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FFFS FOR

CONFIRMATION OF HIGH PRIORITY CALLS

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EVOLUTION SHEET

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1. SCOPE

This Form Fit Functional Specification (FFFS) specifies the functions required from the GSM-R network for the confirmation of high priority calls.
Defined in this FFFS are :

- The mobile application process including the data to be sent to acknowledgement centre
- The fixed application process

Not defined in this FFFS

- The interface to the acknowledgement centre

The confirmations are recorded by an acknowledgement centre to ensure the ability of **post-incident analysis**. The acknowledgement centre itself is external to the GSM-R network and therefore not subject of this specification. Only functional requirements for such a device are mentioned in order to describe the total functionality of the realised service.

The confirmation of high priority calls ensures an automatic confirmation of high priority voice broadcast and voice group calls, particularly of emergency calls, to an acknowledgement centre.

The location dependent addressing according to [1] serves for the addressing of the confirmation message to the correct acknowledgement centre.

2. NORMATIVE REFERENCES

[1] MORANE FFFS for Location Dependent Addressing F 10 T 6001
[2] MORANE SSRS A 04/02 T 6002
[3] MORANE FIS for Confirmation of high priority calls F 12 T 6002
[4] 3GPP TS 23.068 Voice Group Call Service VGCS ()
[5] 3GPP TS 23. Voice Broadcast Service VBS ()
[6] 3G TS 24.087, v 3.0.0: User-to-user signalling (UUS) Service description – Stage 3
[7] 3G TS 24.008, v3.2.1 Mobile Radio Interface Layer 3 Spec.
[8] 3G TS 24.007, Version 3.2.0, Mobile Radio Interface Layer 3 General aspects
[9] MORANE FFFS for Presentation of Functional Numbers, Ref.: F 10 T 6003
[10] MORANE FFFIS for GSM-R SIM cards, Ref.: P 38 T 9001
[11] ETSI ETS 300 102-1
[12] MORANE “Usage of the UUIE in the GSM-R Environment”, Ref. H 22 T 0001
[13] 3GPP TS 24.008 3.3.0 Mobile radio interface layer 3 specification, Core Network Protocols - Stage 3
[14] 3GPP TS 22.087 v3.1.0

3. DEFINITIONS AND ABBREVIATIONS

3.1. Definitions

Application	Logical and/or physical entity that controls the confirmation process. It will have access to services of the GSM-R network at interfaces provided by the mobile termination (mobile application) and/or a fixed network user terminal (fixed network application). The fixed network application is realised by the Acknowledgement Centre(AC).
Ready to Receive State	State of the mobile termination after the voice broadcast or voice group call traffic channel has been set up and the mobile is ready to receive the broadcast or group call speech-information.
Post-Incident Analysis	Analysis that will **not** be done on-line, but triggered by some special events (e.g. post investigation of accidents). Not a time critical feature.
active FNR	active Functional number, in the case of a mobile registered to more than one FNR the active one is the one which would also be presented by the service 'Presentation of Functional Numbers'
Clear-Down	The mobile termination disconnects from the call this clear down can be caused by normal call termination, leaving the service area or radio link failure.

3.2. Abbreviations

AC	Acknowledgement Centre
BSS	Base Station System
CP	Control Protocol
EF	Elementary File (on SIM)
EIRENE	European Integrated Railway Radio Enhanced Network
ETSI	European Telecommunications Standard Institute
FFFS	Form Fit Functional Specification
FIS	Functional Interface Specification
FNR	Functional Number
GC_REF	Group Call reference (parameter in confirmation message)
GMSC	Gateway MSC
GSM	Global System for Mobile Communications
GSM-R	GSM Railways
ISDN	Integrated Service Digital Network
MA	Mobile Application
MORANE	Mobile Radio for Railway Networks in Europe
MSC	Mobile Switching Centre
MSISDN	Mobile Station ISDN Number
MT	Mobile Termination
PABX	Private Automatic Branch eXchange
SAPI	Service Access Point Identifier
SIM	Subscriber Identity Module
SS	supplementary service
SSRS	Sub System Requirement Specification
UUS1	User-to-user Signalling Service #1
VLR	Visitor Location Register

4. MAIN CONCEPTS

The necessity to acknowledge a voice broadcast or voice group call can be indicated to the mobile application in two different ways:

- *Explicit indication*: The confirmation flag is set in the notification message of an incoming broadcast/group call.
- *Implicit indication*: By the incoming call priority level, evaluated by the mobile application, when no flag is available.

