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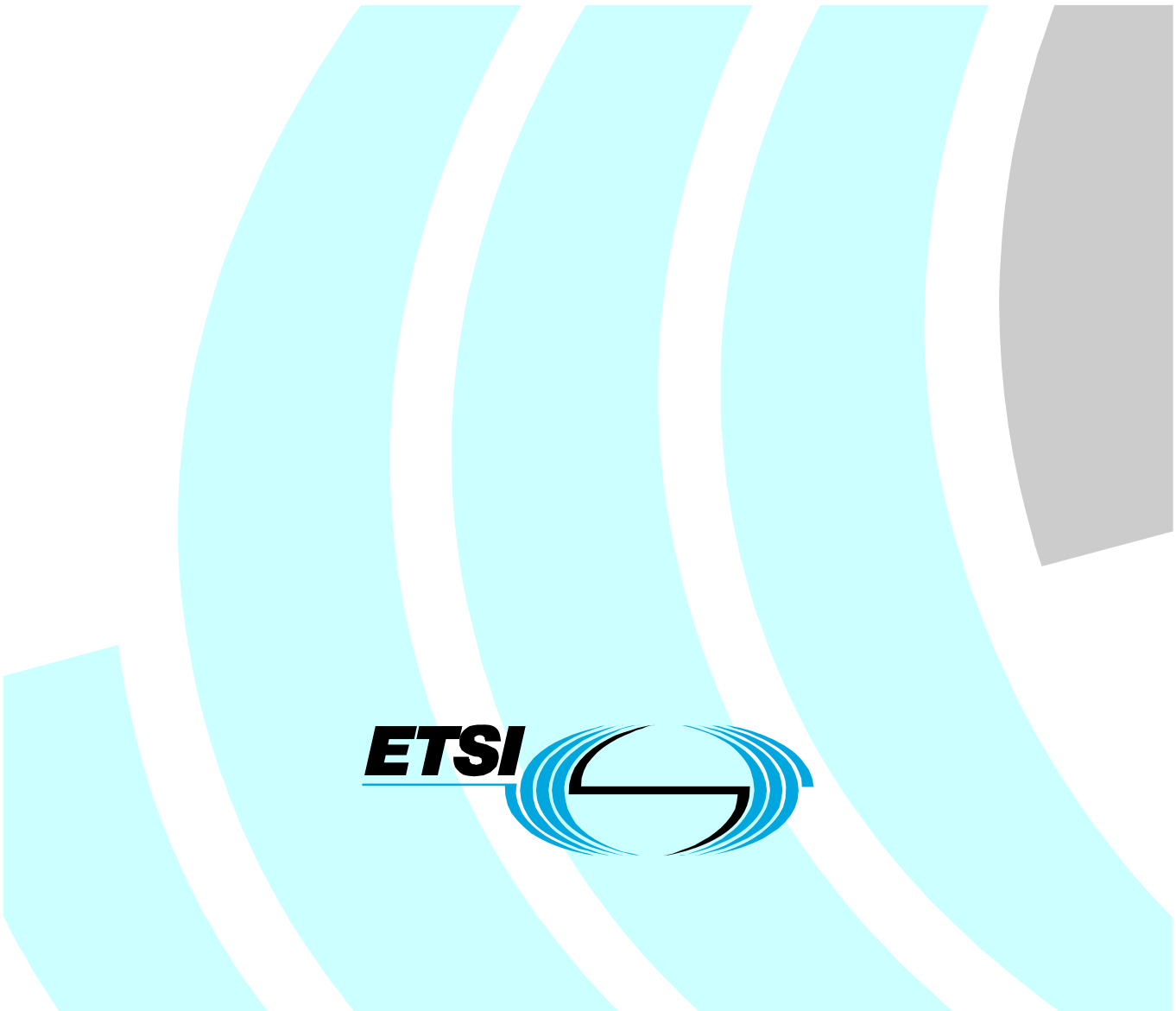
Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 1: General network design



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Contents

Intellectual Property Rights 12

Foreword 12

1 Scope 14

2 References 14
2.1 Normative references 15
2.2 Informative references 15

3 Definitions, symbols and abbreviations 16
3.1 Definitions 16
3.2 Symbols 21
3.3 Abbreviations 22

4 Circuit mode reference points 24

5 Packet mode reference points 24

6 Protocol architecture for V+D 24

7 Addressing and identities 24
7.1 Introduction 24
7.2 Subscriber identities 26
7.2.1 General 26
7.2.2 TSI 27
7.2.3 SSI 28
7.2.4 Composition of subscriber identities 28
7.2.5 Allocation principles for subscriber identities 29
7.2.6 Use of subscriber identities 29
7.2.7 NSAP addresses 30
7.2.8 Installation of TSIs 30
7.3 TETRA Management Identity (TMI) 30
7.3.1 General 30
7.3.2 Composition of management identities 31
7.3.3 Use of management identities 31
7.4 Network layer SAP (NSAP) addresses 31
7.4.1 General 31
7.4.2 Static binding 31
7.4.3 Dynamic binding 32
7.4.3.1 General 32
7.4.3.2 Structure and contents of NSAP addresses 32
7.4.3.3 Use of NSAP addresses 32
7.4.3.4 Binding of NSAP addresses 32
7.5 TETRA Equipment Identity (TEI) 32
7.5.1 General 32
7.5.2 Contents of TEI 33
7.5.3 Allocation principles for TEI 33
7.5.4 Use of TEI 33
7.6 Mobile Network Identity (MNI) 34
7.6.1 Contents of MNI 34
7.7 Layer 2 addresses and labels 34
7.7.1 Overview 34
7.7.2 Event labelling 34
7.7.3 Scrambling labelling 34
7.7.4 Use and implementation of layer 2 addresses 35
7.7.4.1 General requirement 35
7.7.4.2 Implementation of event labels 35
7.7.4.3 Implementation of scrambling labels 35
7.7.5 Use of identities for V+D control channels 35

7.7.6 Labelling of packet channels 36
7.7.6.1 Use of identities for uplink data transfers 36
7.7.6.2 Use of identities for downlink data transfers....36
7.7.7 System information broadcast....37
7.7.8 Reserved value of group address for user information broadcast 37
7.8 Use of individual addresses....37
7.8.1 Air interface addressing functions 37
7.8.2 Address placement in primitives and PDUs 37
7.8.2.1 Use of ISSI at layer 2 37
7.8.2.2 Use of ITSI/ISSI at layer 3....39
7.8.2.2.1 Void....39
7.8.2.2.2 Use of ITSI/ISSI by CMCE....39
7.8.3 Routing principles....40
7.8.3.1 Routing of intra-TETRA calls (within one TETRA network) 40
7.8.3.2 Routing of inter-TETRA calls (between two TETRA networks)....40
7.8.3.3 Routing of external calls (to/from non-TETRA networks) 41
7.8.4 Address and identity comparison....41
7.9 Addressing in interworking and roaming with other telecommunication networks 41

8 Circuit mode basic services....41

9 Mobility Management (MM) in MS 42

10 MLE mobility scenarios and functionalities....42

11 Technical realization of SDS....42

12 Void....42

13 Void....42

14 General on supplementary services....42

Annex A (informative): Circuit mode reference points....43

A.1 Introduction 43

A.2 Reference configuration 43
A.2.1 Configuration examples of TETRA LMNs 44

A.3 TETRA LMN access 45
A.3.1 MS access....45
A.3.1.1 MS functional groups....45
A.3.1.2 MS access points and reference points 45
A.3.2 Void....46
A.3.3 Inter System Interface (ISI) access....46
A.3.4 Location of TETRA functionality 46
A.3.5 TETRA terminals 46

Annex B (informative): Protocol architecture for V+D 47

B.1 Introduction 47

B.2 Mobile/base protocol architecture 47
B.2.1 Overview....47
B.2.2 Air interface layer 1....47
B.2.3 Air interface layer 2....48
B.2.3.1 Medium Access Control (MAC)....48
B.2.3.2 Logical Link Control (LLC) 50
B.2.4 Air interface layer 3....50
B.2.4.1 Mobile/Base Link control Entity (MLE/BLE)....50
B.2.4.2 Sub-Network Access Functions (SNAF) 51
B.2.4.2.1 Mobility Management (MM) 51
B.2.4.2.2 Circuit Mode Control Entity (CMCE)....51
B.2.4.2.3 Packet data handling 52
B.2.4.2.4 TETRA packet data protocol (PDP)....52

B.2.4.2.5 Void....52
B.2.5 Mobile/base protocol stack....52
B.3 Lower Layer Management Entity (LLME) and other layers interaction....53
B.3.1 General description....53
Annex C (informative): Overview of circuit mode basic services....54
C.1 Introduction....54
C.2 Functional groupings in circuit switched mode calls....54
C.2.1 Circuit switched call control, C-plane....54
C.2.2 Circuit switched call, user data, U-plane....54
C.3 Protocols....54
C.3.1 TNP1....54
C.3.2 Void....54
C.3.3 TNP3....54
C.3.4 TNP4....55
C.3.5 AI1....55
C.3.6 AI2....55
C.3.7 TLC1....55
C.3.8 V.24T....55
C.4 Example configuration....55
C.4.1 MS to MS....55
C.4.2 Void....56
C.4.3 Void....56
C.4.4 MS to MS over ISI....56
Annex D (informative): Individual circuit mode call scenarios....58
D.1 Introduction....58
D.2 Procedures - message trunked systems....58
D.2.1 Call set-up - on/off hook signalling....58
D.2.1.1 Call set-up - on/off hook signalling flow....58
D.2.1.2 Traffic channel assignment....59
D.2.2 Call set-up - direct set-up signalling....59
D.2.2.1 Call set-up - direct set-up signalling flow....59
D.2.2.2 Traffic channel assignment....60
D.2.3 Request-to-transmit....61
D.2.4 Response to request-to-transmit....62
D.2.5 Permission to transmit withdrawn....62
D.2.6 Permission to continue with withdrawn call....62
D.2.7 End of transmission....62
D.2.8 Stop-transmission order....62
D.2.9 Call clearing....63
D.2.9.1 Mobile originated....63
D.2.9.2 SwMI originated....64
D.3 Procedures - transmission trunked systems....64
D.3.1 Call set-up - on/off hook signalling....64
D.3.1.1 Call set-up - on/off hook signalling flow....64
D.3.1.2 Traffic assignment....65
D.3.2 Call set-up - direct set-up signalling....65
D.3.2.1 Call set-up - direct set-up signalling flow....65
D.3.2.2 Traffic channel assignment....66
D.3.3 Request-to-transmit....66
D.3.4 Response to request-to-transmit....67
D.3.5 Permission to transmit withdrawn....68
D.3.6 Permission to continue with withdrawn call....68
D.3.7 End of transmission....68
D.3.8 Stop-transmission order....68
D.3.9 Call clearing....68

