PAS 0001-10-2 V1.0.0 (1998-01)

Publicly Available Specification

TETRAPOL Specifications
Part 10: Inter System Interface;
SubPart 2: ISI architecture

Reference

Keywords

Tetrapol

TETRAPOL Secretariat

Postal address: BP 40 78392 Bois d'Arcy CEDEX - FRANCE
Office address: Rue Jean-Pierre Timbaud 78392 Bois d'Arcy CEDEX - FRANCE
Tel.: +33 1 34 60 55 88 - Fax: +33 1 30 45 28 35

Internet

http:// www.tetrapol.com

Contents

Intellectual Property Rights

Foreword

This document is the Publicly Available Specification (PAS) of the TETRAPOL Land Mobile Radio System, which shall provide digital Narrow Band Voice, Messaging, and Data Services. Its main objective is to provide specifications dedicated to the more demanding PMR segment: the Public Safety. These specifications are also applicable to most PMR networks.

Document organisation

This PAS is a multipart document which consists of:

Part 1 General Network Design

Part 2 Radio Air interface

Part 3 Air Interface Protocol

Part 4 Gateway to X.400 MTA

Part 5 Dispatch Centre interface

Part 6 Line Connected Terminal interface

Part 7 Codec

Part 8 Radio conformance tests

Part 9 Air interface protocol conformance tests

Part 10 Inter System Interface

Part 11 Gateway to PABX, ISDN, PDN

Part 12 Network Management Centre interface

Part 13 User Data Terminal to System Terminal interface

Part 14 System Simulator

Part 15 Gateway to External Data Terminal

Part 16 Security

TTR 1 Guide to TETRAPOL features

Part 18 Base station to Radioswitch interface

Part 19 Stand Alone Dispatch Position interface

1. Scope

Interoperability between PMR systems requires a common inter-system interface. This network-to-network interface is referred to as the ISI.

The ISI shall both permit communications between independently operated systems and protect each system in the event of any failure or unauthorised use of the other system.

The ISI protocol is considered here between two TETRAPOL systems, or between a TETRAPOL system and another digital PMR system. Between a TETRAPOL system and another digital PMR system, the ISI may also act as a gateway interface with protocol conversion and filtering.

This document corresponds to sub-part 10.2 of the TETRAPOL inter-system interface which is divided into three sub-parts:

- Part 10.1 ISI Technical requirements
- Part 10.2 ISI Architecture
- Part 10.3 ISI Protocol design

This sub-part establishes the architecture for the TETRAPOL inter system interface with a reference model, a protocol stack and the overall service description as seen from the TETRAPOL switching and management infrastructure point of view. It also details the interworking procedures over the ISI.

2. Normative references

This PAS incorporates by dated and undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter.

[1] PAS 0001-1-1: "TETRAPOL Specifications; General Network Design; Reference Model".

[2] PAS 0001-10-1: "TETRAPOL Specifications; Inter System Interface; ISI Technical Requirements".

[3] ETS 300 170: Private Telecommunication network (PTN) Data link layer protocol at the Q reference point for signalling channel between two private telecommunication network exchanges.

[4] ETS 300 172: Private Telecommunication networks (PTN) Inter-exchange signalling protocol - Circuit mode basic services.

[5] ETS 300 239: Private Telecommunication network (PTN) Inter-exchange signalling protocol - Generic functional protocol for the support of supplementary services.

[6] ITU-T Recommendation X.25: Interface between data terminal equipment (DTE) and data circuit terminating equipment (DCE) for terminals operating in the packet mode and connected to public data networks by dedicated circuits.

[7] ITU-T Recommendation Q.921: ISDN User-Network Interface Data Link Layer Specification.

3. Definitions and abbreviations

3.1. Definitions

For the purposes of this PAS, the following definitions apply:

Call master SwMI: The switching and management infrastructure (SwMI) in charge of the synchronisation of the call establishment over ISI and the call release procedures between SwMIs.

Destination SwMI: A SwMI to which a call is routed over the ISI from the call master SwMI.

Home SwMI: The individual home SwMI of a system terminal is the SwMI that is designated by the country code and network code of its long individual explicit address. The group home SwMI of a network group or of a regional operational group is the SwMI that is designated by the country code and network code of its long group address. Federal groups have no unique home SwMI.

Incoming call: A call that is originated outside of the local system. A call over ISI is said to be an incoming call for a SwMI when its establishment propagates from the ISI to the SwMI.

Local SwMI: A SwMI a system manager is in charge of.

Network: The switching and management infrastructure and the base stations within a system.

Originating SwMI: The SwMI in which the calling user is registered when requesting a call establishment

Outgoing call: A call that is originated from the local system. A call over ISI is said to be an outgoing call for a SwMI when its establishment propagates from the SwMI over the ISI.

Participating SwMI: A SwMI that is involved in the coverage of a call, as defined before the call activation

Radio terminal: System terminal connected to the infrastructure by a radio link, equivalent to the Mobile termination unit MTU.

SwMI: Switching and management infrastructure

System: A system comprises a network and a set of terminals

System manager: The manager in charge of the operation of a system

System Terminal: A service access reference point provided to the user by the System. System terminals ST are Radio terminals, Line connected terminals, Stand alone dispatch positions

Visited SwMI: A SwMI is referred to as the visited SwMI of a terminal, if the terminal is attached to this SwMI and this SwMI is not the home SwMI of the terminal.

3.2. Abbreviations

For the purpose of ISI, the following abbreviations apply:

A/I	Air Interface
ANF	Additional Network Feature
BC	Broadcast call
BN	Base Network
BS	Base station
CC	Call control entity providing circuit mode services within one system
CMCE	Circuit mode control entity
GC	Group call
HLR	Home location register
IC	Individual call
ISI	Inter system interface
MM	Mobility management
MOCH	Multisite open channel
MPC	Multiparty call
OG	Operational group
PAS	Publicly Available Specification
PDU	Protocol data unit
PMR	Private Mobile Radiocommunications
RT	Radio terminal
SAP	Service Access Point
ST	System terminal
SwMI	Switching and management infrastructure
VLR	Visitor Location Register

4. Reference model

4.1. Overall model of the inter-system interface

This clause describes the functional groupings of the voice circuit mode control entities and their relationships via reference points.

TETRAPOL switching and management infrastructures (SwMI) shall interconnect over the ISI by building a QSIG network between the call control entities of each SwMI. The QSIG network shall handle transparently any transit requirement between non adjacent SwMIs. An optional X.25 network may be present at the ISI, as an alternative to QSIG for mobility management flows and access to databases.

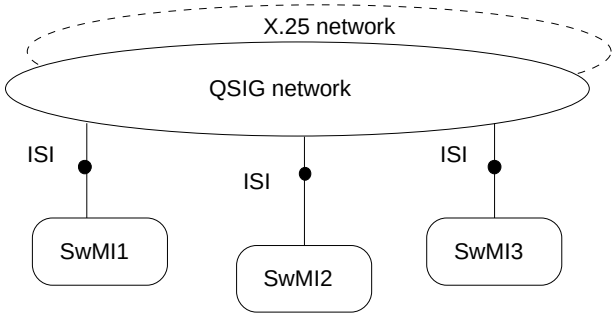


Figure 1: Overall model of the ISI

The services visible at the ISI reference point (R9 or R11 reference point in the TETRAPOL general design reference model) are described in this document.

The interworking operations between SwMIs above the QSIG network are specified with QSIG additional network functions (ANF), and the ANF service access points intermediate between the call control within each SwMI and the ISI.

4.2. SwMI reference configurations

There are several reference configurations depending on the system connected to the TETRAPOL system.

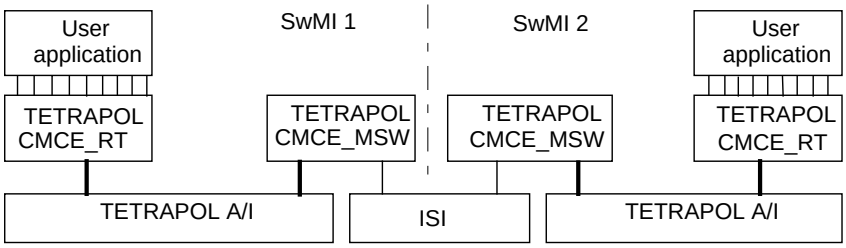


Figure 2: Tetrapol systems view: direct inter-system interface

This view shows a direct inter-system interface between two TETRAPOL SwMIs.

Their local Circuit Mode Control Entities (CMCE), which include their Call Control (CC), Mobility Management (MM) and security (SEC) entities dealing with all calls within one SwMI, have peer to peer relations with their counterparts on the ISI service access point, dealing with intersystem calls.