Which outgoing VBS and VGCS calls have to be confirmed is dependent on the priority level evaluated by the mobile application.

In order to avoid the necessity to implement synchronised clocks on all trains, no absolute time stamps but only relative values are used in the confirmation message.

All together the following parameters are recorded by the confirmation message:

- Identity of the sender
- Duration of the call
- Time since *Clear-Down* of the call
- Group call reference according to [4]
- Priority level of the broadcast/group call
- Cause of termination

The parameter *Duration of the call* defines the time in-between *Ready to Receive State* and *Clear down* of the voice broadcast or voice group call.

After *Clear down* the mobile application starts the confirmation process by automatically originating a call. In order to avoid network congestion, due to simultaneous calls of mobile terminals, the call set-up of each mobile is delayed by a random time offset between 0 and a maximum value. Therefore immediately after each individual subscriber has disconnected from the broadcast/group call (*Clear-Down*), a random timer is started. After the expiry of this timer, the associated mobile application sends the confirmation message to an acknowledgement centre (AC) using the telecommunication service of the GSM-R network UUS1.

The priority of the confirmation message has to be lower than the priority of a broadcast/group call to ensure that the confirmation message can always be interrupted by a new broadcast/group call.

For routing the confirmation message to the appropriate acknowledgement centre (AC) the mechanism of 'location dependent addressing' is used (see [2] and FFFS [1]).
The short code of the AC is stored on the SIM in $EF_{CallConfC}$ (Ref. to [10]). Per MSC zone one acknowledgement centre will be situated. That means the address of the acknowledgement centre to be called always depends on the actual MSC area where the mobile subscriber is located. In the case that a subscriber changes from one MSC area to another during reception of a priority call, the decision for the call routing of the confirmation message is always the location of the mobile subscriber when sending the confirmation message **not** when receiving the group or broadcast call.

The acknowledgement centre has to calculate the absolute call establishment time and *Clear-Down* time of the call itself by using the parameters included in the confirmation message.

5. GENERAL ARCHITECTURE

For group or broadcast incoming calls, which are identified by a confirmation flag in the notification message, the mobile terminations are informed that they have to confirm the message. The confirmation flag is included within the NOTIFICATION messages according to [13]. If no confirmation flag is available the priority level of the incoming broadcast/group call is used to determine the necessity of confirming the call.

For outgoing broadcast/group call, only the priority level (the one assigned by the MSC) is used to determine whether the call has to be confirmed or not.

For the transfer of the confirmation message the standard GSM Supplementary service UUS1 (refer to [14]) is foreseen.
The entities involved in the realisation of the confirmation service are shown in the following figure.

