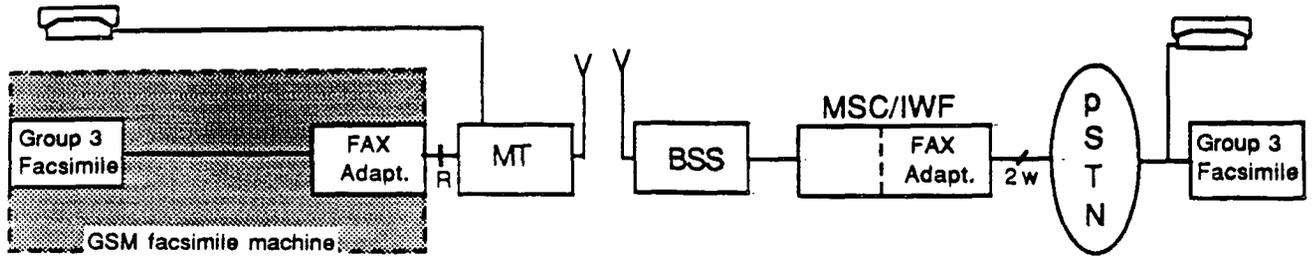


Fig. II-4/03.45
 - T.30 Error Correction Mode -
 Message phase and RCP checkpointing