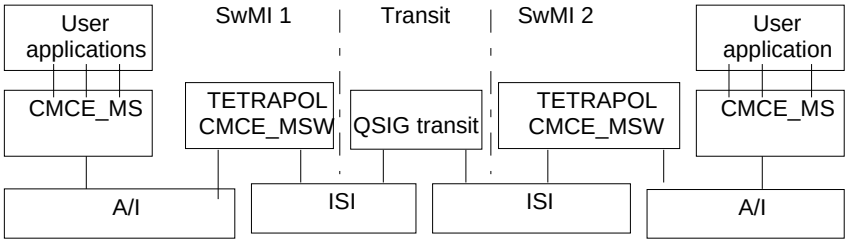


Figure 3: Tetrapol systems view: interface to dispatcher- indirect inter-system interface

This view is similar to the previous one from the CMCE point of view. Here a special node, such as a dispatch center, acts as a QSIG transit. From the ISI point of view, the transit node is transparent. From the QSIG point of view, the inter-system link and the transit connections share the same QSIG stack.

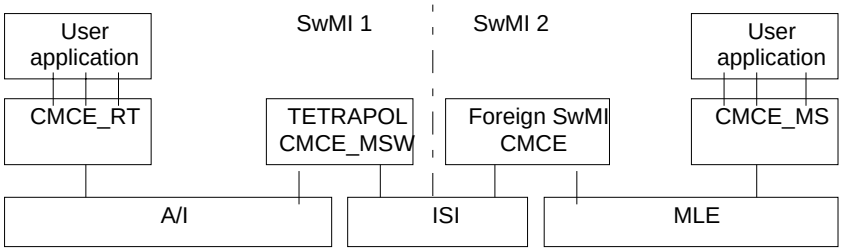


Figure 4: Tetrapol -foreign systems view: direct intersystem interface

In this view, one of the SwMIs is not a TETRAPOL SwMI. This situation shall however be transparent to the CMCE_MS. The TETRAPOL CMCE_MSW shall cope with all conversions necessary for a proper interworking.

4.3. Inter-system protocol stack

The following figure shows how the inter-system flow shall be exchanged between two SwMIs over the ISI at the Q reference point.

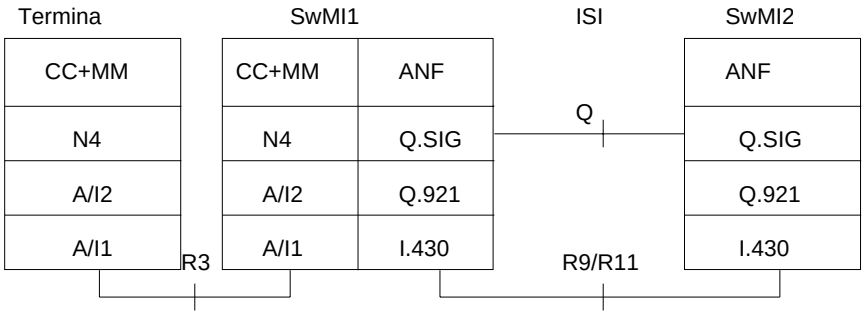


Figure 5: ISI protocol stack

The interface which supports QSIG PDUs at the network layer is called the Q reference point.

R9/R11 is the inter-system interface

R3 is the TETRAPOL air interface (A/I) which is described up to the transport service access points in TETRAPOL PAS Part 2 and 3.

ANF/QSIG are the additional network functions defined for the Inter System Interface on the top of the basic call of QSIG (QSIG-BC) and QSIG generic functions (QSIG-GF).as defined in the documents (3), (4) and (5).

LAP-D is the ITU-T Q.921 layer 2 protocol on which QSIG may rely.

4.4. Inter-system network layer

The CC circuit mode call control entity is dedicated to call processing within one system. In the case of a call over the ISI, It shall collaborate with its peer call control entities from different systems by the means of ANF entities

Within one TETRAPOL system, there may be one or several ISI R11 physical connection, so that a routing algorithm is need to route the messages within one system.

The intersystem interface shall be based on a QSIG network layer protocol to connect to a distant system.

The circuit mode control entity that manages the ISI access is made of three parts dealing with call control, supplementary services and mobility management over the ISI. However all these entities are plugged into some dedicated QSIG Additional Network Functions, so that they may be considered as an adaptation sub-layer. Thus the TETRAPOL function for call control over the ISI do not use a direct service access point to QSIG layer.

QSIG is a network layer protocol defined at the Q reference point as shown on the figure. The description of lower layers in order to access R11 reference point is beyond the scope of this paper.

The following figure displays the functional entities dedicated to ISI at network layer.

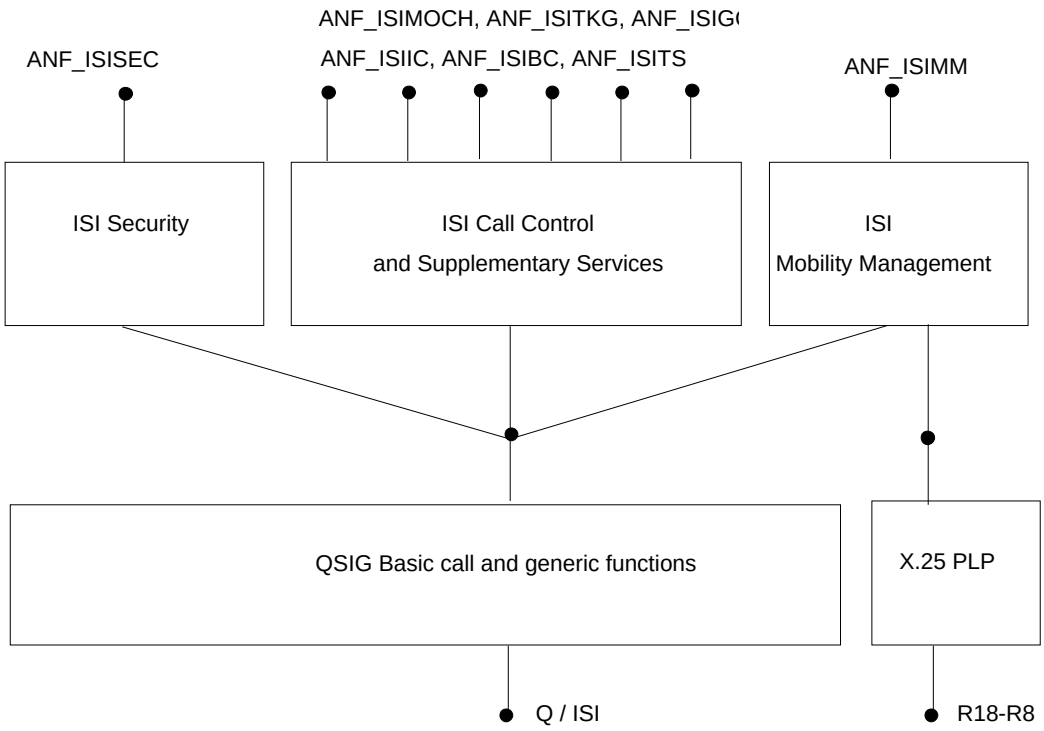


Figure 6: Additional network features above QSIG

Non call related mobility management information may be accessed in two ways: QSIG based or directly packet data access.

- ANF-ISIIC is the QSIG Additional Network Function for individual calls and multiparty calls.

- ANF_ISIMOCH is the QSIG Additional Network Function for multisite open channels.

- ANF_ISIBC is the QSIG Additional Network Function for broadcast calls.

- ANF_ISITKG is the QSIG Additional Network Function for talkgroups.

- ANF-ISIGC is the QSIG Additional Network Function for group calls.

- ANF_ISITS is the QSIG Additional Network Function for the generic transport of supplementary services, status and data.

- ANF-ISIMM is the QSIG Additional Network Function for ISI Mobility Management.

- ANF-ISISEC is the QSIG Additional Network Function for ISI security.

5. Overall service description

5.1. Call control related additional network features

5.1.1. ANF for private calls

5.1.1.1. Description

The ANF_ISIIC additional network feature shall enable a point to point call to be set up between two SwMIs over the ISI. This applies to individually addressed private calls, e.g. TETRAPOL individual call and multiparty call.

The ANF_ISIIC routes the setup request to the destination SwMI over ISI, upon request from the call control entity in the originating SwMI and according to the location of the terminal of the called user. In the destination SwMI, the ANF_ISIIC shall request for the call establishment up to the called terminal.

During the call established phase, the ANF_ISIIC shall transmit the push-to-talk requests between the two SwMIs.

The ANF_ISIIC shall forward the call release requests at the end of the call.

5.1.1.2. Qualification on applicability to TETRAPOL services

The ANF_ISIIC is applicable to TETRAPOL encoded private calls in the following modes:

- clear speech mode;
- end-to-end encrypted mode;
- ISI encrypted mode.

5.1.1.3. Procedures

5.1.1.3.1. Provision/withdrawal

Provision and withdrawal of the ANF_ISIIC shall be prearranged by the system manager.

5.1.1.3.2. Normal procedures

- Activation, deactivation, registration, interrogation

The ANF_ISIIC shall be permanently activated upon provision and permanently deactivated upon withdrawal. Registration and interrogation are not applicable to ANF_ISIIC

- Invocation and operation

The ANF_ISIIC is an extension of the QSIG circuit mode basic call for the purpose of TETRAPOL individual call over the inter-system interface. The ANF information shall be conveyed over the ISI as QSIG facilities, as defined in QSIG generic features.