D.3.9.1 Mobile originated....68
D.3.9.2 SwMI originated....69

D.4 Procedures - quasi-transmission trunked systems....70
D.4.1 Call set-up - on/off hook signalling....70
D.4.1.1 Call set-up - on/off hook signalling flow....70
D.4.1.2 Traffic assignment....71
D.4.2 Call set-up - direct set-up signalling....71
D.4.2.1 Call set-up - direct set-up signalling flow....71
D.4.2.2 Traffic assignment....72
D.4.3 Request-to-transmit....73
D.4.4 Response to request-to-transmit....74
D.4.5 Permission to transmit withdrawn....74
D.4.6 Permission to continue with withdrawn call....75
D.4.7 End of transmission request....75
D.4.8 Stop-transmission order....75
D.4.9 Call clearing....75
D.4.9.1 Mobile originated....75
D.4.9.2 SwMI originated....76

Annex E (informative): Group voice call scenarios....77

E.1 Procedures for message trunked systems....77
E.1.1 General....77
E.1.2 Call set-up....78
E.1.2.1 Call set-up flow....78
E.1.2.2 Traffic channel assignment....79
E.1.3 Request-to-transmit....79
E.1.4 Response to request-to-transmit....80
E.1.5 Permission to transmit withdrawn....81
E.1.6 Permission to continue with withdrawn call....81
E.1.7 End of transmission....81
E.1.8 Stop-transmission order....81
E.1.9 Call clearing....82
E.1.9.1 Mobile originated....82
E.1.9.2 SwMI originated....82

E.2 Procedures for transmission trunked systems....82
E.2.1 General....82
E.2.2 Call set-up....83
E.2.2.1 Call set-up flow....83
E.2.2.2 Traffic channel assignment....84
E.2.3 Request-to-transmit....84
E.2.4 Response to request-to-transmit....85
E.2.5 Permission to transmit withdrawn....86
E.2.6 Permission to continue with withdrawn call....86
E.2.7 End of transmission....86
E.2.8 Stop-transmission order....86
E.2.9 Call clearing....86
E.2.9.1 Mobile originated....86
E.2.9.2 SwMI originated....87

E.3 Procedures for quasi-transmission trunked systems....87
E.3.1 General....87
E.3.2 Call set-up....88
E.3.2.1 Call set-up flow....88
E.3.2.2 Traffic channel assignment....89
E.3.3 Request-to-transmit....89
E.3.4 Response to request-to-transmit....90
E.3.5 Permission to transmit withdrawn....90
E.3.6 Permission to continue with withdrawn call....90
E.3.7 End of transmission....91
E.3.8 Stop-transmission order....91

E.3.9 Call clearing 91
E.3.9.1 Mobile originated 91
E.3.9.2 SwMI originated 92

Annex F (informative): Priority functions for circuit mode services 93

F.1 Introduction 93

F.2 Priority requirements 93
F.2.1 Access priority 93
F.2.2 Call type priority 94
F.2.3 Queue priority 94
F.2.4 Pre-emptive priority 94
F.2.5 Call retention priority 94
F.2.6 Subscriber priority 94

F.3 Mechanisms for supporting priority 94

F.4 Supplementary service activation and invocation 95

Annex G (informative): Mobility Management (MM) in MS 96

G.1 Introduction 96

G.2 Overview of MM relations and procedures 96

G.3 Stimuli of MM 97
G.3.1 Stimulation through TNMM-SAP 97
G.3.2 Stimulation through LMM-SAP 98
G.3.3 Stimulation through peer MM 98
G.3.4 Other stimulation 98

G.4 Outputs from MM 98
G.4.1 Output through TNMM-SAP 98
G.4.2 Outputs through LMM-SAP 99
G.4.3 Output to peer MM 99

G.5 Database requirement 99

G.6 MM procedures 99
G.6.1 Registration 99
G.6.1.1 Registration at roaming 99
G.6.1.1.1 Implicit registration 99
G.6.1.1.2 Registration area 100
G.6.1.1.3 Registration procedure 100
G.6.1.1.4 Registration with authentication 101
G.6.1.1.5 Registration with identity exchange 102
G.6.1.2 Registration at migration 103
G.6.1.2.1 Registration with identity exchange 103
G.6.1.2.2 Registration with authentication 105
G.6.1.3 Network initiated registration 106
G.6.1.4 TEI request 106
G.6.2 Authentication 106
G.6.2.1 Network initiated authentication 106
G.6.2.2 MS initiated authentication 107
G.6.3 De-registration 108
G.6.4 Periodic registration 108
G.6.5 Disable/enable 108
G.6.5.1 Temporary disable 108
G.6.5.2 Enable 108
G.6.5.3 Permanently disable 109
G.6.6 Energy economy mode change 109

G.7 Downloading of group identities 109
G.7.1 Add group identity 109
G.7.2 Delete group identity 110

G.7.3 Delete all group identities....110
G.7.4 Report group identities....111

Annex H (informative): MLE mobility scenarios and functionalities....112

H.1 Introduction....112

H.2 Overview....112

H.3 MLE responsibilities....112

H.4 MS-MLE model....113

H.5 MLE functionalities....114
H.5.1 Monitoring of neighbour cells (scenario 1)....115
H.5.2 Scanning of neighbour cells (scenario 2)....115
H.5.3 MM activation of the MS-MLE (scenario 3)....116
H.5.4 Open up MLE service (scenario 4)....117
H.5.5 Close of MLE service (scenario 5)....118
H.5.6 Changing to serving cell (scenario 6)....118
H.5.7 Surveillance of the serving cell (scenario 7)....118
H.5.8 Inviting MM intervention....119
H.5.8.1 No service can be found (scenario 8)....119
H.5.8.2 LA found outside RA (scenario 9)....120
H.5.9 Set-up of MAC broadcast (SYNC + SYSINFO) (scenario 10)....121
H.5.10 Set-up of MLE broadcast (NETWORK) (scenario 11)....121
H.5.11 MM registering (scenario 12)....122
H.5.12 Announce old cell and go-to-channel (scenario 13)....122
H.5.13 Announce old cell (scenario 14)....122
H.5.14 Announce new cell and successful restoration (scenario 15)....123
H.5.15 Announce new cell and restoration failure (scenario 16)....124
H.5.16 Path lost to the serving cell (scenario 17)....124

H.6 Initial cell selection....125
H.6.1 MLE functions as viewed at the LMM SAP....125
H.6.2 MLE functions....125

H.7 Cell re-selection by roaming....126
H.7.1 Announced cell re-selection....126
H.7.1.1 Announced cell re-selection (type-1)....127
H.7.1.1.1 MLE functions as viewed at the LMM SAP....127
H.7.1.1.2 MLE functions as viewed at the LCMC SAP....128
H.7.1.1.3 MLE functions....128
H.7.1.2 Announced cell re-selection (type-2)....129
H.7.1.3 Announced cell re-selection (type-3)....130
H.7.1.3.1 MLE functions as viewed at the LCMC SAP....130
H.7.1.3.2 MLE functions....131
H.7.2 Unannounced cell re-selection....131
H.7.3 Undeclared cell re-selection....132
H.7.3.1 MLE functions as viewed at the LMM SAP....132

H.8 MLE service requests during cell re-selection....132
H.8.1 Undeclared cell re-selection....133

H.9 No MLE recovery....133

H.10 Use of LLC....133
H.10.1 MS-MLE using the LLC basic link....134
H.10.1.1 Basic link and connectionless MLE service....134
H.10.1.2 Basic link and MLE connections....134
H.10.2 MS-MLE using the LLC advanced link....135
H.10.2.1 Advanced link and connectionless MLE service....135
H.10.2.2 Advanced link and MLE connection....136

Annex I (informative): Void....137

Annex J (informative): Technical realization of SDS and SDS-TL.....138

J.1 Introduction.....138

J.2 General.....138

J.3 Internal organization of the network layer.....138
J.3.1 Service model.....138
J.3.2 Network model.....139
J.3.2.1 Description of the functional entities.....139
J.3.2.2 Description of the relationships between functional entities.....142
J.3.3 Allocation of functional entities.....142
J.3.3.1 Point-to-point message transfer within one SwMI.....142
J.3.3.2 Point-to-multipoint message transfer within one SwMI.....143
J.3.3.3 Point-to-point message transfer within two SwMI.....143
J.3.3.4 Point-to-multipoint message transfer within two SwMI.....143
J.3.3.5 Point-to-point message transfer via an outgoing gateway.....144
J.3.3.6 Point-to-point message transfer via an incoming gateway.....144
J.3.3.7 Point-to-multipoint message transfer via an outgoing gateway.....144
J.3.3.8 Point-to-multipoint message transfer via an incoming gateway.....144

J.4 Protocol architecture.....145
J.4.1 MS protocol stack.....145
J.4.2 BS protocol stack.....146

J.5 Addressing.....146
J.5.1 Uplink addressing on the air interface.....146

J.6 Services provided by the air interface protocol.....147

J.7 Lower layer services used.....148
J.7.1 MLE primitives used in the MS and the LS.....148

Annex K (informative): General on supplementary services.....149

K.1 Introduction.....149

K.2 General.....149
K.2.1 Framework for the description of supplementary services.....149
K.2.2 Alignment with the European Computer Manufacturers Association (ECMA).....149
K.2.3 Methodology.....150

K.3 Supplementary service concepts.....150
K.3.1 Concepts associated with supplementary services.....150
K.3.1.1 Provision.....150
K.3.1.2 Withdrawal.....151
K.3.1.3 Activation.....151
K.3.1.4 Deactivation.....151
K.3.1.5 Definition.....151
K.3.1.6 Registration.....151
K.3.1.7 Interrogation.....151
K.3.1.8 Cancellation.....152
K.3.1.9 Invocation.....152
K.3.1.10 Operation.....152
K.3.1.11 Exceptional procedures.....152
K.3.1.12 Interworking considerations.....152
K.3.2 Supplementary service invocation order.....152
K.3.3 Use of a password option in relation to supplementary services.....153
K.3.3.1 Description.....153
K.3.3.2 Management - normal procedures.....153
K.3.3.2.1 Provision of password option.....153
K.3.3.2.2 Withdrawal of the password option.....153
K.3.3.2.3 Registration of password.....153
K.3.3.2.4 Erasure of password.....153
K.3.3.2.5 Password checking.....153