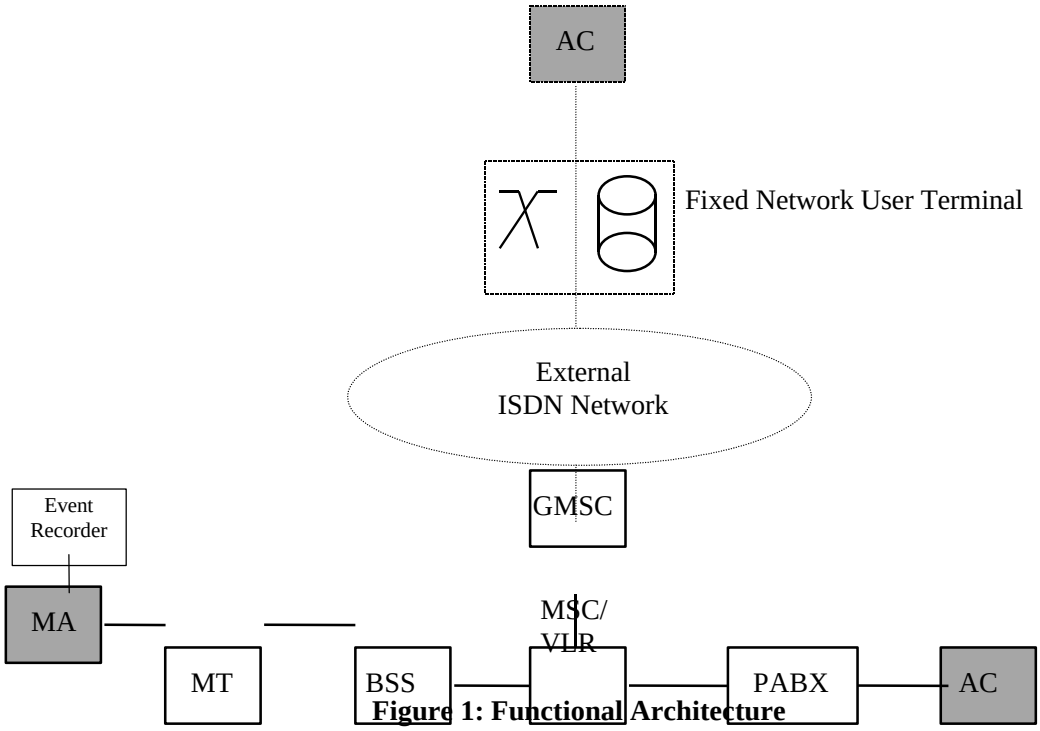


Figure 1: Functional Architecture

NOTE: The functional architecture is only indicative. Normally the acknowledgement centre uses a PABX as fixed network user terminal directly connected to the MSC. But it may also be logically co-located to a fixed network user terminal or co-located with the MSC. The MSC and GMSC may also be collocated.

Considering this functional architecture an end-to-end protocol between the MT and the fixed network user terminal based on the standard GSM supplementary service UUS1 is defined in this FFFS.
The external network has to support the transfer of user-to-user information.

6. SUPPLEMENTARY SERVICE UUS1

The supplementary service UUS1 (Ref. to [14]) enables the transfer of user-to-user information during set-up and clearing phases of a call, with user-to-user information embedded within call control messages. This service allows the transmission of 32 octets to be transmitted per message (although more octets were possible in GSM-network only 32 octets are guaranteed to be transmitted via ISDN-networks).

6.1. Functional message definition

The SETUP message may contain a user-user information element (optional) according [13]. This user-user information element is used for the transfer of the confirmation message to the acknowledgement centre. The usage of the user-user information element implicitly invokes the UUS1 supplementary service.
The supplementary service UUS1 has to be activated in the HLR for all SIMs used on cab radios by default.

Beside the SETUP message the ALERTING, CONNECT, DISCONNECT, RELEASE and RELEASE COMPLETE messages may contain as well a user-user information element according (Ref. to [7]). These messages could be used to acknowledge the reception of a confirmation message towards the mobile application. This service uses for acknowledgement of the confirmation message either RELEASE_COMPLETE or DISCONNECT message. The pair SETUP-RELEASE COMPLETE is the fastest way to use the layer 3 protocol, without assigning any traffic-channels.

6.2. Interaction with other GSM supplementary services

The supplementary service *Calling Line Identification Presentation* (CLIP) is used in addition of UUS1 to record also the MSISDN of the calling subscriber in the acknowledgement centre beside the functional address that is already contained in the confirmation message. The usage of CLIP is necessary to store all the relevant data in one entity, without having the need of retrieving additional registers in case of post-incident analysis.

6.3. Signalling flow

Confirmation of the acknowledgement message (UUS1-acknowledge) can be sent either in RELEASE_COMPLETE or in DISCONNECT message towards the MS. In case the AC uses RELEASE_COMPLETE message for UUS1-acknowledge the remote fixed network application releases the call at the earliest possible time by answering the SETUP with a RELEASE COMPLETE message at an interface complying to ETS 300 102-1[11]). In this case the call set-up is not completed and no further call release procedures are required.
The message flow for the two cases is described here.

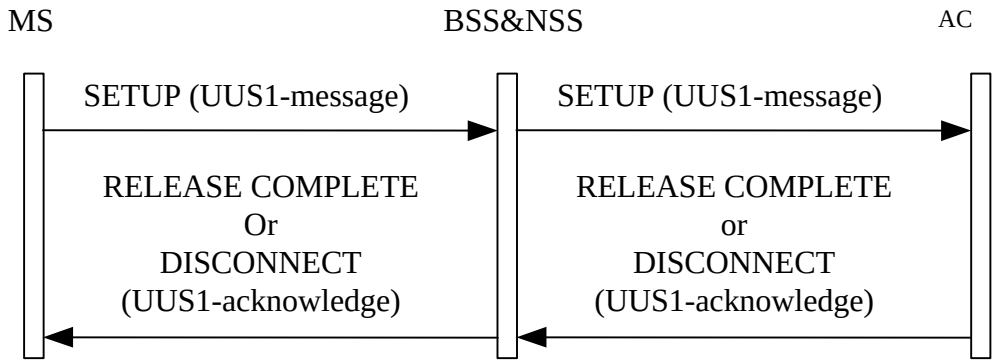


Figure 2: Message flow with User-to-User information

6.4. Normal operation with successful outcome

The user-to-user information is transferred transparently embedded in signalling messages towards the fixed network user terminal. If an external network is used, it has to support the transfer of user-to-user information.