- Establishment of a private call

When an individual call request is received by a call control entity in the SwMI and once it has analysed that the call setup request is allowed from the calling party, it shall retrieve the location of the called terminal.

The call control functional entity of the originating SwMI shall instanciate the ANF_ISIIC when the called terminal is located in another SwMI.

The ANF_ISIIC shall then route the call request over the ISI to the destination SwMI.

- Maintenance of an individual call

The originating SwMI shall be the call master SwMI and, as such, shall arbitrate the transmission requests.

- Termination of an individual call

When a user hooks on, the call over ISI shall be released.

5.1.1.3.3. Exceptional procedures

- Activation, deactivation, registration, interrogation

Not applicable

- Invocation and operation

The ANF_ISIIC may reject a outgoing call setup request when the ISI is not available.

The ANF_ISIIC may reject an incoming call setup request when the requested service is not available in the destination SwMI.

5.1.1.4. Interaction with other PSS1 supplementary services and ANF

No interaction with other supplementary services and ANFs for which PSS1 standards were available at the time of publication of this specification has been found, so that the supplementary services shall behave as normal when applicable.

5.1.1.5. Interaction with TETRAPOL supplementary services and other ANF

There shall be no interaction between ANF_ISIMM and other TETRAPOL supplementary services and additional network features that shall behave as normal when applicable.

5.1.1.6. Functional model

The functional model for private calls over ISI shall comprise the following functional entities:

Calling FE: Functional entity detecting the outgoing request to activate ANF_ISIIC

Called FE: Functional entity informing of an incoming request from the ANF_ISIIC

Calling DB: Functional entity providing access to the profile of the calling terminal

Calling DB: Functional entity providing access to the SwMI location of the called terminal

The following functional relationships shall exist between these functional entities:

rprofile between CallingFE and CallingDB

rlocation between CallingFE and CalledDB

route between CallingFE and CalledFE

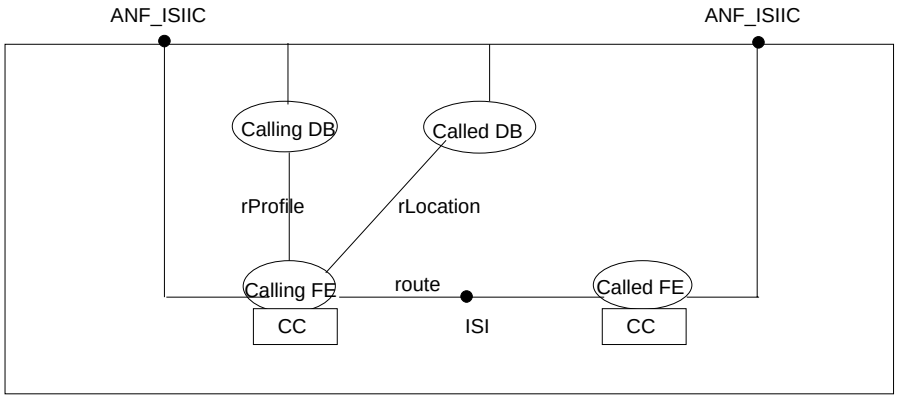


Figure 7: ANF_ISIIC

The CallingFE

- detects an outgoing private call request, from ANF_ISIIC service access point
- requests the profile of the calling user
- requests the location of the called terminal

- intermediates between the calling call control and QSIG to route the call to the called FE

The CallingDB

- provides access to the calling user's profile information, e.g. whether the calling user is allowed to place outgoing calls to the called party

The CalledDB

- indicate the SwMI where the called user is attached

The CalledFE

- informs an incoming private call, at the ANF_ISIIC service access point

- intermediates between the called call control and QSIG

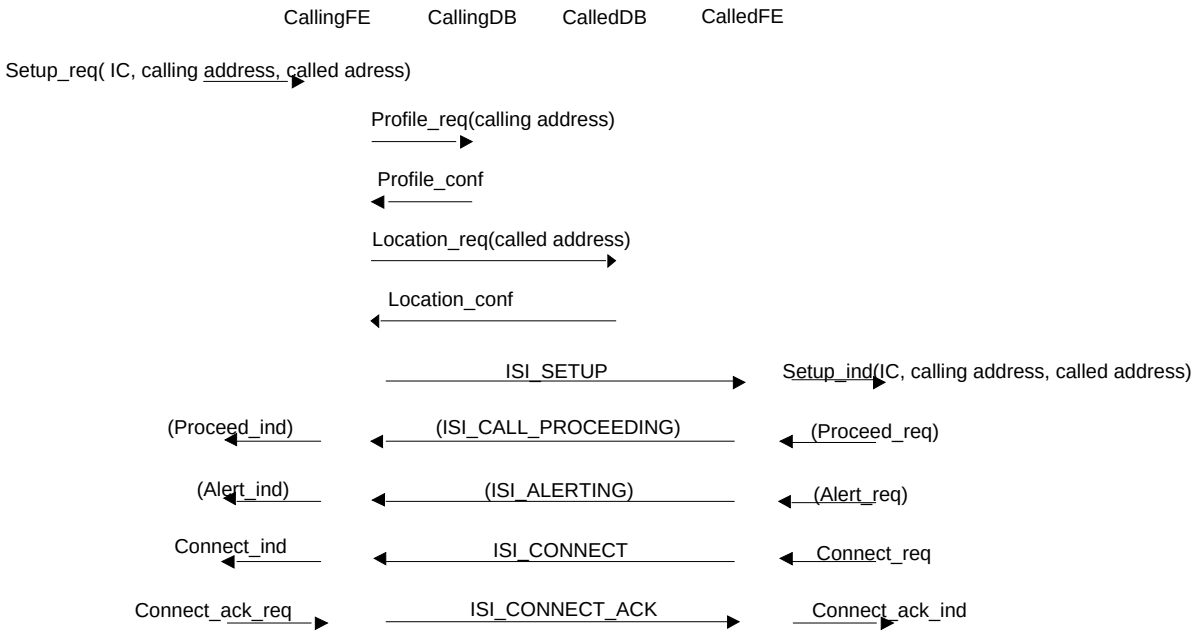
CallingFE and CalledFE are assumed to be located in different SwMIs, so that route is over ISI and ANF_ISIIC is invoked.

Whether CallingDB or CalledDB imply an ISI information flow is an ANF_ISIMM issue.

5.1.1.7. Information flows

The signalling procedures over the ISI between an OriginatingFE and a DestinationFE are supported by the ad hoc QSIG facilities. The relationship between the protocol data units over ISI and the QSIG basic call flows is specified in Part 10-3 for each ISI protocol data unit.

The successful establishment of an individual call over ISI shall be sequenced as follows:



ISI_CALL_PROCEEDING and ISI_ALERTING are optional information flows.

Disconnection of the individual call over ISI may be as follows

or as follows

An unsuccessful establishment of an individual call over ISI shall terminate with a disconnection over ISI.

5.1.2. ANF for multisite open channel

5.1.2.1. Description

The ANF_ISIMOCH additional network feature shall enable an MOCH:

- to be setup over a predefined coverage area involving several SwMIs;
- to be setup by an authorised terminal;
- to involve a set of operational groups spread over the coverage.

The MOCH coverage definition shall be pre-arranged between the system managers of the SwMIs before the MOCH can be established.

The terminals allowed to request the establishment of the MOCH shall be predefined by each system manager. The establishment operational group may have different member terminal in different SwMIs. A system manager is allowed to modify at any time the operational group membership of those terminals that are allowed to establish this MOCH from that SwMI.

The policy for electing the call master SwMI shall be also pre-arranged, either being statically predefined or elected as being the call originating SwMI.

If the originating SwMI is elected as the call master SwMI, the setup is performed with a unique ANF_ISIMOCH instance.

If the originating SwMI happens not to be the call master SwMI, then the ANF_ISIMOCH shall forward the request to setup the MOCH to the actual call master SwMI, and the ANF_ISIMOCH instance shall be released. Upon receipt of a request for setting up an MOCH over ISI, the call master SwMI shall instanciate a new ANF_ISIMOCH and proceed with it.

The ANF_ISIMOCH routes the setup request to all destination SwMI over ISI upon request from the call control entity in the originating SwMI. In the destination SwMIs, the ANF_ISIMOCH shall request for the call establishment.

During the call established phase, the ANF_ISIMOCH shall transmit the push-to-talk requests between the participant SwMIs and the call master SwMI.

The ANF_ISIMOCH shall forward the call release requests at the end of the call.

5.1.2.2. Qualification on applicability to TETRAPOL services

The ANF_ISIMOCH is applicable to TETRAPOL encoded MOCH in the following modes:

- clear speech mode;
- end-to-end encrypted mode;
- ISI encrypted mode.

5.1.2.3. Procedures

5.1.2.3.1. Provision/withdrawal

Provision and withdrawal of the ANF_ISIMOCH shall be prearranged by the system manager.

5.1.2.3.2. Normal procedures

- Activation, deactivation, registration, interrogation

The ANF_ISIMOCH shall be permanently activated upon provision and permanently deactivated upon withdrawal. Registration and interrogation are not applicable to ANF_ISIMOCH.