K.3.3.3 Management - exceptional procedures 153
K.4 Supported supplementary services 154
K.4.1 Format of description 156
Annex L (informative): Packet mode reference points 157
L.1 Introduction 157
L.2 Physical interfaces 157
L.3 Configurations 157
L.3.1 Basic configurations 157
L.3.2 Void 157
L.3.3 Interworking 157
L.4 Reference points 157
L.4.1 MS reference points 157
L.4.2 Void 158
L.4.3 Void 158
L.4.4 TETRA to TETRA reference point 158
L.4.5 TETRA to non-TETRA reference point 159
L.5 Protocol stacks 159
L.5.1 Protocol stacks at R1 reference point 159
L.5.2 Protocol stacks at R2 reference point 159
L.5.3 Protocol stacks at R4 reference point 160
Annex M (informative): Quality of Service (QoS) 161
M.1 Introduction 161
M.2 Quality of network service 161
M.2.1 Determination of quality of network service 161
M.2.1.1 Connection oriented quality of network service 162
M.2.1.2 Connectionless quality of network service 162
M.2.2 QoS negotiation and non-negotiation 162
M.2.3 QoS parameter set for connection oriented services 162
M.2.3.1 Summary 162
M.2.3.2 NC establishment delay 163
M.2.3.3 NC establishment failure probability 163
M.2.4 Throughput (User information transfer rate) 163
M.2.4.1 Throughput for constant delay services 163
M.2.4.2 Throughput for variable delay services 164
M.2.5 Transit delay 164
M.2.5.1 Transit delay for constant delay services 164
M.2.5.2 Transit delay for voice services 164
M.2.5.3 Transit delay for variable delay services 164
M.2.6 Residual error rate 165
M.2.7 Transfer failure probability 165
M.2.8 NC resilience 165
M.2.8.1 NC release delay 166
M.2.8.1.1 NC release delay at the peer user 166
M.2.8.1.2 NC release delay at the invoking user 166
M.2.8.2 NC release failure probability 166
M.2.8.3 NC protection 166
M.2.8.4 NC priority 167
M.2.9 Maximum acceptable cost 167
M.2.10 Air interface parameters 167
M.2.10.1 Duration of interruption of user traffic due to call restoration 167
M.2.10.2 Call restoration success rate 167
M.2.10.3 Interruption of user traffic due to slot stealing 167
M.2.11 Supplementary service parameters 168
M.2.11.1 Maximum time to activate a supplementary service 168
M.2.12 Connection oriented QoS negotiation 168

M.2.13 QoS parameter set for connectionless services....168
M.2.13.1 Summary....168
M.2.13.2 Transit delay....169
M.2.13.3 Protection from unauthorized access....169
M.2.13.4 Cost determinants....169
M.2.13.5 Residual error probability....169
M.2.13.6 Priority....170
M.2.13.7 Connectionless QoS negotiation....170
M.3 Applicability of QoS parameters to TETRA services....170
Annex N (normative): TETRA type approval code information element....172
N.1 Encoding of the TAC information element....172
N.2 Application for the TAC value....172
Annex O (normative): TETRA final assembly code information element....175
O.1 Encoding of the FAC information element....175
O.2 Application for the FAC value....175
O.3 WEB page contents for FAC data base....175
Annex P (normative): TETRA electronic serial number information element....178
P.1 Encoding of the ESN information element....178
P.2 Usage of the ESN....178
P.3 Usage of check sum of the equipment identity....178
Annex Q (informative): Change requests....179
History....180

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Terrestrial Trunked Radio (TETRA).

The present document is part 1 of a multi-part deliverable covering Voice plus Data (V+D), as identified below:

EN 300 392-1: "General network design";

EN 300 392-2: "Air Interface (AI)";

EN 300 392-3: "Interworking at the Inter-System Interface (ISI)";

ETS 300 392-4: "Gateways basic operation";

EN 300 392-5: "Peripheral Equipment Interface (PEI)";

EN 300 392-7: "Security";

EN 300 392-9: "General requirements for supplementary services";

EN 300 392-10: "Supplementary services stage 1";

EN 300 392-11: "Supplementary services stage 2";

EN 300 392-12: "Supplementary services stage 3";

ETS 300 392-13: "SDL Model of the Air Interface (AI)";

ETS 300 392-14: "Protocol Implementation Conformance Statement (PICS) proforma specification";

TS 100 392-15: "TETRA frequency bands, duplex spacings and channel numbering";

TS 100 392-16: "Network Performance Metrics";

TR 100 392-17: "TETRA V+D and DMO specifications";

TS 100 392-18: "Air interface optimized applications".

NOTE: Part 10, sub-part 15 (Transfer of control), part 13 (SDL) and part 14 (PICS) of this multi-part deliverable are in status "historical" and are not maintained.

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1 Scope

The present document defines addressing for Terrestrial Trunked Radio system (TETRA) supporting Voice plus Data (V+D). It also gives background information of the air interface, the interworking between TETRA systems and to other systems via gateways, the terminal equipment interface on the Mobile Station (MS), the security aspects in TETRA networks, the management services offered to the operator, the performance objectives, and the supplementary services that come in addition to the basic and tele-services used as a basis for TETRA standardization.

The present document defines and specifies the TETRA addressing and identities and their organization in groups corresponding to the different functions.

It establishes the background of the TETRA general network design for standardization purposes:

- it gives information about the circuit mode and packet mode reference points for the MS and switching and management infrastructure;
- it gives information about a model of the air interface protocol stack, different functions of layers and sublayers;
- it gives information about the functions provided by the circuit mode teleservices used for speech and basic services used for data transfer;
- it gives information about the functions related to the management of the users' mobility across networks and inside a network including roaming and migration;
- it gives information about the functions related to the transport of short data messages as a service specific to TETRA;
- it gives information about the functions related to the support of packet data service in a way specific to TETRA;
- it gives information about the supplementary services that mainly extend the capabilities of the circuit mode basic and teleservices;
- it gives information about the various possibilities of individual circuit mode call scenarios and provides guidance on priority concepts for packet data and circuit mode services and on the service quality.

NOTE: This part of the multi-part document may, by its nature as a general design statement, require updating when later parts of the multi-part document are completed and maintained (in order to avoid any non-alignment). If a discrepancy occurs between this part and any other part of the multi-part document, then the other part will take precedence. The present document may be maintained mainly on those clauses, which are referred from other parts or standards.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific.

- For a specific reference, subsequent revisions do not apply.
- Non-specific reference may be made only to a complete document or a part thereof and only in the following cases:
  - if it is accepted that it will be possible to use all future changes of the referenced document for the purposes of the referring document;
  - for informative references.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

For online referenced documents, information sufficient to identify and locate the source shall be provided. Preferably, the primary source of the referenced document should be cited, in order to ensure traceability. Furthermore, the reference should, as far as possible, remain valid for the expected life of the document. The reference shall include the method of access to the referenced document and the full network address, with the same punctuation and use of upper case and lower case letters.

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

[1] ITU-T Recommendation E.164: "The international public telecommunication numbering plan".

[2] ITU-T Recommendation E.218: "Management of the allocation of terrestrial trunk radio Mobile Country Codes".

[3] ITU-T Recommendation E.213: "Telephone and ISDN numbering plan for land mobile stations in public land mobile networks (PLMN)".

[4] ETSI EN 300 392-2: "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 2: Air Interface (AI)".

[5] ETSI EN 300 392-7: "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 7: Security".

[6] ETSI EN 300 392-10-22: "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 10: Supplementary services stage 1; Sub-part 22: Dynamic Group Number Assignment (DGNA)".

[7] Void.

2.2 Informative references

The following referenced documents are not essential to the use of the present document but they assist the user with regard to a particular subject area**.** For non-specific references, the latest version of the referenced document (including any amendments) applies.

[i.1] ITU-T Recommendation I.130: "Method for the characterization of telecommunication services supported by an ISDN and network capabilities of an ISDN".

[i.2] ITU-T Recommendation I.411: "ISDN user-network interfaces - Reference configurations".

[i.3] ITU-T Recommendation X.213: "Information technology - Open systems Interconnection - Network service definition".

[i.4] ITU-T Recommendation X.219: "Remote Operations: Model, notation and service definition".

[i.5] ISO/IEC 8348: "Information technology - Open Systems Interconnection - Network service definition".

[i.6] ECMA-165: "Private Integrated Services Network (PISN) - Generic Functional Protocol for the Support of Supplementary Services - Inter-Exchange Signalling Procedures and Protocol (QSIG-GF)".

[i.7] ETSI ETR 086 (all parts): "Trans European Trunked Radio (TETRA) systems; Technical requirements specification".

[i.8] ETSI EG 202 118: "Services and Protocols for Advanced Networks (SPAN); The structure of the TETRA numbering resource, interworking and high level policy for administration".

[i.9] ETSI EN 300 392-10 (all sub-parts): "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 10: Supplementary services stage 1".

[i.10] ETSI EN 300 392-5: "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 5: Peripheral Equipment Interface (PEI)".

[i.11] ISO/IEC 11572: "Information technology - Telecommunications and information exchange between systems - Private Integrated Services Network - Circuit mode bearer services - Inter-exchange signalling procedures and protocol".

[i.12] ETSI EN 300 392-3-1: "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 3: Interworking at the Inter-System Interface (ISI); Sub-part 1: General design".

[i.13] ETSI TS 101 747: "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); IP Interworking (IPI)".

[i.14] ITU-T Recommendation V.24: "List of definitions for interchange circuits between data terminal equipment (DTE) and data circuit-terminating equipment (DCE)".

[i.15] ITU-T Recommendation V.28: "Electrical characteristics for unbalanced double-current interchange circuits".

[i.16] ETSI TR 102 300-5: "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Designers' guide; Part 5: Guidance on numbering and addressing".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

announced cell re-selection: cell re-selection where MS-MLE informs the SwMI both in the old cell (leaving cell) and in the new cell (arriving cell) that cell change is performed

NOTE: There are three types of announced cell re-selection:

- type 1:

  the MS-MLE knows the new cell and the traffic channel allocations on the cell before deciding to leave its serving cell;

- type 2:

  the MS-MLE knows the new cell before changing to it, but does not know the channel allocation on the new cell in advance;

- type 3:

  the MS-MLE does not know the new cell before changing to it. The old cell is only informed by the MS-MLE that it wants to change cell.

attached MS: MS camped and registered on the cell

NOTE: The MS may be in idle mode (i.e. not actively processing a transaction) or in traffic mode (i.e. actively processing a transaction in reception and/or in transmission). It is the MM which decides when a MS is said to be attached.

authentication: function which allows the infrastructure to check that a MS is valid to operate in the system or which allows a MS to check that the infrastructure is valid to operate in

background measurement: measurement performed by the lower layers while maintaining current service toward the service users, i.e. MS-MLE

bearer service: type of telecommunication service that provides the capability for the transmission of signals between user-network interfaces

call: complete information exchange between two or more parties

call transaction: all of the events associated with one continuous transmission of information during a call (including control signalling)

NOTE 1: A call consists of one or more call transactions.