An application associated to the fixed network user terminal has to clear the call and has to acknowledge the received user-to-user information using the user-user information element of either the RELEASE COMPLETE or DISCONNECT message.

The procedure is under control of the mobile application, despite the call is always cleared by the fixed network application associated to the acknowledgement centre. On reception of the positive acknowledgement in either the RELEASE COMPLETE or DISCONNECT message the mobile application considers the confirmation procedure as successful.

6.5. Exceptional procedures or unsuccessful outcome

If no acknowledgement message has been received by the mobile application, despite the call has been cleared (e.g. due to network congestion or radio link failure), the mobile application repeats the procedure by setting up an other call using an updated confirmation message (see section7.1.2).

If a negative acknowledgement message is received by the mobile application, there are two cases to distinguish (see TASK MS-2 part3):

- negative acknowledgement #1 (NACK1) indicates a reparable error , the mobile is requested to repeat the confirmation (as long as the maximum repetition value is not reached) using an updated confirmation message,

- negative acknowledgement #2 (NACK2) indicates a fatal error, the mobile shall not repeat but rather more store an error locally on an event recorder.

If the signalling of the confirmation call cannot be completed (e.g. interruption of the call by a call with higher priority) the mobile application repeats the procedure by setting up a call using an updated confirmation message after termination of the preceding signalling relationship. When more than one confirmation is pending the earliest call shall be confirmed first.

7. APPLICATIONS

The applications are associated to the mobile termination (mobile application) or to the fixed network user terminal (fixed network application). Refer to section 3.1.

In the following the functions required from the applications are specified:

Mobile application:

- Provision of functional called party number when initiating the call
- Provision and reception of the confirmation message
- Procedure control (normal and exceptional procedures)
- Repetition of the AC response

Fixed network application:

Consideration concerning the fixed network application assume the usage of UUS1 as transport mechanism for the user information.

- Clearing of incoming confirmation call with acknowledgement in the UUI
- Recording of the confirmation message
- Calculation of absolute time stamps
- Recording of the corresponding CLIP
- Recording the reception time of the confirmation message

7.1. Mobile application

The mobile application uses service point SAP_M for access to the Call Control sublayer (see figure 4) of the mobile termination to set-up a mobile originated call for the transfer of the confirmation message. This service access point may be provided by an AT command interface according to [8].

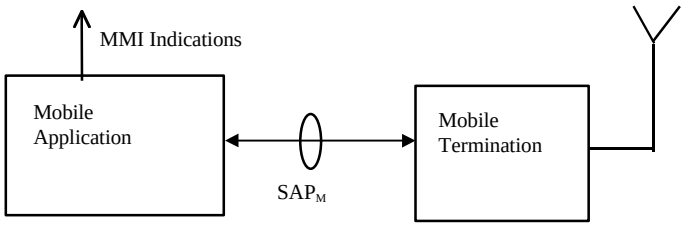


Figure4: Mobile Application connected with MT

7.1.1. Storage of configuration data

The mobile application has to be initialised with configuration data:

- Priority level, which triggers confirmation procedure (PL_ACK)
- Time-out for call clearing (T_ACK)
- Number of repeated trials in case of unsuccessful outcome (N_ACK)
- Priority level of the confirmation call itself (PL_CONF)
- Number of the AC using location depending addressing (CONF_NR)

7.1.2. Confirmation procedure

Group or broadcast calls, which are identified by an acknowledgement flag in the notification message or have a priority level greater than certain threshold PL_ACK, have to be confirmed. Triggered by the *Ready to Receive Event* the mobile application starts a timer T_DUR to record the duration of the group or broadcast call. Additionally the own Functional Number is backed up. In case of a registration of more than one Functional Number the same selection-algorithm as used by the service 'Presentation of Functional Numbers' applies (refer to [9]).