- Invocation and operation

The ANF_ISIMOCH is an extension of the QSIG circuit mode basic call for the purpose of TETRAPOL MOCH over the inter-system interface.

- Definition of the MOCH coverage area

The system managers shall pre-define the global coverage area of the MOCH in terms of SwMIs involved. They shall allocate this coverage to a common MOCH identifier. They shall decide at that time whether the call master SwMI for the MOCH be the originating SwMI or a pre-agreed one. The system managers shall agree on the operational groups, whose members are allowed to setup the MOCH.

Each of the system managers in the involved SwMIs shall define, on his own, the local coverage associated to the common MOCH identifier, the default operational groups participating locally in this MOCH. There shall be a default operational group, involving for instance just one dispatcher, defined for unattended MOCH identifiers coming from the ISI. Each system manager is allowed to modify this local information before the MOCH establishment.

- Establishment of an MOCH

When a MOCH set up request is received by a call control entity in the SwMI and once it has analysed that the call establishment request is allowed from the calling party, it shall retrieve the coverage area of the call to be setup. If the coverage area involves more than one SwMI, then either the request is forwarded to the designated SwMI through an ANF_ISIMOCH that shall be immediately released, or the originating SwMI proceeds with the setup over ISI with a unique ANF_ISIMOCH.

The call control functional entity of the call master SwMI shall instanciate the ANF_ISIMOCH when the coverage of the being established MOCH call shall involve more than one SwMI.

An MOCH is a multigroup addressed call: if the originating SwMI provides a list of operational groups for the MOCH, these operational groups shall supersede or be added to those pre-defined locally for participation.

The ANF_ISIMOCH shall then route the call request over the ISI to the destination SwMIs.

- Maintenance of an MOCH

The ANF_ISIMOCH shall forward the requests to transmit between the call master SwMI and the participant SwMIs.

- Termination of an MOCH

When a terminal that belongs to the establishment operational group of the MOCH requests it to terminate, then the call master SwMI shall synchronize the call releases over ISI.

5.1.2.3.3. Exceptional procedures

- Activation, deactivation, registration, interrogation

Not applicable

- Invocation and operation

The ANF_ISIMOCH shall process unattended MOCH identifiers as if they were equivalent to an ad hoc locally predefined one, that should involve a dispatcher. This dispatcher shall then manually decide whether the unknown MOCH shall have its coverage area extended to the local SwMI.

5.1.2.4. Interaction with other PSS1 supplementary services and ANF

No interaction with other supplementary services and ANFs for which PSS1 standards were available at the time of publication of this specification has been found, so that the supplementary services shall behave as normal when applicable.

5.1.2.5. Interaction with TETRAPOL supplementary services and other ANF

There shall be no interaction between ANF_ISIMM and other TETRAPOL supplementary services and additional network features that shall behave as normal when applicable.

5.1.2.6. Functional model

The functional model for MOCH over ISI shall comprise the following functional entities:

Originating FE: Originating SwMI call control functional entity

MasterFE: Call master SwMI call control functional entity

Participating FE: SwMI within the coverage of the MOCH

MOCH DBaccess: Database access functional entity for the definition of the MOCH

The following functional relationships shall exist between these functional entities:

rMaster between OriginatingFE and MOCH DB access

rcoverage between MasterFE and MOCH DB access

forwardroute between Originating FE and Master FE

route between Originating FE and Participating FE

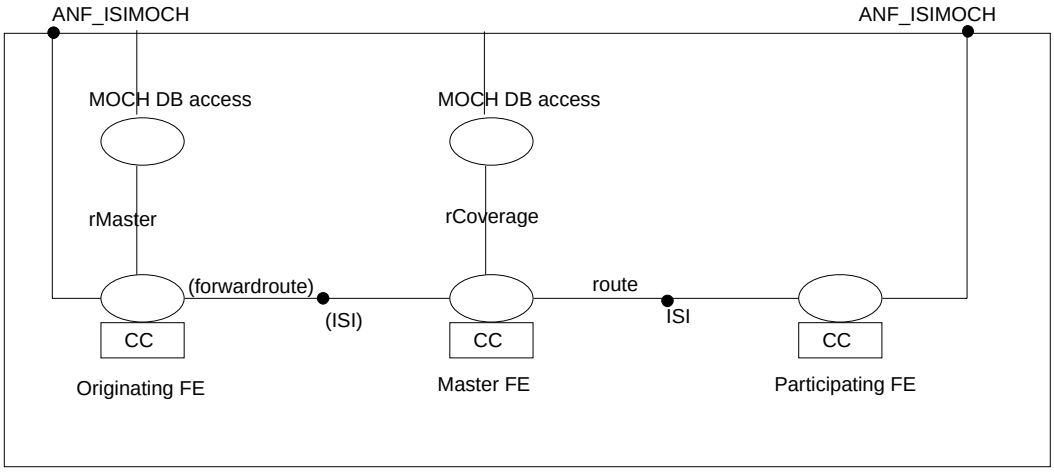


Figure 8: ANF_ISIMOCH with master FE different from originating FE

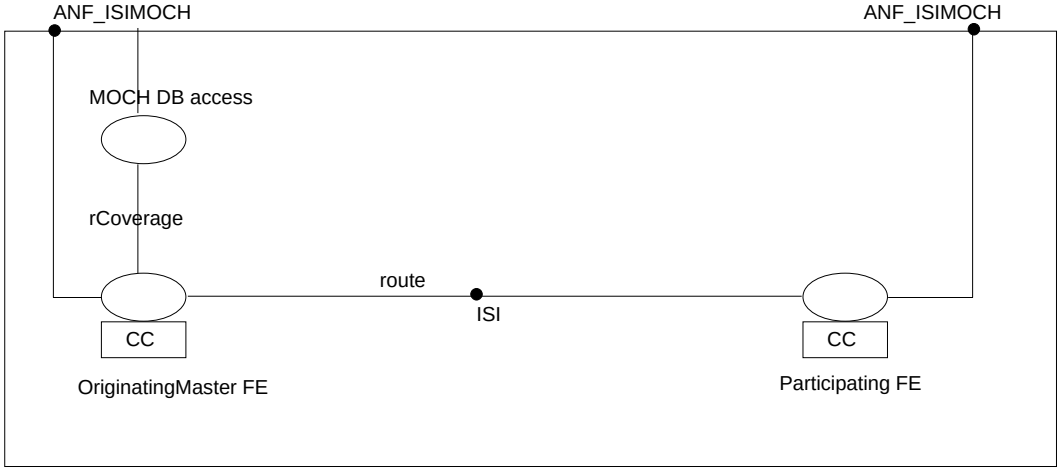


Figure 9: ANF_ISIMOCH with Master FE equals originating FE

The OriginatingFE

- detects a setup request for an MOCH whose coverage comprises several SwMIs
- intermediates between the call control and QSIG to route the call to the participating FE

The MasterFE

- requests the coverage extension to the other SwMIs
- intermediates between the call control and QSIG to route the call to the participating FE

The MOCH DB access

- indicates the SwMI coverage for the MOCH.

The ParticipatingFE

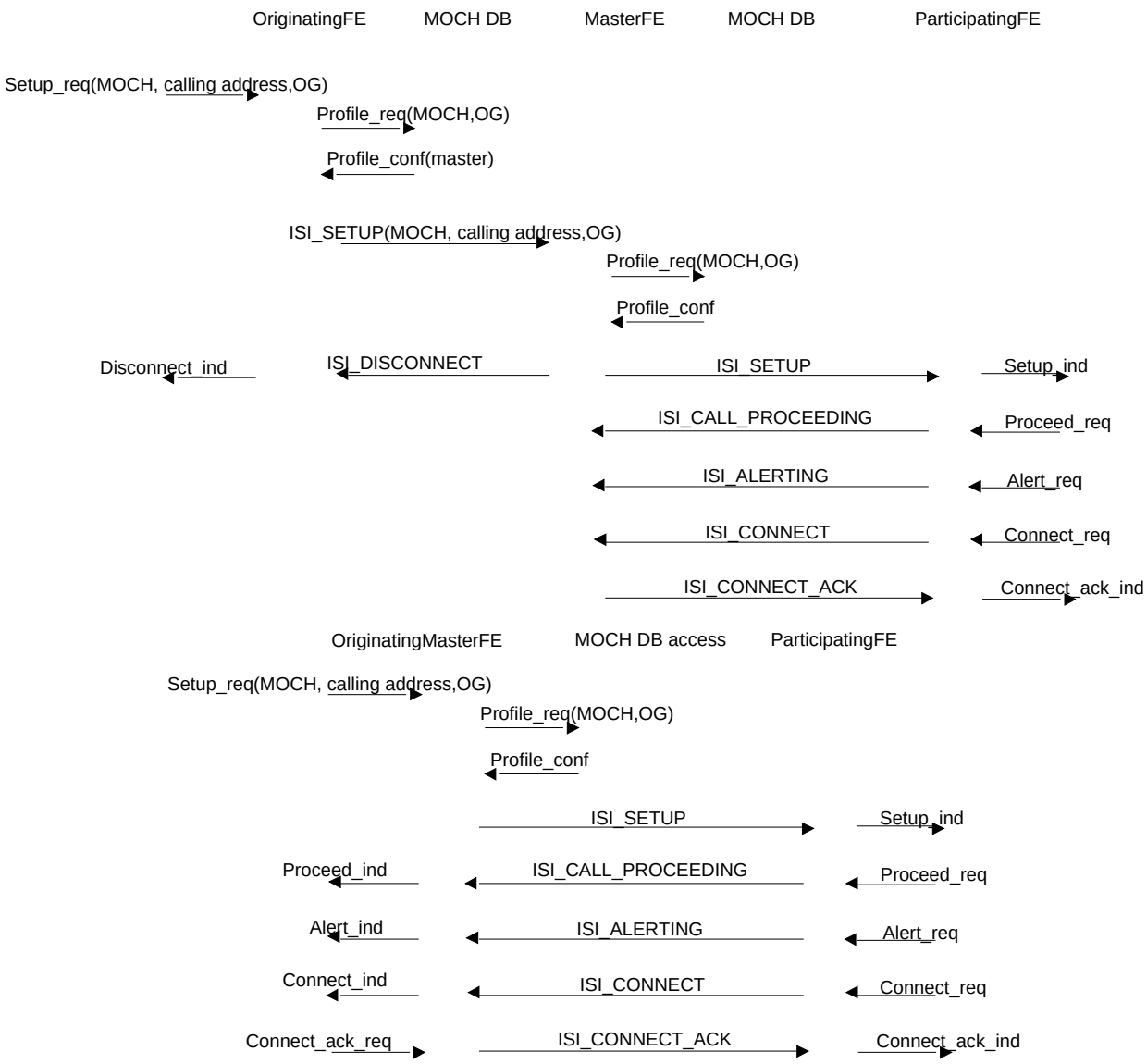
- detects an incoming MOCH setup request
- intermediate between the call control and QSIG