NOTE 2: In a half-duplex call, the call consists of a sequence of unidirectional transactions.

camped MS: MS synchronized on the cell BS and that has decoded the Broadcast Network CHannel (BNCH) of the cell

NOTE: The synchronization procedure is performed by the MAC and the interpretation of the network information from the BNCH (V+D) is performed by a procedure in the MLE. It is the MLE which decides when a MS is said to be camped on a cell.

cell re-selection: act of changing the serving cell from an old cell to a new cell

NOTE: The cell re-selection is performed by procedures located in MLE and in the MAC. When the re-selection is made and possible registration is performed, the MS is said to be attached to the cell.

cell-id: channel number of the main carrier on the cell

constant delay service: Network Service (NS) where the transit delay of the NSDUs between the network connection endpoints remains essentially constant for the duration of the connection

direct set-up signalling: signalling procedure where immediate communication can take place between the calling and the called users without the alerting process and without an explicit response from the called user that he has answered

NOTE: In TETRA application layer between the user and lower layers confirms the direct set-up so that it can reject the call set-up as appropriate e.g. for call priority reasons.

external calls: call where only one of the parties (either the source or the destination) is in a TETRA network

NOTE: For external calls the other party is in a non-TETRA network; see also inter-TETRA calls.

foreground measurement: measurements performed by the lower layers while employing the whole capacity

NOTE: No concurrent service is maintained during foreground measurements.

functional group: set of functions which may be needed in TETRA Land Mobile Network (LMN) access arrangements

NOTE 1: In a particular access arrangement, specific functions in a function group may but need not be present.

NOTE 2: Specific functions in a functional group may be performed in one or more pieces of equipment.

Grade Of Service (GoS): certain traffic engineering variables which may be used to provide a measure of the adequacy of a Network Service (NS) under specified conditions

home network: network where a subscriber has a direct subscription

NOTE: This means that a subscriber identity has been allocated in advance of any network access.

initial cell selection: act of choosing a first serving cell to register in

NOTE: The initial cell selection is performed by procedures located in MLE and in the MAC. When the cell selection is made and possible registration is performed, the MS is said to be attached to the cell.

internal calls: call where both the source (the calling party) and the destination (the called party) both lie in a single TETRA network domain

interrupted measurement: measurements performed by the lower layers interrupting current services

inter-TETRA call: call where source and destination are in different TETRA networks

Inter-TETRA Connections (ITCs): ITCs are provided by the InterVening Networks (IVNs) at the Inter-System Interface (ISI) and terminate at interfaces at C reference points

NOTE 1: The ITCs may be grouped into bundles, each connecting to a specific type of IVN. Bundles, in turn, may comprise more than one interface between the TETRA SwMI and the IVN.

NOTE 2: Bundle is a collection of ITCs which utilizes the same scenario over the inter system interface.

Inter-TETRA Links (ITLs): communication links connecting SwMIs at ISI

NOTE: ITLs are provided by the Intervening Network Adaption (INA) and terminate at interfaces at the Q reference point in the ISI. An ITL is characterized by its ITL identity which corresponds to the instance of the Q reference point. The ITL comprises one (1) DQ channel and a number of UQ channels each of them having certain channel characteristics.

InterVening Network (IVN): network which is used to interconnect two TETRA SwMIs at the ISI

NOTE: The network may be of the following types:

- dedicated transmission system e.g. PCM;
- permanent circuit switched e.g. PSTN and ISDN;
- on-demand circuit switched e.g. PSTN and ISDN.

interworking unit: one or more items of equipment or a part of an item of equipment whose operation provides a network relay function

NOTE: The interworking unit is a real system that receives data from one correspondent network entity and forwards it to another correspondent network entity. Such equipment may be integrated into a real sub-network which is being interconnected.

intra-TETRA call: call where both source and destination are in the same TETRA network sub-domain

Location Area (LA): area within radio coverage of a base station or group of base stations within which a MS is allowed to operate

LXX SAP: any or all of the following SAPs: LCMC SAP, LCO SAP, LSCL SAP

message trunking: method of traffic channel organization where each traffic channel is permanently allocated for the complete duration of the call

NOTE 1: A message trunking call may include several separate call transactions (several pressel activations by separate terminals).

NOTE 2: The channel is only de-allocated if the call is (explicitly) released or if a time-out expires (see also transmission trunking, quasi-transmission trunking).

migration: act of changing to a LA in another network (either with different MNC and/or MCC) where the user does not have subscription (ITSI) for that network

Mobile Network Identity (MNI): identity that uniquely identifies the network

NOTE: The MNI is broadcast by all TETRA base stations to uniquely identify the network.

Mobile Station (MS): physical grouping that contains all of the mobile equipment that is used to obtain TETRA services

NOTE: By definition, a MS contains at least one Mobile Radio Stack (MRS).

monitoring: act of measuring the power of neighbour cells and calculating the path loss parameter C2

NOTE: The measurement and calculation of the path los parameter C2 is based upon information on neighbour cells broadcast by the serving cell (see EN 300 392-2 [4], clause 10).

network: collection of subscriber terminals interconnected through telecommunications devices

Network SAP Address (NSAP Address): addresses that belong to other (non-TETRA) addressing domains

NOTE: These other domains include ISDN, PSTN and PDN domains.

nominal radio coverage area: geographical area over which the radio transmission performance exceeds a defined level

NOTE: The boundary of the nominal radio coverage area is defined by a Bit Error Ratio (BER) contour as defined in EN 300 392-2 [4], clause 6.

on/off hook signalling: signalling procedure which includes an alerting process to the called user

NOTE: The calling user should get an explicit response from the called user that he has answered before the call can be set-up.

Quality of Service (QoS): certain characteristics of a Network Connection (NC) as observed between the NC endpoints which are attributable solely to the Network Service (NS) provider

quasi-transmission trunking: method of traffic channel organization where each traffic channel is allocated for the each call transaction

NOTE: In quasi-transmission trunking the traffic channel is only allocated for the duration of a call transaction (while the pressel is activated) and in addition the channel de-allocation is delayed for a short period at the end of the transaction (after the pressel release). During this "channel hold-time", the channel allocation may be re-used for a new call transaction that is part of the same call. A delayed channel de-allocation procedure will apply at the end of each transaction.

R0: reference point within the Mobile Terminating Unit (MTU) that corresponds to the top of the MRS not including the routing

NOTE: R0 acts as the network service boundary and exists in all MTUs.

R1: reference point between packet mode Terminal Equipment (TE2) and the MTU (MTU2)

NOTE: There may be several alternative interface protocols at R1, including existing packet mode standards.

R2: reference point at the TETRA air interface

R6: reference point between one TETRA network and another TETRA network

R7: reference point between one TETRA network and a non-TETRA packet data network

R10: logical reference point equivalent to R0

ranking: procedural method of listing cells in descending order from the most suitable for communication to the least suitable for communication

NOTE: The method comprises multiple calculations of C_4 parameters and C_3 parameters, defined in EN 300 392-2 [4], clause 10. Inputs to the ranking procedure are:

- outputs from the monitor process (e.g. C_2 parameters);
- outputs from the scanning process (e.g. C_1 parameters);
- network parameters received in the MLE broadcast.

reference configuration: conceptual configuration useful in identifying various possible physical access arrangements to a TETRA LMN

NOTE 1: Two concepts are used in defining reference configurations:

- reference points; and
- functional groups.

NOTE 2: Physical interfaces that do not correspond to a reference point will not be described in the TETRA deliverables.

reference point: conceptual point dividing functional groups

NOTE: In a specific access arrangement, a reference point may correspond to a physical interface between pieces of equipment, or there need not be any physical interface corresponding to the reference point. Physical interfaces that do not correspond to a reference point (e.g. transmission line interfaces) will not be the subject of TETRA LMN interface recommendations.

registration: act of becoming an active and recognized TETRA user

NOTE: TETRA user is identified by exchange of ITSI with the SwMI.

relaying: network entity forwards information received from one correspondent network entity to another correspondent network entity

roaming: changing LA within a network of the same MNC/MCC

NOTE: For roaming the user needs a valid registration (ITSI).

routing: determination of an appropriate route between network addresses

scanning: measuring the power of neighbour cells and calculate the path loss parameter C

NOTE: The measurement and calculation of the path loss parameter C_2 is based upon the information on the neighbour cells broadcasted by the neighbour cells themselves (see EN 300 392-2 [4], clause 10).

Search Area (SA): area comprising all LAs where a MS may search for service

NOTE: The search area is considered to be defined at subscription.

segmentation: generating two or more derived PDUs from an initial or derived PDU

service coverage area: percentage of the nominal radio coverage area over which a specified grade of service and quality of service is maintained for a given service type

NOTE: A particular service coverage area is specific to one service and one network.

serving cell: cell that is currently providing service to the MS

Short Subscriber Identity (SSI): network specific portion of a TSI

NOTE 1: A SSI is only unique within one TETRA sub-domain (one TETRA network).

NOTE 2: There are four different types of SSI (see clause 7.2.3):

a) Individual SSI (ISSI);

b) Group SSI (GSSI);

c) Alias SSI (ASSI);

d) Un-exchanged SSI (USSI).

sub-network: collection of equipments and physical media which forms an autonomous whole and which can be used to interconnect real systems for purpose of communication

supplementary service: service which modifies or supplements a bearer service or a teleservice

NOTE: A supplementary service cannot be offered to a customer as a stand-alone service. It should be offered in combination with a bearer service or a teleservice.

surveillance: monitoring the quality of the radio link to the serving cell

TETRA Equipment Identity (TEI): electronic serial number that is permanently embedded in the TETRA equipment

NOTE: A TEI is embedded in both MSs (in the MT) and in LSs (in the NT).

TETRA Management Identity (TMI): network address that allows the operator to address a particular Mobile Termination (MT) or Line Termination (LT)

NOTE 1: TMIs are assigned to a particular piece of equipment by the network operator. TMIs are unique in all TETRA networks.

NOTE 2: The management entity has no functionality in the present set of deliverables.

TETRA Subscriber Identity (TSI): global TETRA network address that is used to identify an individual or a group subscriber within the domain of all TETRA networks

NOTE: A valid TSI refers to a TSI that has been allocated by the network where it is being used (see figure 25 for addressing domain).

TLC-SAP: management service access point

NOTE: TLC-SAP is a way of modelling layer-to-layer communication for management and control purpose.

transmission trunking: traffic channel organization where each traffic channel is individually allocated for each call transaction (for each activation of the pressel)

NOTE: The channel is immediately de-allocated at the end of the call transaction, subject to unavoidable protocol delays (see also message trunking, quasi-transmission trunking).

unannounced cell re-selection: cell re-selection where the MS-MLE does not inform the old cell (leaving cell) that it intends to change to a new cell

NOTE: Only the new cell (arriving cell) is informed about the MS-MLE.

undeclared cell re-selection: cell re-selection where the MS-MLE does not inform the old cell (leaving cell) nor the new cell (arriving cell) that cell change is performed

variable delay service: Network Service (NS) where the transit delay of the NSDUs between the Network Connection (NC) endpoints does not remain constant for the duration of the connection

visited network: network where a subscriber has an indirect subscription

NOTE 1: This means that a valid subscriber identity is only allocated as part of the first network access.