After disconnecting from the broadcast/group call (*Clear Down*), the associated mobile application stops timer T_DUR. Immediately a timer T_REL, that records the time since call clearing and a timer T_RAN that causes a random delay to avoid congestion are started. After expiration of T_RAN the mobile application determines a functional number according the location dependent addressing scheme and provides the confirmation message to the mobile termination with the contents according to the value T_DUR and the actual value T_REL. The call to the acknowledgement centre is set-up and the timer T_ACK is started, during which an answer to the confirmation message is expected.

If a positive acknowledgement of the confirmation message (UUS1) is received, all running timers are stopped and the procedure is recorded as successfully finished.

In all other cases except the reception of N_ACK2 (in case of reception of N_ACK1, time-out of T_ACK or radio resource failure) the call is cleared and the procedure is repeated after re-initialisation of the appropriate parameters (T_REL is continually running and its actual value can be used in an updated confirmation message).

If another call which has to be confirmed arrives before the confirmation of the previous call has been finished all the relevant data for the confirmation shall be backed up and an updated message shall be sent after the new call is ended (after expiry of the random timer which shall be started again). In any case the order of the confirmation shall be that of the incoming calls.

If the mobile has no network connection for any reason the repetitionmechanism shall be frozen and be restarted when the mobile is able to reach the network again. This is to prevent useless attempts in case of failure of a single BTS or in regions with no overall GSM coverage.
A similar mechanism applies for powered off mobile stations: after power on the mobile shall restart to confirm remaining entries if there are any. For this reason non volatile memory for the pending confirmation table plus the provision of timers which do not stop counting in case of power failure are necessary.

If the procedure cannot be finished successfully after N_ACK trials the unsuccessful outcome is recorded locally on the event recorder by the mobile application as exceptional incident.

For cab radios every unsuccessful outcome of a confirmation message shall be recorded in an event recorder for post-incident analysis.
For handheld mobile radios an indication shall be given on the MMI to inform the user about an unsuccessful outcome.

7.1.3. Functional description using SDL charts

The following SDL-charts show the principle function of the service only. The separation into tasks is meant to be one of several possibilities. No assignment to any particular software- or hardware entities is specified herein.

Remark: Only new introduced signals are shown

7.1.3.1.TASK MS-1:

Function
Triggering Confirmation:

- Deciding whether confirmation service routine has to be invoked or not
- Informing about begin of call
- Informing about end of call

Actually, this is very likely not a standalone task, but rather a part of the layer 3 call control for group- and broadcast-calls. The basic intention of the SDL-charts is to show which information is necessary to trigger a confirmation, but not in which SW or HW entity the function is done. In this sense the definition of input-signals is problematic because it is very dependent of the task-border what to has be seen as an internal-signal or really as input-signal respectively. The signal input symbol marked with 'see remark' only appears not to violate the rules for SDL-charts, where at least one input is necessary for any state transition.

Signals
Input-signals (from TASK MS-2):
none

Input-signals (from other sources e.g. Layer3 Call Control, refer to [8]):
Information concerning notification (marked with 'see remark')

(internal signals are not mentioned here)

Output-signals (to TASK MS-2):
Conf. Request = Confirmation request
End of call

Global Storage

Storage of TASK MS-1 (only additional parameters mentioned):
Parameters necessary for deciding:
PL_ACK threshold value (switch for Confirmation Service enable/disable)

Information to be passed to TASK MS-2:
GC_REF
CAUSE
PL_CALL
FNR (active Functional Number)

7.1.3.2.TASK MS-2:

Function

Confirmation Service Routine:

- Getting confirmation-parameters
- sending confirmation-message
- workout problems
- backup confirmation data
- maintain timers
- send data to external event recorder

The signals with the prefix MNCC and their names are not to be taken too seriously. Whether they are external or internal signals depends on how this function (TASK MS-2) will be implemented finally. Their appearance in the SDL-charts shall indicate the triggering of the layer 3 messages SETUP and RELEASE_COMPLETE anyhow (similar to layer primitives they have endings 'REQ' and 'IND' but are not necessarily used between different layers). As mentioned before the SDL-charts shall only show the principle function in addition to the text description, but not implementation details as the assignment to HW or SW entities were.