MasterFE and DestinationFE are assumed to be located in different SwMIs, so that route is over ISI and ANF_ISIIC is invoked.

5.1.2.7. Information flows

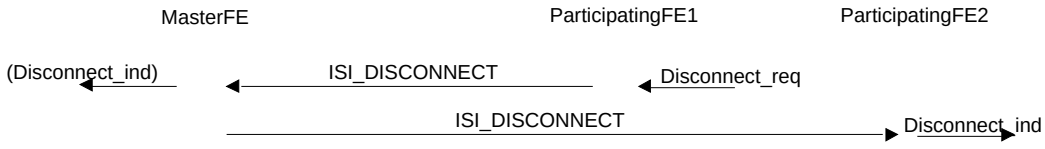
The signalling procedures over the ISI between an OriginatingFE and a ParticipatingFE are supported by the ad hoc QSIG facilities. The relationship between the protocol data units over ISI and the QSIG basic call flows is specified in Part 10-3 for each ISI protocol data unit.

The successful establishment of an MOCH over ISI shall be sequenced as follows:

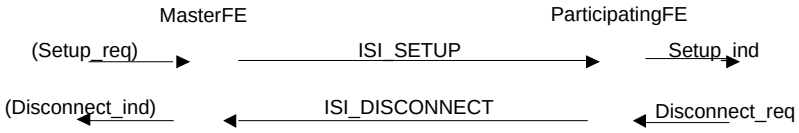


CALL_PROCEEDING_PDU and ALERTING_PDU are optional information flows.

Clearing the MOCH over ISI may be as follows



An unsuccessful establishment of an MOCH over ISI may be as follows:



5.1.3. ANF for broadcast call

5.1.3.1. Description

The ANF_ISIBC additional network feature shall enable an broadcast call to be set up, over a predefined coverage involving several SwMIs.

The BC coverage definition shall be pre-arranged between the system managers of the SwMIs before the BC can be established.

The ANF_ISIBC routes the setup request to all destination SwMI over ISI upon request from the call control entity in the originating SwMI. In the destination SwMIs, the ANF_ISIBC shall request for the call establishment.

During the call established phase, the originating SwMI is granted the permission to talk for the duration of the broadcast call.

The ANF_ISIBC shall forward the call release requests at the end of the call.

5.1.3.2. Qualification on applicability to TETRAPOL services

The ANF_ISIBC is applicable to TETRAPOL encoded broadcast call in the following modes:

- clear speech mode;
- end-to-end encrypted mode;
- ISI encrypted mode.

5.1.3.3. Procedures

5.1.3.3.1. Provision/withdrawal

Provision and withdrawal of the ANF_ISIBC shall be prearranged by the system manager.

5.1.3.3.2. Normal procedures

The procedures for BC shall be identical to those of the MOCH.

5.1.3.3.3. Exceptional procedures

The procedures for BC shall be identical to those of the MOCH.

5.1.3.4. Interaction with other PSS1 supplementary services and ANF

No interaction with other supplementary services and ANFs for which PSS1 standards were available at the time of publication of this specification has been found, so that the supplementary services shall behave as normal when applicable.

5.1.3.5. Interaction with TETRAPOL supplementary services and other ANF

There shall be no interaction between ANF_ISIBC and other TETRAPOL supplementary services and additional network features that shall behave as normal when applicable.

5.1.3.6. Functional model

The functional model for broadcast call is identical to the functional model for MOCH.

5.1.3.7. Information flows

The information flows for broadcast call are identical to the information flows for MOCH.

5.1.4. ANF for talkgroups

5.1.4.1. Description

The ANF_ISITKG additional network feature shall enable two talkgroups related to the same operational group to be temporarily linked together.

The ANF_ISITKG shall provide the link over ISI and shall route the activation requests from one SwMI to the other to the call master SwMI over ISI upon request from the call control entity in the other SwMI.

During an activation, the ANF_ISITKG shall transmit the push-to-talk requests between the participant SwMIs and the call master SwMI.

The ANF_ISITKG shall forward the call release requests at the end of the call.

5.1.4.2. Qualification on applicability to TETRAPOL services

The ANF_ISITKG is applicable to TETRAPOL encoded talkgroup in the following modes:

- clear speech mode;
- end-to-end encrypted mode;
- ISI encrypted mode.

5.1.4.3. Procedures

5.1.4.3.1. Provision/withdrawal

Provision and withdrawal of the ANF_ISITKG shall be prearranged by the system manager.

5.1.4.3.2. Normal procedures

- Activation, deactivation, registration, interrogation

The ANF_ISITKG shall be permanently activated upon provision and permanently deactivated upon withdrawal. Registration and interrogation are not applicable to ANF_ISITKG

- Invocation and operation

The ANF_ISITKG is an extension of the QSIG circuit mode basic call for the purpose of TETRAPOL talkgroup over the inter-system interface.

- Definition of the coverage of a talkgroup

The ANF_ISITKG additional network feature shall enable an talkgroup coverage to be set up, over a predefined coverage involving several SwMIs. The ANF_ISITKG is instanciated at the definition of the talkgroup coverage and shall stay instanciated until the talkgroup coverage definition is cleared.

The call master SwMI shall be designated and agreed between system managers.

The talkgroup coverage definition shall be pre-arranged between the system managers of the SwMIs before the talkgroup can be activated.

The ANF_ISITKG allocates a permanent ISI channel that shall be realised only when the coverage definition is cleared.

The system managers in all SwMIs of the talkgroup coverage shall relate the allocated ISI channels to the talkgroup definition in their own systems.

- Activation of a talkgroup

Upon activation of the talkgroup, each SwMI shall allocate internal trunked resources and link them with the ad hoc ISI channels, as identified by the ANF_ISITKG instance.

Transmission arbitration shall be performed by the call master SwMI.

The deactivation of the talkgroup does not need to be synchronised between SwMIs.

5.1.4.3.3. Exceptional procedures

- Activation, deactivation, registration, interrogation

Not applicable

- Invocation and operation

The ANF_ISITKG may reject a outgoing request when the ISI is not available.

The ANF_ISITKG may reject an incoming request when the requested service is not available in the destination SwMI.

5.1.4.4. Interaction with other PSS1 supplementary services and ANF

No interaction with other supplementary services and ANFs for which PSS1 standards were available at the time of publication of this specification has been found, so that the supplementary services shall behave as normal when applicable.

5.1.4.5. Interaction with TETRAPOL supplementary services and other ANF

There shall be no interaction between ANF_ISITKG and other TETRAPOL supplementary services and additional network features that shall behave as normal when applicable.