NOTE 2: The present document also makes use of the standard terms used in ISO in particular:

- logical channel;
- end system;
- access point;
- service primitive;
- Data Terminal Equipment (DTE).

3.2 Symbols

For the purposes of the present document, the following symbols apply:

>>	Possible physical interfaces
Ud	TETRA Direct Mode air interface access point
Um	TETRA air interface access point

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

(V)ASSI	Visiting Short Subscriber Alias Identity or Visitor ASSI
(V)ATSI	Visiting TETRA Subscriber Alias Identity or Visitor ATSI
(V)GSSI	Visiting Short Subscriber Group Identity or Visitor GSSI
(V)GTSI	Visiting TETRA Subscriber Group Identity or Visitor GTSI
AI-1	Air Interface layer 1
AI-2	Air Interface layer 2
AI-3	Air Interface layer 3
AL	Ambience Listening
AP	Access Priority
AP2	Access Point for Bearer Services at R reference point
AP3	Access Point for Teleservices
AS	Area Selection
ASSI	Alias Short Subscriber Identity
ATSI	Alias TETRA Subscriber Identity
BER	Bit Error Ratio
BIC	Barring of Incoming Calls
BLE	Base Link control Entity
BLER	BLock Error Rate
BOC	Barring of Outgoing Calls
BS	Base Station or Base Station (Cell)
CAD	Call Authorized by Dispatcher
CC	Call Control
CCBS	Call Completion to Busy Subscriber
CCNR	Call Completion on No Reply
CFB	Call Forwarding on Busy
CFNRc	Call Forwarding on Mobile Subscriber Not Reachable
CFNRy	Call Forwarding on No Reply
CFU	Call Forwarding Unconditional
CLIP	Calling Line Identification Presentation
CLIR	Calling/connected Line Identification Restriction
CMCE	Circuit Mode Control Entity
COLP	COnnected Line identification Presentation
CR	Call Report
CRC	Cyclic Redundancy Check
CRT	Call Retention
C-SAP	Control Service Access Point
CW	Call Waiting
DGNA	Dynamic Group Number Assignment
DL	Discreet Listening
DSD	Destination Short Data
DSDA	Destination Short Data Agent
ESN	Electronic Serial Number
FAC	Final Assembly Code
FEC	Forward Error Corrrection
GSM	Global System for Mobile communications
GSSI	Group Short Subscriber Identity
GTSI	Group TETRA Subscriber Identity
HDB	Home Data Base
HOLD	Call HOLD
IC	Include Call
IGSD	Incoming Gateway Short Data
IMEI	International Mobile Equipment Identity
IMSI	International Mobile Subscriber Identifier
INA	Intervening Network Adaption
IP	Internet Protocol
ISD	Inter-system Short Data
ISDN	Integrated Services Digital Network

ISI	Inter-System Interface
ISSI	Individual Short Subscriber Identity
ITL	Inter TETRA Links
ITSI	Individual TETRA Subscriber Identity
IVN	InterVening Network
LA	Location Area
LCMC-SAP	Link entity Circuit Mode Control entity-Service Access Point
LE	Late Entry
LLC	Logical Link Control
LLCE	Logical Link Control Entity
LLME	Lower Layer Management Entity
LMM-SAP	Link entity Mobility Management-Service Access Point
LMN	Land Mobile Network
LS	Line Station or Line-connected Station
LSC	List Search Call
LTPD-SAP	Link entity TETRA Packet Data-Service Access Point
LXX	Link entity XX
MAC	Medium Access Control
MCC	Mobile Country Code
MLE	Mobile Link Entity
MM	Mobility Management
MNC	Mobile Network Code
MNI	Mobile Network Identity
MS	Mobile Station
MSIN	Mobile Station Indentification Number
MS-ISDN	Mobile Station Integrated Services Digital Network (number)
MT	Mobile Termination (short form for MTU)
MT0	Mobile Termination type 0
MT2	Mobile Termination type 2
MTU	Mobile Termination Unit
NC	Network Connection
NS	Network Service
NSAP	Network Service Access Point
NSDU	Network Service Data Unit
NT	Network Termination
OGSD	Outgoing Gateway Short Data
OSD	Originating Short Data
OSDA	Originating Short Data Agent
PC	Priority Call (SS-PC)
PC	Protocol Control
PDN	Packet Data Network
PDP	Packet Data Protocol
PDU	Protocol Data Unit
PHL	PHysical Layer
PPC	Pre-emptive Priority Call
PSS1	Private integrated Signalling System 1
PSTN	Public Switched Telephone Network
PTN	Private Telephonic Network
QoS	Quality of Service
RA	Registration Area
ROSE	Remote Operating Service Element
RSSI	Radio Signal Strength Indicator
R_T	TETRA R reference point
SA	Search Area
SAP	Service Access Point
S-CLNP	Specific ConnectionLess Network Protocol
SDP	Short Data Protocol
SDS	Short Data Service
SDU	Service Data Unit
SIM	Subscriber Identity Module
SMI	Short Management Identity

SNA	Short Number Addressing
SNAF	Sub-Network Access Functions
SNDCP	SubNetwork Dependant Convergence Protocol
SS	Supplementary Service
SSI	Short Subscriber Identity
STMI	Short TETRA Management Identity
SwMI	TETRA Switching and Management Infrastructure
TAC	Type Approval Code
TE	Terminal Equipment
TE2	TE presenting a TETRA interface
TEI	TETRA Equipment Identity
TETRA	Trans-European Trunked RAdio
TL	Transmission Line
TLC1	TETRA Link layer Control No. 1
TMI	TETRA Management Identity
TMSI	Temporary Mobile Subscriber Identifier
TN	Transit Network
TNP1	TETRA Network Protocol No. 1
TNP3	TETRA Network Protocol No. 3
TNP4	TETRA Network Protocol No. 4
TNSDS	TETRA Network Short Data Service
TPI	Talking Party Identification
TSI	TETRA Subscriber Identity
UPT	Universal Personal Telecommunications
USSI	Un-exchanged Short Subscriber Identity
V.24T	Physical Layer Protocol over the RT reference point
V+D	Voice plus Data
VDB	Visited Data Base

4 Circuit mode reference points

Annex A gives information of the general reference configuration and the circuit mode reference points for TETRA MSs and the inter system interface used in TETRA standardization.

5 Packet mode reference points

TETRA packet mode services are based on Internet protocols. TETRA reference points are presented in annex L.

6 Protocol architecture for V+D

Annex B describes protocol architecture principles used in TETRA standardization.

7 Addressing and identities

7.1 Introduction

Clause 7 defines the TETRA addresses and identities that shall be used by all TETRA equipment.

The identities are organized into the following groups corresponding to the different functions of the addresses and identities:

a) TETRA Subscriber Identities (TSI);

b) Short Subscriber Identities (SSI);

c) TETRA Management Identities (TMI);

d) Network Layer SAP addresses (NSAP);

e) TETRA Equipment Identities (TEI);

f) Mobile Network Identity (MNI).

TETRA addresses and identities are designed to support the following objectives:

a) to allow a large number of networks (and network operators) to co-exist, and for each network to support a large number of subscribers;

b) to be able to uniquely identify any subscriber in any network;

c) to allow the use of shortened identities for intra-TETRA calls to reduce the signalling information in the set-up messages;

d) to support efficient roaming and migration of subscribers.

The main TETRA identities are the subscriber identities. A key difference between TETRA and public mobile networks is the existence of group identities. As far as possible, group identities within TETRA shall be treated identically to individual identities, i.e. group and individual identities shall have the same structure and shall be allocated from the same TETRA identities space.

Nonetheless, the individual subscriber identities shall have a special role to provide a unique identification of terminal users because an individual subscriber identity can only refer to one mobile (or fixed) termination. By contrast, a group subscriber identity can refer to several mobile (or fixed) terminations.

The subscriber identities may be transferable, and may be removed from the equipment by the user. An additional non-transferable management identity shall be defined to allow a termination to be addressed independently from the subscribers.

NOTE 1: Fleet addressing is outside the scope of the present document.

The different addressing domains relevant to TETRA are shown in figure 1. The TETRA domain is shown as intersecting three other domains (PSTN, ISDN and PDN). This indicates that a given individual TETRA subscriber address may be associated with one address in each of these public domains.

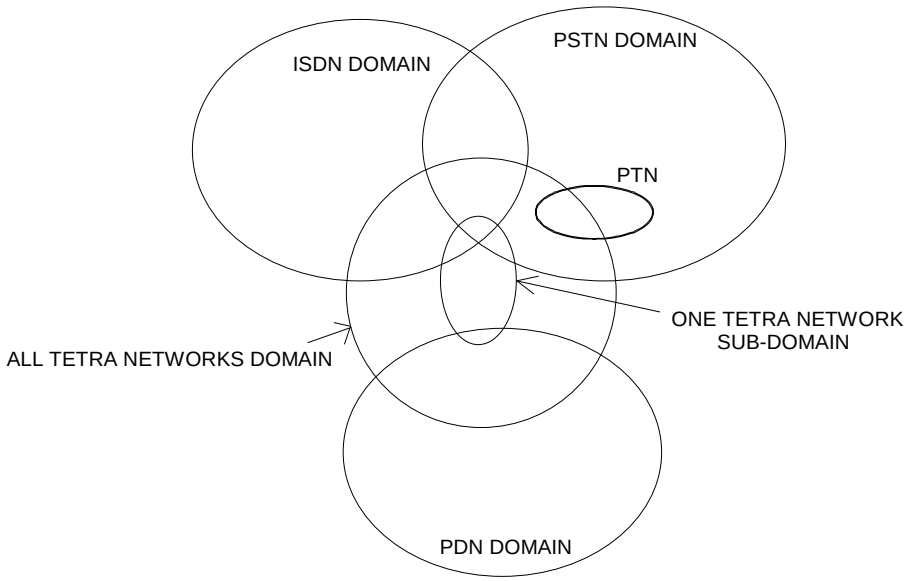


Figure 1: Addressing domains within TETRA

Within the TETRA domain, the TETRA identities can have different roles. The relationship between the different TETRA identities and the other addresses is shown in figure 2.

NOTE 2: The X.121 and E.163 N-SAP addressed are historic and no longer used.