Signals

Input-signals:
Conf. Request (from TASK MS-1)
End of call (from TASK MS-1)
MNCC_RELEASE_COMPLETE_IND (from layer 3 - Call Control refer to [8])

Internal-signals:
T_RAN expired
T_ACK expired

Output-signals:
MNCC_SETUP_REQ (to layer 3 - Call Control refer to [8])
MNCC_RELEASE_COMPLETE_REQ (to layer 3 - Call Control refer to [8])

Global Storage

For the format and values of the following parameters refer to the related FIS [3]
Storage of Task MS-2:
Parameters for setting up the confirmation call:
N_ACK_MAX
PL_CONF

CONF_NR

Buffer with N_NESTED_MAX - times the following:

T_DUR_s
T_REL_s
PL_CALL
CAUSE
GC_REF
FNR

Event Recording

In order not to overload the SDL-charts only in case of an error the event recording is shown there.

Therefore the detailed process of event-recording is described here:
For every call to be confirmed three groups of entries are sent from the MA to the on board event-recorder:

* 1.Immediately after reception of the signal 'Confirmation Request'
  the parameters of the incoming call PL_CALL and GC_REF
  plus the active value of the functional number of the mobile station (FNR)
  are sent to the recorder (Entry #1)

* 2.Immediately after reception of the signal 'End of call'
  the measured duration of the call (value of T_DUR)
  and the cause of call termination (value of CAUSE)
  are sent to the recorder (Entry #2)

* 3.Finally after reception of the acknowledgement from the AC, or in case of errors where mentioned in the SDL-chart the résumé is stored (Entry #3)

Provisions to link the three entries unambiguously have to taken.

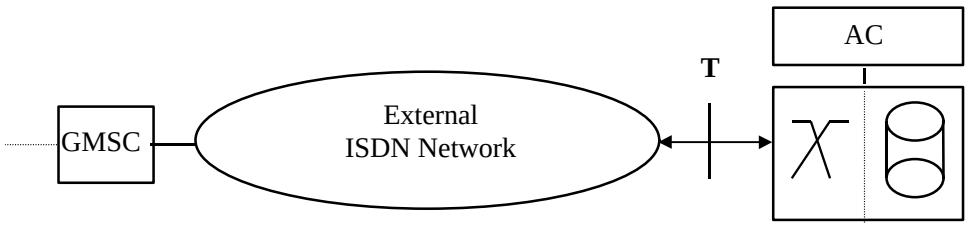
For the **format of entries** #1-3 refer to the related FIS [3].

The **active functional number** is that functional number which is selected for 'presentation of functional numbers' (refer also to FFFS for Presentation of Functional Numbers [9]).

7.2. Acknowledgement Centre application

7.2.1. ISDN access

For example a simple PABX can serve as fixed network user terminal (network termination NT2).



Fixed Network Terminal

Figure5: Acknowledgement centre connected with Fixed Network User Terminal

7.2.2. Procedures

The application has to handle the incoming confirmation calls. It should be intended to clear the calls at the earliest possible time (e.g. answer the call with a RELEASE COMPLETE Message according to ETS 300 102-1 [11]) in order to avoid the assignment of B-channels.

The user information for acknowledgement is inserted into the call clearing message by the application.

The user-to-user information of any incoming confirmation call is interpreted as confirmation message. Absolute time stamps are determined and recorded afterwards by the acknowledgement centre. The variation in call set-up times leads to an inaccuracy in the calculation of absolute time stamps.

7.2.3. Functional description using SDL charts

7.2.3.1.TASK AC-1

Function

Accepting and answering confirmation calls, triggering the recording of the received data.
This is very likely the bottleneck of the service - parallel design is highly recommended.

In case of successful storage "ACK" is sent back to the confirming mobile, in case of unsuccessful outcome either "NACK-1" or "NACK-2" is sent back. The latter to indicate that no repetition is allowed.
Means for indication of error-states are not described here but shall be foreseen according to the respective network maintenance concept.

Signals

Output signal: RECORD CONF. (to TASK AC-2)
Input signals. RECORDED OK, RECORD ERR, RECORD FATAL ERR (from task AC-2)
All other signals as in recent protocol-stack, not mentioned here.

7.2.3.2.TASK AC-2

Function

Recording the received confirmation data and adding a time-stamp to remove the relativity of the time-information.
The retrieval of the data is not described here but it should be mentioned that recording must have the higher priority over reading.

Signals

Input signal: RECORD CONF. (from TASK AC-1)
Output signals. RECORDED OK RECORD ERR and RECORD FATAL ERR (to task AC-1)