- ① Manual intervention
- ② Not mandatory

Fig. II-5/03.45
 - Mobile Terminated Call - Speech than Fax



① Manual intervention

② Not mandatory

Fig. II-6/03.45
- Mobile Terminated Call - Auto Answer

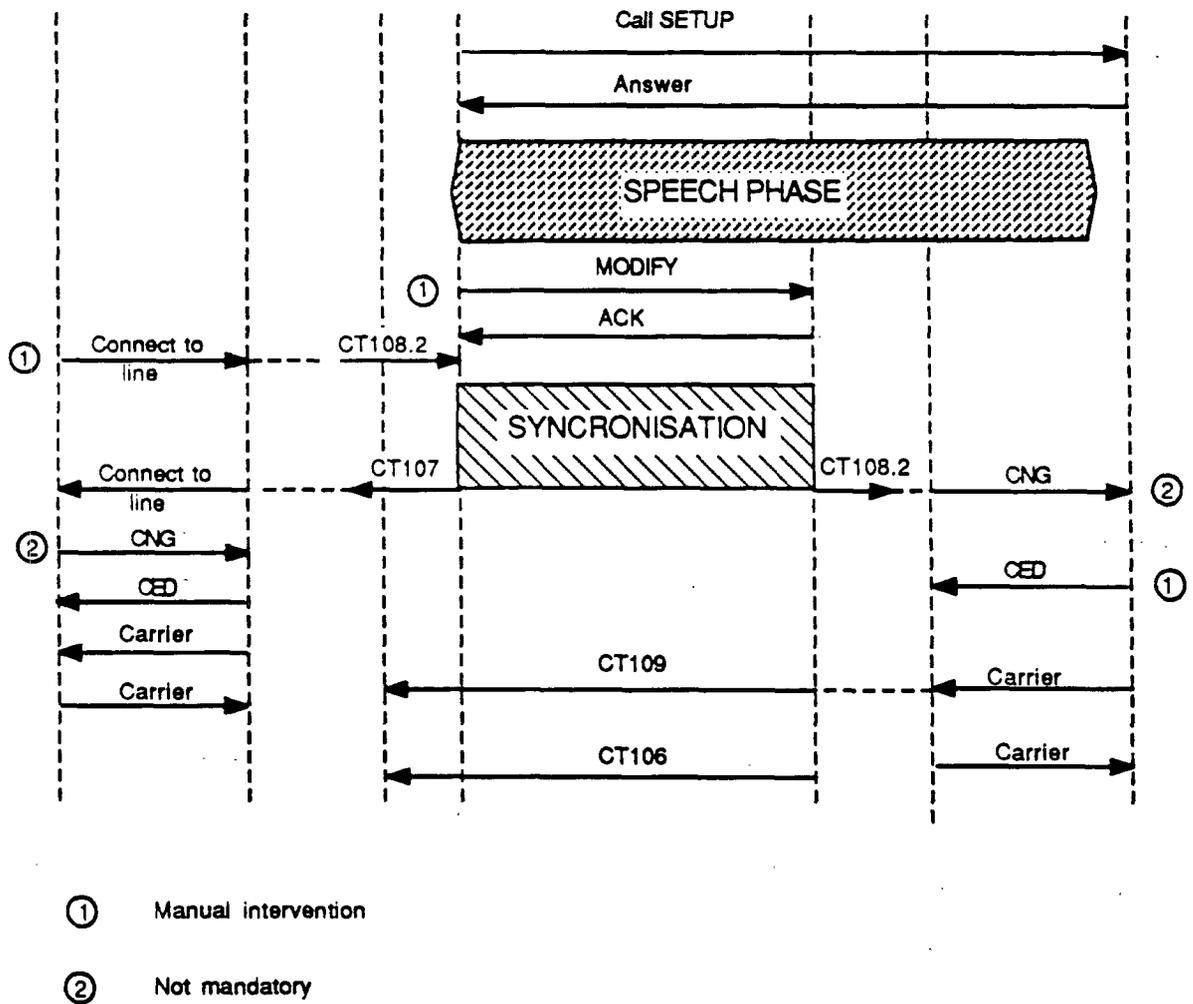
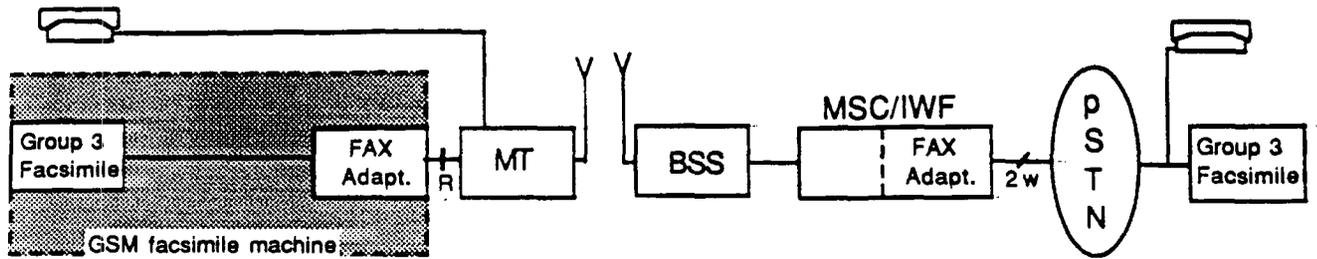