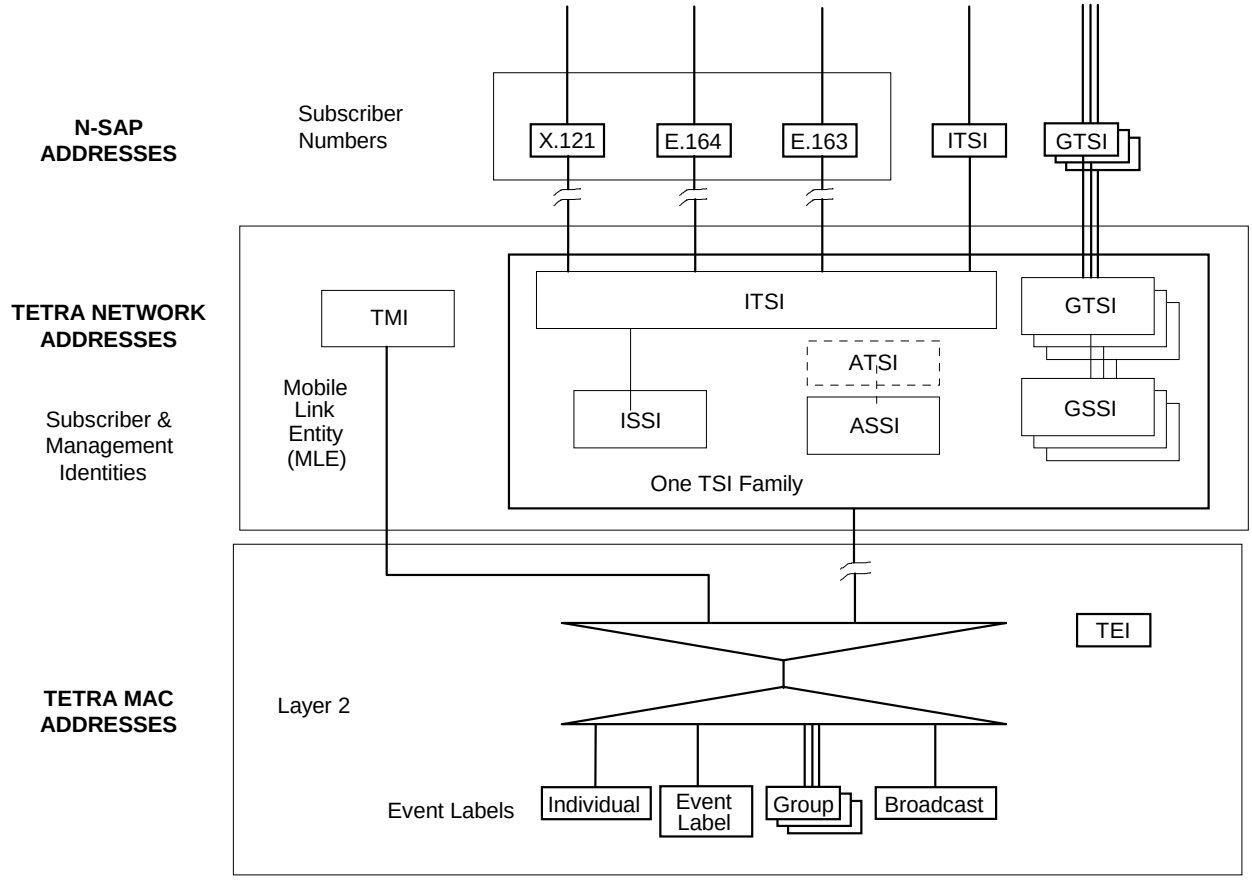


Figure 2: Relationship between TETRA addresses

The use of addresses in TETRA set-up messages and other messages are described in clause 7.8.

7.2 Subscriber identities

7.2.1 General

Subscriber identities (TSI or SSI) shall exist in two sizes:

- TETRA Subscriber Identity (TSI), 48 bits long;
- Short Subscriber Identity (SSI), 24 bits long.

The SSI shall be a truncation of the TSI.

Each TSI shall be unique across the complete TETRA domain, i.e. all TETRA networks, but each SSI shall only be unique in one TETRA sub-domain, i.e. one TETRA network.

NOTE: These subscriber identities do not necessarily correspond to "chargeable subscribers". The definition of "chargeable subscribers" is outside the scope of the present document.

7.2.2 TSI

Each MS or LS shall contain at least one family of TSIs. Each family shall contain one Individual TETRA Subscriber Identity (ITSI) and may also have one ATSI and several Group TETRA Subscriber Identities (GTSIs):

One TSI family:

- 1 × ITSI;
- 1 × ATSI;
- N × GTSI.

This TSI family shall be valid for a home TETRA network. Likewise, one or several visitors TSI families may also coexist with the home TSI family but shall have a slightly different composition:

- they shall not contain a visiting equivalent to the individual identities, i.e. no "(V)ITSI".

The binding between home and visitors TSI families is outside the scope of the present document. The lifetime of these addresses is an operator option, but the visitors TSI family shall be deleted at de-registration.

In visited networks, an alias address shall be provided by the SwMI. Other MSs shall continue to use the (home) individual address to access MS in visited networks.

The following will only consider the requirements for a single family. A single termination may contain more than one TSI family, and in this case each family shall meet these requirements independently of the other families.

TSIs shall be allocated by the network operators. A valid TSI shall refer to a TSI that has been allocated by the network where it is being used. A MS or LS shall possess at least one valid ITSI before it can be used. Special procedures are defined to allow a migrating subscriber to attach to a visited network and to "exchange" an existing ITSI for a valid TSI for that visited network. This exchanged TSI shall be known as a visitors ATSI or (V)ATSI, and this new (V)ATSI should be allocated when the migrating visitor first contacts the visited network.

A valid ITSI shall be required in order to support the air interface addressing procedures (refer to clauses 7.2.6 and 7.8).

To support secure network operations, an ATSI may be allocated in addition to the ITSI. There shall only be one ATSI per ITSI and the ITSI-ATSI pairing shall only be known to the network operator. The ATSI cannot be derived from a knowledge of the ITSI, and a given subscriber shall only be known to other subscribers by his ITSI.

Because the ATSI shall not be available to other users, the network operator may change the value of the ATSI at frequent intervals without notifying any of the other users. Infrastructure routing tables are assumed to operate using the public ITSI.

If a valid ATSI is available for a given network, this shall be used in place of the ITSI as described in clauses 7.2.6 and 7.8.

The ATSI does not replace the ITSI. The ITSI shall remain available (by definition) and can still be used if required.

To support group addressing, one (or more) GTSI shall be allocated in addition to the ITSI. There may be several GTSI per ITSI and the same GTSI may be associated to several ITSIs. The binding between the GTSI and the ITSI is outside the scope of the present document, and a given group subscriber shall only be known to other subscribers by his GTSI.

NOTE 1: There is no group equivalent of the ATSI.

The GTSIs may be either pre-allocated (like ITSIs) or may be allocated dynamically by the network using standard TETRA procedures as part of normal operation. (V)ASSIs and (V)GSSIs are exchanged by the visited network.

NOTE 2: No standard procedures are defined for the dynamic allocation of ITSIs.

The method(s) of TSI installation are described in clause 7.2.8.

7.2.3 SSI

The SSI is the network specific part of the TSI. SSIs shall be unique within a given TETRA sub-domain (i.e. a given network). The same SSI value may be used in many TETRA sub-domains.

An Individual Short Subscriber Identity (ISSI) shall be formed from an ITSI by removing the Mobile Country Code (MCC) and the Mobile Network Code (MNC). Likewise, a GTSI shall be truncated to a Group Short Subscriber Identity (GSSI).

Valid values for an SSI shall correspond to the valid types of TSI as follows:

- ISSI = SSI from ITSI;
- ASSI = SSI from ATSI (see clause 7.2.2, note 1);
- GSSI = SSI from GTSI;
- USSI = SSI from a foreign ITSI.

If an ASSI is available, this shall be used in place of the ISSI. (For more details see clauses 7.2.6 and 7.8.) The ASSI does not replace the ISSI. The ISSI shall remain available (by definition) and may still be used by the infrastructure if required. The ISSI may also be used by the MS if for example the ASSI assignment expires.

NOTE: There is no group equivalent of the ASSI.

Most MS operations should use the valid home (or visitor) values of SSI. However, an Un-exchanged SSI (USSI) shall also be defined to support migration. This non-valid SSI, based on the home ISSI, shall be used instead. The USSI shall be formed by using the home ISSI as defined in clause 7.7. Additional rules for the use of SSIs are defined in clause 7.7.

The USSI enables a MS to register with the visited network. As part of this registration, the USSI shall be exchanged for a valid ASSI. A special flag in the messages shall indicate when an USSI is used. Visiting group SSI(s) may also be exchanged at the same time.

7.2.4 Composition of subscriber identities

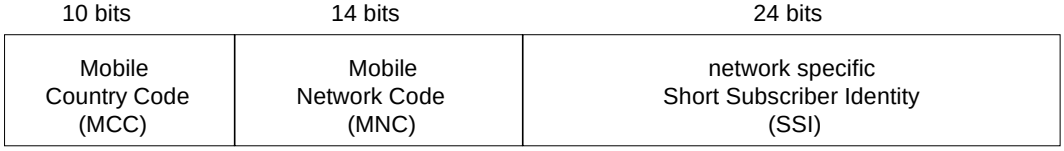


Figure 3: Contents of TSI

TSI identities shall have a fixed length structure that has the same information elements as defined in ITU-T Recommendation E.218 [2], refer to figure 3.

The partitioning of the address space between ITSIs, ATSIs and GTSIs shall only be known inside the relevant sub-domain. Outside of this sub-domain ITSI, ATSI and GTSI cannot be distinguished.

The ASSI shall be unique for the whole sub-domain (the whole network). The relationship between a given ASSI and the corresponding ITSI is not defined in the present document.

NOTE: The uniqueness of ASSI in the whole network does not prevent allocation of the same ASSI to more than one MS in different parts of the network, if roaming management ensures the uniqueness. The mechanisms for that are outside the scope of the present document.

7.2.5 Allocation principles for subscriber identities

MCC shall use 10 bits to encode the 3 decimal digit value of the country code as defined in ITU-T Recommendation E.218 [2], refer to figure 3.

EXAMPLE: France has the country code 208 Decimal.
This is coded as 00 1101 0000 Binary (0D0 hexadecimal).

The undefined binary codes (decimal values 1 000 to 1 023) are reserved and shall not be used.

MNC shall be allocated by the National Administration for each country. A unique MNC shall be allocated to each operator. The MNC is coded in binary using 14 bits. The range of MNC shall be limited to four decimal digits i.e. the maximum value is 9 999 decimal or 270F in hexadecimal format, refer to TR 102 300-5 [i.16], EG 202 118 [i.8]or ITU-T Recommendation E.218 [2].