5.1.4.6. Functional model

The functional model for talkgroup over ISI shall comprise the following functional entities:

Originating FE: Call Originating functional entity

Participating FE: Call participating functional entity

Group DB: Database access functional entity for the coverage of the MOCH

The following functional relationship shall exist between these functional entities:

rcoverage between OriginatingFE and GroupDB

route between Originating FE and Participating FE

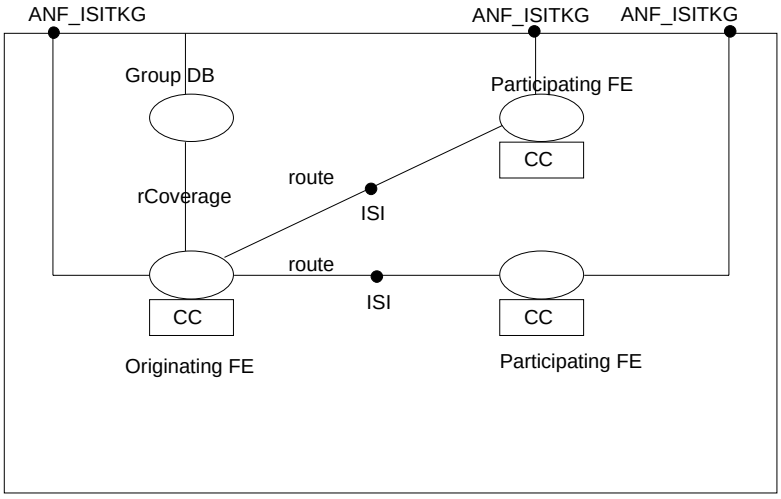


Figure 10: ANF_ISITKG

The OriginatingFE

- detects the definition of a coverage over more than one SwMI
- requests the coverage extension to the other SwMIs
- intermediates between the call control and QSIG to route the call to the participating FE
- detects a talkgroup activation

- requests other participating FE to activate the talkgroup

The group DB

- indicates the SwMI coverage definition

The ParticipatingFE

- detects an incoming coverage definition request
- detects a talkgroup activation
- requests other participating FE to activate the talkgroup

- intermediate between the call control and QSIG

The Activating FE is assumed to be a ParticipatingFE.

The OriginatingFE is assumed to be a Participating FE

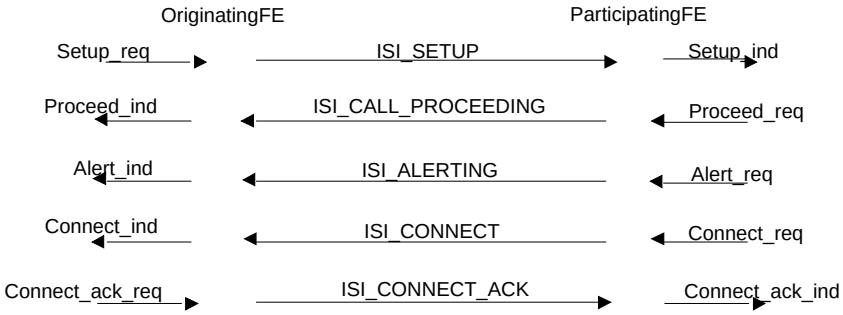
OriginatingFE and DestinationFE are assumed to be located in different SwMIs, so that route is over ISI and ANF_ISIIC is invoked.

The group DB is assumed to collocate with the OriginatingFE.

5.1.4.7. Information flows

The signalling procedures over the ISI between an OriginatingFE and a ParticipatingFE are supported by the ad hoc QSIG facilities. The relationship between the protocol data units over ISI and the QSIG basic call flows is specified in Part 10-3 for each ISI protocol data unit.

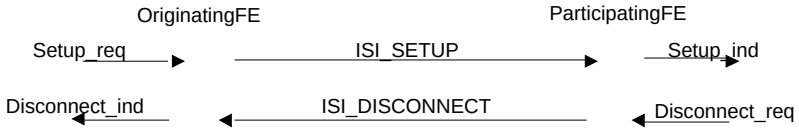
The successful establishment of a secured communication support over ISI shall be sequenced as follows:



CALL_PROCEEDING_PDU and ALERTING_PDU are optional information flows.

Clearing the secured communication support over ISI may be as follows

An unsuccessful establishment support over ISI may be as follows:



The activation of a talkgroup shall be as follows

5.1.5. ANF for group calls

5.1.5.1. Description

The ANF_ISIGC additional network feature shall enable a group call to be set up:

- over a coverage involving several SwMIs;
- between participants located in several SwMIs, whether home or visited SwMIs;
- from a calling party that may neither belong to the group nor belong to the same country or network as the group members.

The ANF_ISIGC routes the setup requests to all destination SwMI over ISI upon request from the call control entity in the originating SwMI. In the destination SwMIs, the ANF_ISIGC shall request for the call establishment.

During the call established phase, the ANF_ISIGC shall transmit the push-to-talk requests between the participant SwMIs and the call master SwMI.

The ANF_ISIGC shall forward the call release requests at the end of the call.

5.1.5.2. Qualification on applicability to TETRAPOL services

The ANF_ISIGC is applicable to TETRAPOL encoded group call in the following modes:

- clear speech mode;
- end-to-end encrypted mode;
- ISI encrypted mode.

5.1.5.3. Procedures

5.1.5.3.1. Provision/withdrawal

Provision and withdrawal of the ANF_ISIGC shall be prearranged by the system manager.

5.1.5.3.2. Normal procedures

- Activation, deactivation, registration, interrogation

The ANF_ISIGC shall be permanently activated upon provision and permanently deactivated upon withdrawal. Registration and interrogation are not applicable to ANF_ISIGC

- Invocation and operation

The ANF_ISIGC is an extension of the QSIG circuit mode basic call for the purpose of TETRAPOL group call over the inter-system interface.

- Establishment of a group call

When a group call request is received by a call control entity in the SwMI and once it has analysed that the call setup request is allowed from the calling party, it shall retrieve the coverage area of the call to be setup.

The call control functional entity of the originating SwMI shall instanciate the ANF_ISIGC when the coverage of the being established group call shall involve more than one SwMI.

If the originating SwMI dismisses being the call master SwMI of that call, then the call request is forwarded to the group home SwMI. Otherwise the originating SwMI becomes the call master SwMI.

The ANF_ISIGC shall then route the call request over the ISI to the destination SwMIs.

The group call is established in the SwMIs from the coverage area where members of the group are registered.

- Maintenance of a group call

The ANF_ISIGC shall forward the requests to transmit between the call master SwMI and the participant SwMIs.

- Termination of a group call

When a user that has the right to terminate the group call requests the call release, then the call master SwMI shall synchronise the call releases over ISI.

5.1.5.3.3. Exceptional procedures

- Activation, deactivation, registration, interrogation

Not applicable

- Invocation and operation

The ANF_ISIGC may reject a outgoing group call setup request when the ISI is not available.

The ANF_ISIGC may reject an incoming group call setup request when the requested service is not available in the destination SwMI.

5.1.5.4. Interaction with other PSS1 supplementary services and ANF

No interaction with other supplementary services and ANFs for which PSS1 standards were available at the time of publication of this specification has been found, so that the supplementary services shall behave as normal when applicable.

5.1.5.5. Interaction with TETRAPOL supplementary services and other ANF

There shall be no interaction between ANF_ISIGC and other TETRAPOL supplementary services and additional network features that shall behave as normal when applicable.

5.1.5.6. Functional model

The functional model for group call over ISI shall comprise the following functional entities:

Originating FE: Call Originating functional entity

Individual DB: Database access functional entity of the calling party

Master FE: Call master functional entity

Participating FE: Call participating functional entity

Group DB: Database access functional entity for the coverage of the group call

The following functional relationship shall exist between these functional entities:

rProfile between OriginatingFE and IndividualDB

rGroup between OriginatingFE and GroupDB

rforward between OriginatingFE and MasterFE

rcoverage between MasterFE and GroupDB

route between MasterFE and Participating FE

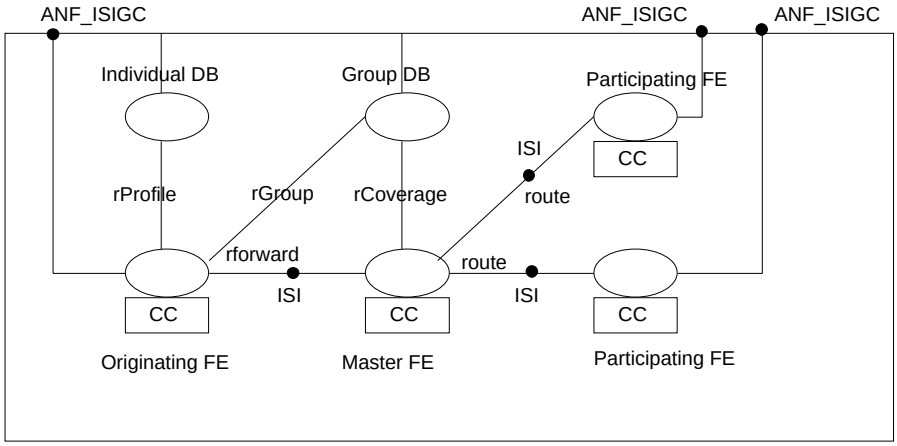


Figure 11: ANF_ISIGC with Master FE different from Originating FE

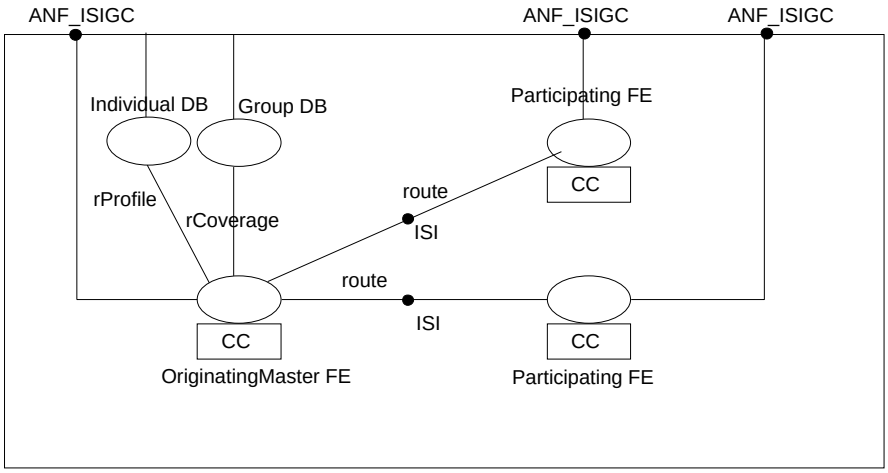


Figure 12: ANF_ISIGC with Master FE is Originating FE

The OriginatingFE

- detects an outgoing group call setup request over more than one SwMI
- checks calling party profile