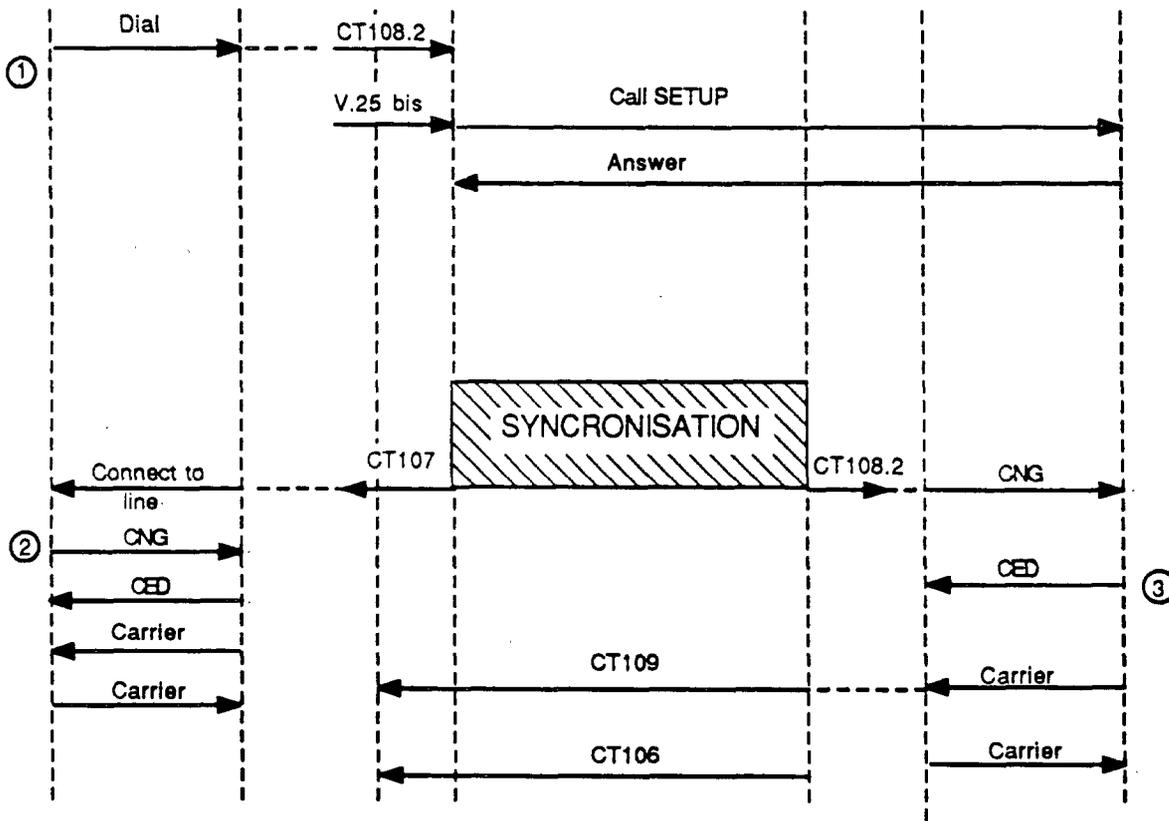
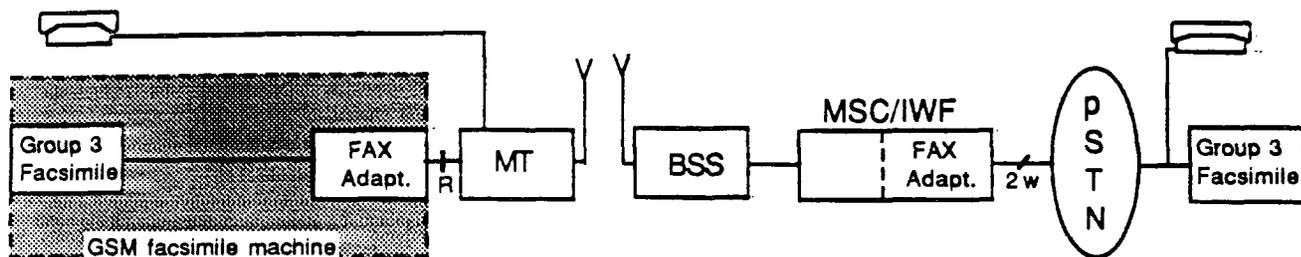
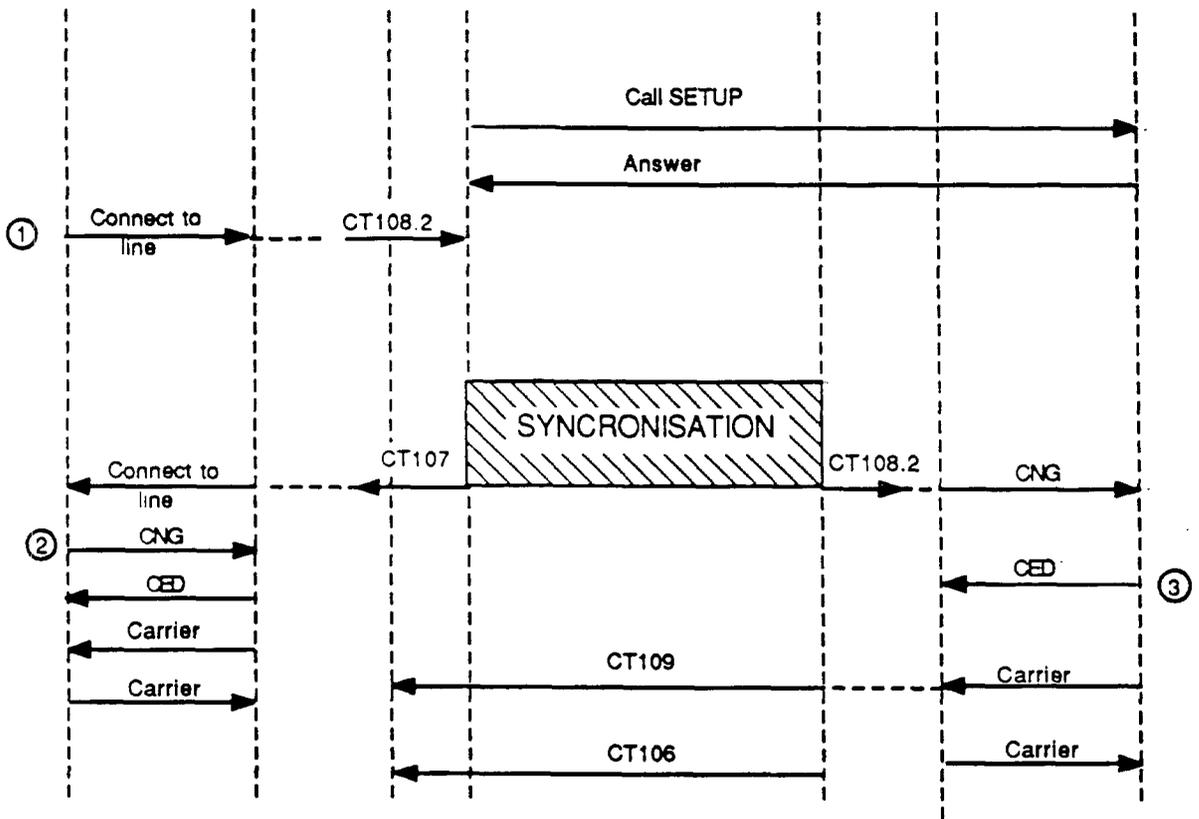
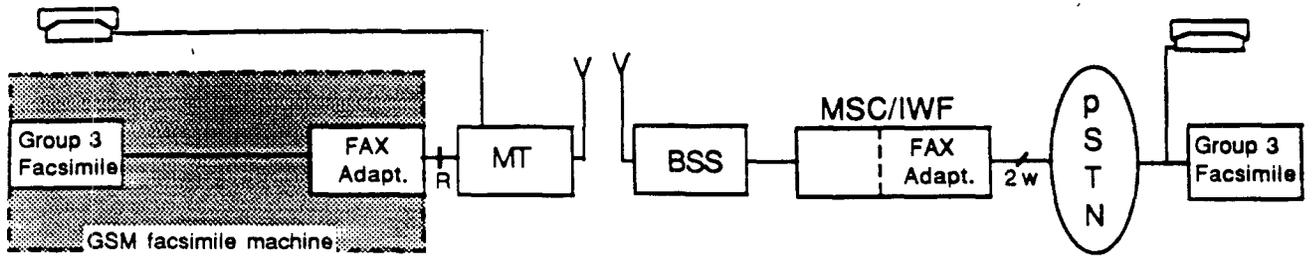


Fig. II-7/03.45
 - Mobile Originated Call - Speech than Fax



- ① Manual intervention
- ② Not mandatory
- ③ PSTN Fax apparatus may be manually or automatically answered

Fig. II-8/03.45
- Mobile Originated Call - Auto Calling



- ① Manual intervention
- ② Not mandatory
- ③ PSTN Fax apparatus may be manually or automatically answered

Fig. II-9/03.45
 - Mobile Originated Call - Manual Calling