The SSIs (ISSI, ASSI or GSSI) shall be allocated by the network operator.

NOTE: The ISSI assignment is expected to be a long term assignment, but the ASSI and GSSI assignments are expected to be more dynamic. It is the responsibility of the network operator to ensure that all of these identities are allocated uniquely at all times.

7.2.6 Use of subscriber identities

Subscriber identities shall be used for two distinct roles:

a) as a lower layer address (MAC address) for the air interface as described in clause 7.7 (SSI);

b) as a network routing address (TSI).

The MM and the CMCE shall use subscriber identities as network routing addresses. This may include both source and destination addresses.

At the air interface the CMCE destination address shall be either:

a) an ISSI or GSSI for intra-TETRA calls i.e. destination MS, group or gateway home is the same TETRA network as the source MS current network; or

b) an ITSI or GTSI for inter-TETRA calls i.e. destination MS, group or gateway home is a different TETRA network to the source MS current network.

NOTE: The use of a SSI as the destination address is provided to allow the use of a short set-up message for TETRA calls at the air interface.

At the air interface the CMCE source address shall be either:

a) an ISSI or ASSI always on uplink;

b) an ISSI on downlink only when the source MS home TETRA network is the destination MS current network; or

c) an ITSI on downlink for inter-TETRA calls, i.e. source MS or source gateway home TETRA network is a different TETRA network to the destination MS current network. If an ASSI is available, this shall be used at lower layers in preference to the ISSI for the source address by a MS and for the destination address by the SwMI when appropriate.

At the intersystem interface (ISI) the CMCE source and destination addresses shall be ITSI or GTSI.

7.2.7 NSAP addresses

In some cases NSAP addresses shall be used as the source and destination addresses instead of using subscriber addresses. This alternative shall apply to the following cases:

a) by CMCE for call where the destination TETRA subscriber is identified by an MS-ISDN number;

b) by the CMCE for external calls to E.164 numbers;

c) by an external protocol, such as Internet IP.

NOTE: The Internet IP protocol uses TETRA SNDCP protocol at the air interface.

The SSI shall continue to be used as the lower layer address, but any combination of ITSI and NSAP may be used as a network routing address within the infrastructure.

The binding of NSAP addresses to ITSIs, whether fixed of dynamic, are not defined in the present document.

7.2.8 Installation of TSIs

TSIs may be installed by several alternative mechanisms:

- ITSIs or GTSI may be installed as follows:

  a) by the network operator (i.e. not usually changed by the user);

  b) by inserting a "smart card";

  c) by the user entering a login code via a local MS/LS application.

NOTE 1: These mechanisms are only provided as examples. No methods of installation are defined by the present document.

In addition GTSIs (but not ITSIs) may also be allocated (downloaded) over the air interface to allow dynamic groups and to enable the user to automatically "collect" his GTSIs by registering the ITSI (e.g. when replacing faulty equipment or when "logging-in" to a new MS); refer to Dynamic Group Number Assignment supplementary service [6].

Visitors to a TETRA network shall initially register using their permanent (home) ITSI according to the procedure described in EN 300 392-2 [4], clause 16. If this migration is accepted, the network shall allocate a temporary visitors (V)ATSI (and possibly visitors (V)GTSIs) using spare TSI addresses (allocated from the sub-domain of the visited network). The visitor shall then use the (V)ASSI as his source address for all subsequent messages in this visited network unless protocol exceptions allow usage of the ITSI.

NOTE 2: Allocations of (V)ASSIs to visitors are temporary, and it is assumed that the network will subsequently wish to re-allocate them to another migrating subscriber. The network operator should create suitable mechanisms to avoid duplicate allocations.

7.3 TETRA Management Identity (TMI)

7.3.1 General

The TMI is defined as a non-transferable network (layer 3) identity. The TMI shall be allocated to a termination before it can be used, and it cannot be exchanged dynamically or transferred between terminations by the user.

The TMI shall be allocated by the network operator and should be installed in the termination prior to delivery to the customer.

The TMI shall only be used as an address by the internal network management functions using a specific set of management messages. These management messages, and therefore the TMI address space, should be inaccessible to normal network users.

7.3.2 Composition of management identities

The composition of the TMI shall be identical to the TSI as described in clause 7.2.4. The MCC and MNC fields shall have the same values as the corresponding TSI. However, the TMI identities should be allocated from a separate address space, i.e. the management address space. TMI shall be composed of Mobile Network Identity (MNI) (i.e. MNI = MCC + MNC) and Short Management Identity (SMI), (see also clause 7.6).

NOTE: The SMI part of a TMI may be numerically equal to the SSI part of a TSI, but the TMI and TSI identities remain distinct because they relate to different families of messages. The SMI is also a valid layer 2 address.

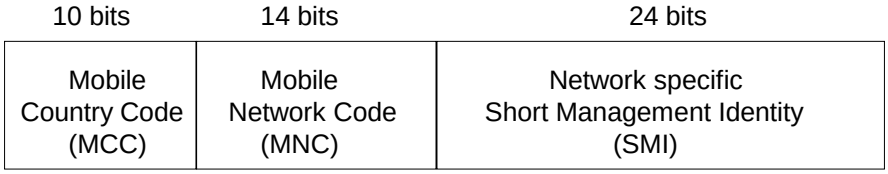


Figure 4: Contents of TMI

A visitor's TMI shall not be allocated to a migrating station. The TMI shall only be allocated by the home network.

7.3.3 Use of management identities

The TMI shall only be used to support management functions such as defined in the MLE (see EN 300 392-2 [4], clause 18). The TMI shall not be used for messages to or from any other than the network management entities. These management functions may include both standardized and non-standardized functions.

NOTE: Secure networks may restrict the use of the TMI, e.g. they may allow no TMI functions at all.

7.4 Network layer SAP (NSAP) addresses

7.4.1 General

NSAP addresses are an additional method of addressing that may be used to provide direct compatibility with external (non-TETRA) networks. The use of NSAP addresses is an operator option for the V+D systems.

The mapping between NSAP addresses and a TETRA terminal is described as "binding". This binding may take place when an NSAP address is allocated to a particular TETRA mobile (MT) or to an independent source of identity such as a Subscriber Identity Module (SIM) card. This binding is described as static. Alternatively, the association may be flexible so that the association may be changed by either the network operator or the user. This is dynamic binding.

7.4.2 Static binding

Procedures for static binding are the responsibility of the administration of any particular network and are outside the scope of the present document.

7.4.3 Dynamic binding

7.4.3.1 General

The TETRA network shall treat NSAP addresses as "user numbers" that are associated with the TE. A "binding" process is defined whereby a NSAP addresses becomes temporarily associated with one MT or one NT.

All NSAP addresses shall conform to the one of the existing international standards, e.g. ITU-T Recommendation E.164 [1] or to a standard private numbering plan. None of these standards provides support for group addressing and therefore a NSAP address should not be bound to a GTSI.

NSAP addresses shall be used to address external users (destination NSAP) and for external users to address TETRA users.

NOTE: It is assumed that GTSI binding to an NSAP address is possible at a gateway.

7.4.3.2 Structure and contents of NSAP addresses

The structure and contents of the NSAP is defined by the appropriate numbering plan e.g.:

NSAP = ITU-T Recommendation E.164 [1].

7.4.3.3 Use of NSAP addresses

Each network operator may allocate NSAP addresses in addition to TSIs.

NSAP addresses may also be used by the CMCE for routing calls from external users (non-TETRA users) according to the principles outlined in ITU-T Recommendation E.213 [3].

NSAP addresses may also be used as part of external protocols.

7.4.3.4 Binding of NSAP addresses

In order to receive calls, a NSAP address shall be temporarily bound (attached) to one ITSI. This binding may be changed by the user and/or by the network manager at any time. Ideally a user should be able to bind an NSAP address to a new ITSI by simply unplugging the TE and plugging it into the new MT (or NT).

Alternatively, a network operator can create the binding over the air interface.

NSAP address binding requires a set of binding protocols. TE binding shall be reported to the MTU with a TE protocol. MTU binding shall be reported to the infrastructure using the MM registration procedures, and every change of binding shall be reported with a new registration.

NOTE: User changes are assumed to correspond to the attachment of new TE.

7.5 TETRA Equipment Identity (TEI)

7.5.1 General

The TEI uniquely identifies one piece of TETRA equipment, either one MT or one NT.

The TEI shall be allocated by the equipment manufacturer. One manufacturer may supply several networks, and therefore the TEI shall not be specific to one network.

7.5.2 Contents of TEI

Contents of TEI shall be as presented in figure 5.

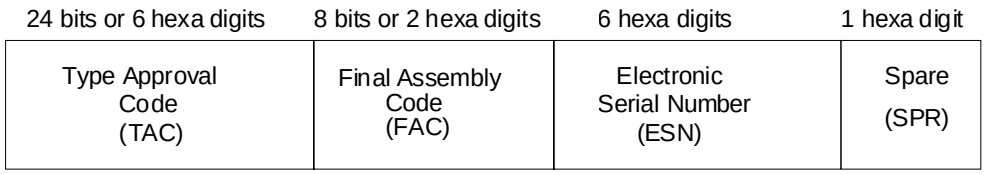


Figure 5: Contents of TEI

Type Approval Code and Final Assembly Code information elements shall be encoded as binary encoded information elements.

When those are presented for human reader e.g. printed on the equipment the values shall be presented using hexadecimal digits indicating the same value as the binary value.

TEI Electronic Serial Number digits shall use the hexadecimal digits.

The spare digit (equivalent to 4 bits) shall be set to "0" (0000_2) in a TEI conforming to the present document.

All the information elements shall contain leading zero bits in the information element. So the total length of the TEI shall be 60 bits or 15 hexadecimal digits.

7.5.3 Allocation principles for TEI

ETSI shall allocate individual Type Approval Codes (TACs) and keep register of the assigned codes. The allocation of individual TACs will remain private within ETSI. Refer to annex N for an application form or site http://portal.etsi.org/dvbandca/.

NOTE 1: For the purpose of the present document the TAC means "presumption of conformity" to the relevant harmonized standards covering the product. Although use of an external type approval body is no more needed in Europe ETSI still allocates TACs. It is manufacturer's discretion, when a new TAC is needed for a TETRA equipment implementation.

NOTE 2: TAC is independent of any national type approval certification. Any national type approval identification is outside the scope of the present document.

Final Assembly Code (FAC) shall identify the manufacturer and may identify the place of final assembly. ETSI shall assign individual FACs and keep register of the assigned codes. ETSI may maintain a public Web page of allocation of FACs (see annex O). Refer to annex O for an application form or site http://portal.etsi.org/dvbandca/.