- may forward the request to the master FE

The Master FE

- may receive a forwarded setup request
- requests the coverage extension to the other SwMIs and determines the ad hoc routing
- intermediates between the call control and QSIG to route the call to the participating FE

- synchronises the call release

The group DB

- indicates the SwMI coverage definition

The ParticipatingFE

- detects an incoming coverage definition request

- intermediate between the call control and QSIG

The OriginatingFE is assumed to be a Participating FE

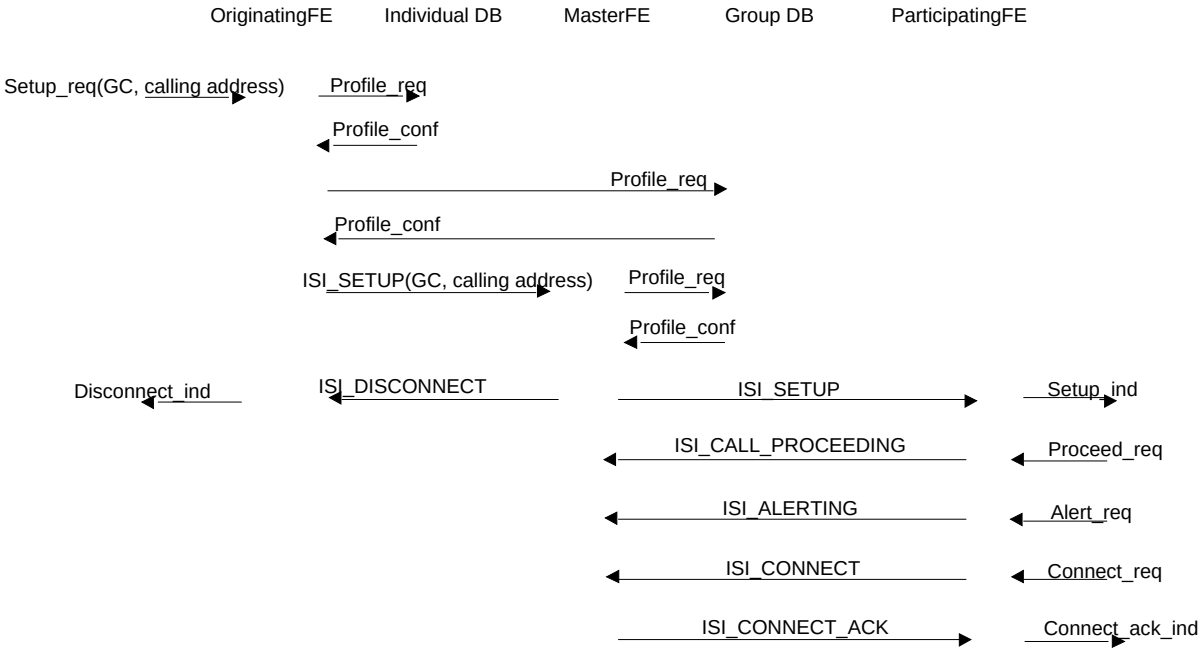
OriginatingFE and DestinationFE are assumed to be located in different SwMIs, so that route is over ISI and ANF_ISIIC is invoked.

The group DB is assumed to collocate with the OriginatingFE.

5.1.5.7. Information flows

The information flows for group call setup are identical to the information flows for MOCH.

The information flow for activation of a group call is identical to the information flow for talkgroup.



5.1.6. ANF for supplementary and data transport services

5.2. Mobility, registration and subscription related additional network features

5.2.1. Scope of ANF_ISIMM

The ANF_ISIMM shall provide additional network features to the mobility management functional entity in the SwMI in order to extend its functionalities over the inter-system interface.This includes:

- Database access for registration and subscription management

- Mobility of terminals: migration between systems

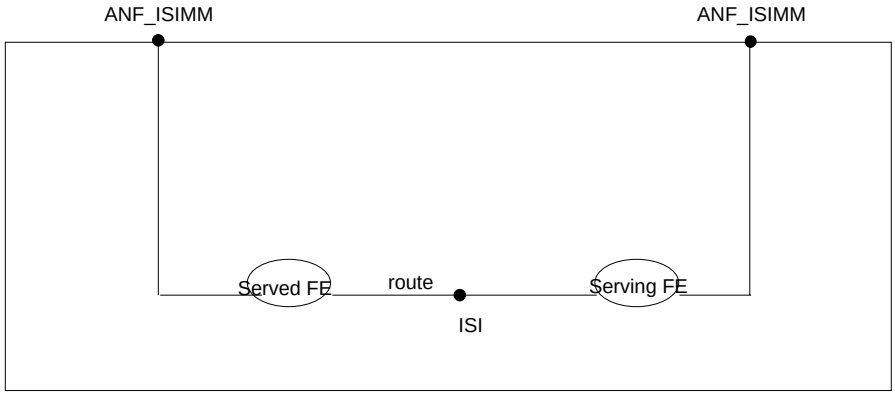


Figure 13: ANF_ISIMM

5.2.2. ANF for registration and subscription management

5.2.2.1. Database query

The additional network function shall make it possible to query the HLR of a terminal, in order to read parts of its profile or find out the SwMI where it is attached.

5.2.2.2. Remote ISI access selection

In the case a SwMI provides several inter-system access points, this feature may provide the ability of a remote SwMI to indicate which inter-system access point is preferred for a call setup involving an individual terminal or a group of terminals, depending on whether the routing algorithm in the destination SwMI allows for traversing the complete destination SwMI or whether internal routing resources in the destination SwMI are mainly reserved for internal calls.

5.2.2.3. Group management

This feature shall provide the ability for a group home SwMI to request an update of a group membership for terminals in a visited system.

This feature shall also manage federal groups, i.e. groups shared among several SwMI, and network group translation, i.e. translation of group identities valid within one network.

5.2.3. ANF for mobility and migration

5.2.3.1. Database update

An additional network feature shall provide for HLR update, according to access restrictions pre-arranged between systems.

5.2.3.2. Migration of terminal

This feature shall provide the ability for a terminal migrating from one system to another to register in the newly visited system.

This feature shall provide the ability for a SwMI to request the updating of location data or subscription data from the individual home SwMI.

This feature shall also provide the ability for an individual home SwMI to request a de-registration of that terminal from the previously visited system.

In support of migration of a terminal between systems, the ANF shall detect a migration request of a terminal and shall provide for its new registration in a different system.

5.2.3.3. Fallback mode and HLR recovery

Should the ANF_ISIMM functional entity be not able to request the update of an HLR, then it shall turn in a fallback mode until the path to the HLR is recovered.

Should an HLR request for a database recovery, then the ANF_ISIMM may provide the information related to migrated terminals. VLR registration data shall be assumed more accurate than HLR ones.

5.2.3.4. Qualification on applicability to telecommunication services

The ANF_ISIMM additional network feature is applicable as an extension to the following mobility management services from the TETRAPOL SwMI:

- Terminal location management, subscription management, group management;
- Roaming within a location area of a base station;
- Roaming between different base stations in a base network;
- Roaming between base stations connected to different switches in a base network;
- Roaming between different base networks in a SwMI;
- Migration between systems;
- Cell selection and cell reselection algorithms (Note that broadcasting network information and adjacent cell parameters is not related to the ISI);
- Registration procedures in a cell from a location area of a base station in a base network of a SwMI;
- Deregistration for a cell of a location area of a base station in a base network of a SwMI;
- Authentication procedure at registration.

5.2.3.5. ANF_ISIMM procedures

5.2.3.5.1. Provision and withdrawal

Provision of ANF_ISIMM service shall be pre-arranged between the system managers of the interconnected SwMIs.

Withdrawal of ANF_ISIMM service shall be performed by the system manager.

5.2.3.5.2. Normal procedures

- Activation, deactivation, registration, interrogation

ANF_ISIMM shall be permanently activated upon provision, and shall be permanently deactivated upon withdrawal. Registration and interrogation are not applicable to this ANF. Some features of ANF_ISIMM may be not relevant to some inter-system interfaces, e.g. migration.

- Migration of a terminal between systems

The ANF_ISIMM shall be invoked when a terminal requests to register in a cell of a visited system, whose country code and network code happen to be different from those of the terminal, and this visited system can not retrieve any or sufficient information in its VLR regarding that terminal.

In that case, the ANF_ISIMM shall check whether the terminal is allowed to migrate to that visited system. If the terminal is allowed to register in the visited system, the ANF_ISIMM shall retrieve from the HLR the subset of the user profile needed for the visited system.

The ANF_ISIMM shall be invoked by the home system of the terminal, in order to deregister the terminal from another visited system.

- Group management

Three aspects of group management shall be considered over the ISI:

- Group distribution for terminals in visited systems, when the membership of a group is changed while the terminal is in a remote system.

  The ANF_ISIMM shall provide the group numbers relevant for the terminal while being in the visited system, as initiated from the group home system. The remote system shall download the group numbers distributed to visited terminals as requested by the group home SwMI.

- Fallback mode and database recovery

Should the ANF_ISIMM functional entity be not able to request the update of an HLR, then it shall turn in a fallback mode until the path to the HLR is recovered. When the path to the HLR is recovered, the ANF_ISIMM shall participate in the database synchronisation between the HLR and the VLR.

Should an HLR request for a database recovery, then the ANF_ISIMM may provide the information related to migrated terminals. VLR registration data shall be assumed more accurate than HLR ones.

5.2.3.5.3. Exceptional procedures

- Activation, deactivation, registration, interrogation

Not applicable

- Invocation and operation for migration

The visited system may reject a migration request, providing an appropriate failure cause:

- if there is no available ISI connection to the home SwMI of that terminal, at the time of the migration;
- when the ANF_ISIMM is unable to retrieve the user profile of the migrating terminal, or;
- when the analysis of the profile of the migrating terminal shows it is not allowed to register is that system.

- Invocation and operation for group management

  A group downloading from a home SwMI to a visited SwMI shall fail with an appropriate failure:

  - if there is no available ISI connection between the home and the visited SwMI at the time of the request;
  - if the terminal is being migrating away from the visiting system;
  - if the visited system fails to download the groups to the terminals.

5.2.3.5.4. Interaction with other PSS1 supplementary services and additional network features

No interaction with other supplementary services and ANFs for which PSS1 standards were available at the time of publication of this specification has been found, so that the supplementary services shall behave as normal when applicable.

5.2.3.5.5. Interaction with other TETRAPOL supplementary services and additional network features

There shall be no interaction between ANF_ISIMM and other TETRAPOL supplementary services and additional network features that shall behave as normal when applicable.

5.3. Security related additional network features

6. Inter-System service procedures

6.1. Routing to the ISI service access point

6.1.1. General aspects

Routing at the network layer is the process of selecting a path between end-elements. To reach a given destination, e.g. another SwMI, from a terminal attached in a SwMI, there is frequently a choice of possible paths and the routing procedure is required to select a path with spare capacity, and as such the routing algorithm may be considered as a search algorithm, with a distance criterion that may be based either on static distance table (number of intervening nodes or cost) or on an heuristic function related to the use of the network resources.

6.1.2. Number of ISI service access points per system

The reasons for few service access points deal with a centralised security:

- safety issues: the more service access point, the smaller the granularity of the sub-systems seen from outside: a user may be localised by an SwMI if its places location request to several ISI service access point; as the user is nearer to the service access point, which becomes a spotlight in any location answer;
- centralisation of the gateways;
- access to an internal backbone of high speed transit switches.

The reasons for many service access points are economical ones:

- to optimise the external routing: less internal resources are used to access the called user;
- not to care too much of the fading of the voice quality within the called SwMI.

Hence, there shall be one ISI service access point for a small network, and there may be several ISI service access points for nation-wide networks, if they can provide for a high speed internal routing.

6.1.3. How to find an ISI service access point ?

An outgoing call involving more than one system shall be routed to the nearest ISI service access point. The address of the service access point may either be considered as an explicit address of the service access point or as a functional address. In the former case, there shall be no ambiguity to route the call to it, as the service access point belong to a TETRAPOL base network. In the latter case, the functional address shall be translated into an explicit one by the calling base network, which may lead to different local interpretations and routings.

Incoming call are routed from one ISI service access point to the called users. It is mandatory that the remote TETRAPOL system uses one ISI service access point per call, in order to prevent multiple routings to a single Base Network within a TETRAPOL system. The sole ISI service access point to use is the one access point provided as an information element of the location answer from the database.

6.1.4. Service access point distance criteria

Routing may be supported by a rather static routing table available within each SwMI, and updated each time a new connection is created between SwMIs. Routing may be also dynamically computed.

If one system may be accessed through several service access points from one TETRAPOL system, the nearest service access point shall be chosen during a location request, according to one of the following distances used as heuristic criteria:

  - The distance between a calling user and an ISI service access point may be measured by the number of TETRAPOL base networks needed as a transit between them.
  - The distance between a calling user and an ISI service access point may be measured by the number of TETRAPOL 'internal' resources that shall be allocated for the call, scare resources may be weighted against plentiful ones.
  - The distance between a calling user and an ISI service access point may be measured by the number of on-going call through that ISI service access point. In that case, it is the service access point that provides the information.
  - The distance may be measured with an evaluation of the estimated charging of the ISI.
- The distance may be measured with a static priority attached to each service access point.

Only one ISI service access point shall be used for a call.

6.1.5. Routing a call to the ISI

A call shall be routed to the ISI service access point as if the ISI service access point were a special subscriber from a special base network of the system.

6.1.6. Fault handling

The call shall be partially aborted if one of the following events occurs:

  - Unknown ISI service access point;
  - Unavailable ISI service access point;
- The foreign system can not handle the call.

The call setup procedure shall be tried again when a routing fails due to the system resources.

6.2. Procedures over the ISI

6.2.1. TETRAPOL domain

The ISI procedures between two TETRAPOL systems shall follow those defined in the document (3) with the following extensions:

- In order to have a more balanced resource allocation scheme and an optimised QSIG topology, the originating SwMI shall per default be elected as the call master SwMI.
- It is not compulsory to have a permanent connection to the HLRs after the call setup; the home SwMI may be not a participant of the call.

6.2.2. Foreign domain

The ISI procedures between a TETRAPOL system and a system that does not belong to the TETRAPOL domain shall follow the procedures defined in PAS 300 392-3.

6.3. Routing from the ISI service access point

6.3.1. ISI information processing

From the destination system point of view, the information received from the ISI shall be processed as if the foreign calling party were in a special base network of the destination network.

6.3.2. Fault handling

There shall be no fault handling mechanism for incoming calls, as it is the originating system responsibility to replace a call.

6.4. Fall back modes

There shall be no ISI-specific fall back mode over the ISI, as it is the responsibility of the originating system to replace a call setup.

However, the ISI layer 2 mechanism shall be able to reallocate a new traffic chDIRel if the previous one fails.

6.5. Charging the ISI

The charging policy is to a large extent outside of the scope of this specification, as they are an operator issue. However, the subject has some technical consequences, as the ISI is shared between systems that must have some common rules:

The ISI charging is dealt with by the call master SwMI, which means that between TETRAPOL systems, the originating SwMI supports all costs of the ISI, and between a TETRAPOL system and a foreign system, the TETRAPOL system takes care of the charging issue for incoming calls only.

7. Inter-System link management

7.1. Controlling the inter-system access points

7.1.1. Isolating a TETRAPOL system

The TETRAPOL network management shall be able to isolate a system from the outside world

7.1.2. Disabling a physical link

7.1.2.1. Disabling a QSIG link

The TETRAPOL network management shall be able to individually manage the ISI service access, enabling/disabling any QSIG link, distributing special data for a special link encryption.

7.1.2.2. Disabling a LAP_D link

The TETRAPOL network management shall be able to cut a LAP_D link allocated for a call.

7.1.3. Disabling a logical link

The TETRAPOL network management shall be able to specialise an ISI service access point for incoming calls only or outgoing calls only, i.e. to bare incoming or outgoing calls through this service access point.

The TETRAPOL network management may be able to disable some logical ISI links allocated for a call.

7.1.3.1. Removing an ISI service access point

7.1.3.1.1. Consequence on incoming calls

When removing an ISI service access point, the remote systems may still use some previously requested location information. Thus when a TETRAPOL system routing procedure receive the cause " remote system unreachable ", it shall request for a location update.

7.1.3.1.2. Consequence on outgoing calls

If the system has several ISI service access points, the routing map shall be amended when a service access point is removed.

7.1.3.2. Changing the routing to an ISI service access point

The routing to a service access point shall not be changed for on-going calls.

7.2. Inter-system managed objects

The inter-system managed objects shall include:

- End of inter-system trunk;
- Inter-system trunk managed object, incorporating an end of inter-system trunk and a T2 trunk objects, with a synthetic state as an attribute.

History

Document history		
Date	**Status**	**Comment**
30 November 1996	Draft	Version 0.0.7
16 December 1996	Edition	Version 0.0.8
18 Novembre 1997	Update following review	Version 0.1.0
30 January 1998	TETRAPOL Forum approval	Version 1.0.0