NOTE 3: Manufacturer may freely use one or multiple FACs in a single or multiple manufacturing sites. An economical use of FACs is encouraged.

Electronic Serial Number (ESN) shall be an individual serial number that uniquely identifies each equipment within each TAC+FAC. ESN shall be allocated by the manufacturer.

NOTE 4: In order to have compatibility with the previous version of the present document the ESN field may contain only binary coded decimal digits although the coding supports hexadecimal coding.

7.5.4 Use of TEI

TEI shall be used to support TETRA security functions e.g. MS enable and disable as described in EN 300 392-7 [5].

7.6 Mobile Network Identity (MNI)

7.6.1 Contents of MNI

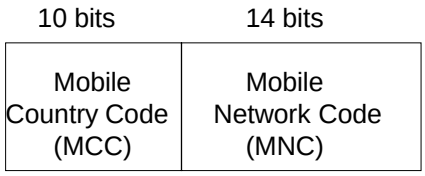


Figure 6: Contents of MNI

The MCC and MNC are the same as the MCC and MNC fields used in the ITSI and TMI identities, see figure 6. The coding for these fields is defined in clause 7.2.5.

7.7 Layer 2 addresses and labels

7.7.1 Overview

The clauses 7.7.1 to 7.7.8 shall apply to MTs.

In the lower layers of the air interface, the primary layer 2 addresses shall be based on the SSIs as defined in clause 7.2.3. This use of subscriber identities requires a subscriber identity to be allocated to all terminations before they can access the network.

The clauses 7.7.1 to 7.7.8 describe additional layer 2 addressing functions. These additional functions are divided as follows:

- event labelling, using information bits that are part of the message content;
- scrambling labelling, using a scrambling technique, not part of the message content.

7.7.2 Event labelling

As an example, an event label may be used to identify all of the separate transmission events that belong to one or more transactions. These labels shall be cell specific to a particular channel (i.e. they may not be unique outside that cell) and they may be used to label both traffic events and control events.

The shortest duration of one label shall be one transaction, but the same label may be used for more than one transaction.

NOTE: An event label may be unique for a complete cell, or for part of a cell: e.g. specific to one carrier, or to one slot on one carrier.

In addition to providing a cell specific reference for each event, the event labels may also be used to define control groups by each BS. These ad-hoc groups may be used by each BS to control e.g. priorities (random access) and battery saving.

7.7.3 Scrambling labelling

The scrambling labelling functions are defined to ensure that transmissions on a given channel are only received by the intended endpoints. Scrambling labelling shall contain an infrastructure endpoint identification. This scrambling label shall consist of the MNI from layer 3 and a cell number (colour code) from layer 2. This BS identity shall be geographically unique.

NOTE: The cell number can only provide protection against co-channel interference when all co-channel sites belong to the same operator. The operator should allocate a different cell number for all co-channel cells (for reasonable cluster sizes). However, the co-channel sites may belong to different operators, and this level of co-operation cannot be assumed. Therefore the MNI is also required.

7.7.4 Use and implementation of layer 2 addresses

7.7.4.1 General requirement

A scrambling label shall be used as part of every transmission event for both signalling and traffic, except for the downlink synchronization channel where the unscrambled scrambling label shall be located. In addition to this, event labelling may also appear. However, there are some exceptions to this general requirement as described in the following clauses.

The scrambling label shall be used for all downlink transmissions except for the V+D downlink synchronization channel where the unscrambled scrambling label shall be located.

The scrambling label shall be used for all uplink station transmissions. Un-reserved uplink transmissions shall also include an individual subscriber identity (either the ISSI, the ASSI or the USSI).

7.7.4.2 Implementation of event labels

Event labelling identities shall be either:

a) a network/layer 3 call reference (for circuit mode call traffic channels) called Call ID, 14 bits (see EN 300 392-2 [4], clause 14);

b) an SMI, ISSI, USSI, GSSI or ASSI (i.e. the SSI may serve a dual role of MS identification as layer 2 and layer 3 address, 24 bits);

c) an event label, which is a local layer 2 temporary address that replaces an SMI, ISSI, GSSI or ASSI. It is specific to one channel and is valid for a specified time call reference that is specific to one cell site (or part of a cell site) and valid at least for one transaction. The size of the event label shall be 10 bits.

7.7.4.3 Implementation of scrambling labels

The scrambling label shall be generated as an algorithmic combination of a network specific cell number and the MNI (i.e. the MCC + MNC elements only). These identities shall be used as the "seed" for the colour code scrambling function with every transmission or reception as described in EN 300 392-2 [4], clause 8.

NOTE: At the receive side, there is assumed to be no extraction of the scrambling label. An erroneous reception would only be detected by the normal channel coding as a decoding failure. This means that the receiver need not distinguish between different errors (e.g. errors due to noise, fading, Doppler or errors due to a co-channel interferer).

7.7.5 Use of identities for V+D control channels

The following rules shall apply to all V+D control (signalling) channels.

MAC PDUs may be addressed with either an event label or an SSI or SMI. The SSI used for an SSI shall be used for all unreserved uplink MAC PDUs. This shall be:

a) the ISSI or ASSI value that has been allocated by this network. For migrating mobiles this shall be the visitors (V)ASSI once allocated; or

b) an USSI for migrating mobiles before (V)ASSI allocation; or

c) a GSSI only in the case of presence checking request.

NOTE 1: The use of USSI is indicated within the message.

The following rules give the precise usage:

1) for MS originated calls and all layer 3 responses to MS terminated group calls, the MS shall use the ISSI or ASSI if one is available. The ASSI shall be used in preference to an ISSI if both are available. An USSI shall only be used if no valid SSI is available;

NOTE 2: An USSI should only be used for the first access to a new (visited) TETRA network. This should be followed by an identity exchange to obtain a (V)ASSI.

2) for MS terminated individual calls (ISSI, ASSI), the MS shall reply with the same SSI as used by the BS;

3) for MS terminated management calls (STMI), the MS shall reply with the STMI;

4) on the uplink, a GSSI is used in the MAC header only for the layer 2 group presence indication.

When required, the USSI shall be generated by the MS by copying an existing home ISSI (i.e. an ISSI allocated by a different home network).

On reserved access, the allocated event label should be used to replace SSI.

7.7.6 Labelling of packet channels

All MAC PDUs shall contain a SSI or a locally allocated event label. Event labels should be used for all data transfers that require multiple bursts.

NOTE: The first burst of a data transfer will usually include the ISSI or ASSI. Therefore the event label offers no advantage for data transfers that only occupy a single burst.

Event labels may be used for any MAC PDU (both user data and control).

7.7.6.1 Use of identities for uplink data transfers

Uplink PDUs shall only be addressed with a SSI. The SSI used for uplink MAC PDUs shall be either:

a) the ISSI or ASSI value that has been allocated by this network. For migrating mobiles this will be the visitors (V)ASSI; or

b) an Un-exchanged Short Subscriber Identity (USSI).

The type of SSI in use shall be indicated in the MAC PDU.

An ASSI or ISSI shall be used if one is available and the ASSI shall be used in preference to an ISSI if both are available. An USSI shall only be used if no valid value is available.

NOTE: An USSI is only used for the first access to a new (visited) TETRA network. This is followed by an identity exchange to obtain a (V)ASSI.

When required, the USSI shall be generated by the MS by copying an existing home ISSI (i.e. an ISSI allocated by a home network).

7.7.6.2 Use of identities for downlink data transfers

Downlink PDUs may be addressed with either a SSI or a SMI.

The SSI used for downlink MAC PDUs shall be:

a) an ISSI; or

b) an ASSI; or

c) a GSSI; or

d) the USSI used by the MS in the initial registration request.

These alternative SSIs shall not be distinguished in the downlink MAC PDUs.

The MS shall respond to all valid addresses on the downlink (all values of ISSI, ASSI, GSSI and SMI). In particular in the home TETRA network, it shall respond to a valid ISSI even if an ASSI is available for that family.

7.7.7 System information broadcast

Broadcast MAC PDUs (e.g. control messages) shall be unaddressed (i.e. they shall not contain any SSI address). These unaddressed messages shall be implicitly addressed to all MSs.

7.7.8 Reserved value of group address for user information broadcast

A specific SSI shall be reserved for broadcasting information to all MSs in a TETRA network. The content of the 24 bits shall be all ones (1). To broadcast information over the whole TETRA domain, a special TSI shall be obtained by adding a MNI containing all ones (1) to the previously defined SSI. Partial user broadcast shall be obtained by combining different MNI and SSI.

This reserved address defines a group to which all MSs shall belong. For example it may be used as the distribution address for CMCE calls. It may also be used by the SwMI for sending broadcast signalling messages.

7.8 Use of individual addresses

The use of TETRA addresses (notably the ITSI and ISSI) for the air interface is outlined in the following clauses.

7.8.1 Air interface addressing functions

The address functions for all layers are summarized in table 1.

NOTE: Table 1 only considers address related functions. Refer to the protocol architecture in annexes B and L for details of other functions.

The overview through all layers of the functions related to the addresses are illustrated in figure 9.

Table 1: Addressing functions per layer

Layer	Protocol	Addresses used	Address function
3	CMCE	ITSI/ISSI	End-to-end routing
3	MLE	ISSI	internal endpoint routing
			address management
2	MAC	SSI and/or event label	Uplink burst addressing
			Battery saving (V+D)
			Downlink filtering
1	PHL	Scrambling label	Scrambling

7.8.2 Address placement in primitives and PDUs

7.8.2.1 Use of ISSI at layer 2

The placing of the SSI addresses into primitives and PDUs is shown in figure 9. Although the SSI is a layer 3 address, it shall also be used in the air interface layer 2.

The relevant SSI address shall be supplied to layer 2 by the MLE. It shall appear in the layer 2 primitives as a separate parameter: i.e. it shall remain visible down to the MAC layer. This SSI address shall only be "invisible" at the physical layer.

This SSI parameter shall be the SOURCE-SSI in request primitives (i.e. at the sending side) and shall be the DESTINATION-SSI in the indication primitives (i.e. at the receiving side).

In all cases, the SSI shall be the value allocated by the current network. For a migrating terminal this shall be the (V)ASSI allocated by the visited system (see clause 7.7).

The SSI mentioned as the source address shall not be a group address (GSSI), except in the case of the layer 2 group presence indication.

At the sending side, the MAC layer may place the source SSI into any suitable uplink PDUs unless an event label has been assigned. The MAC may choose to only send the ISSI in the first burst. It may then substitute an event label at any time, and may then use this event label to label future MAC bursts for the same ISSI.

At the receiving side the MAC layer may have received the destination ISSI at any time (e.g. in a previous message) and may only receive an event label in a particular burst. Nonetheless it shall always provide the destination ISSI as a parameter in each indicate primitive (i.e. convert any event labels to the associated ISSI).

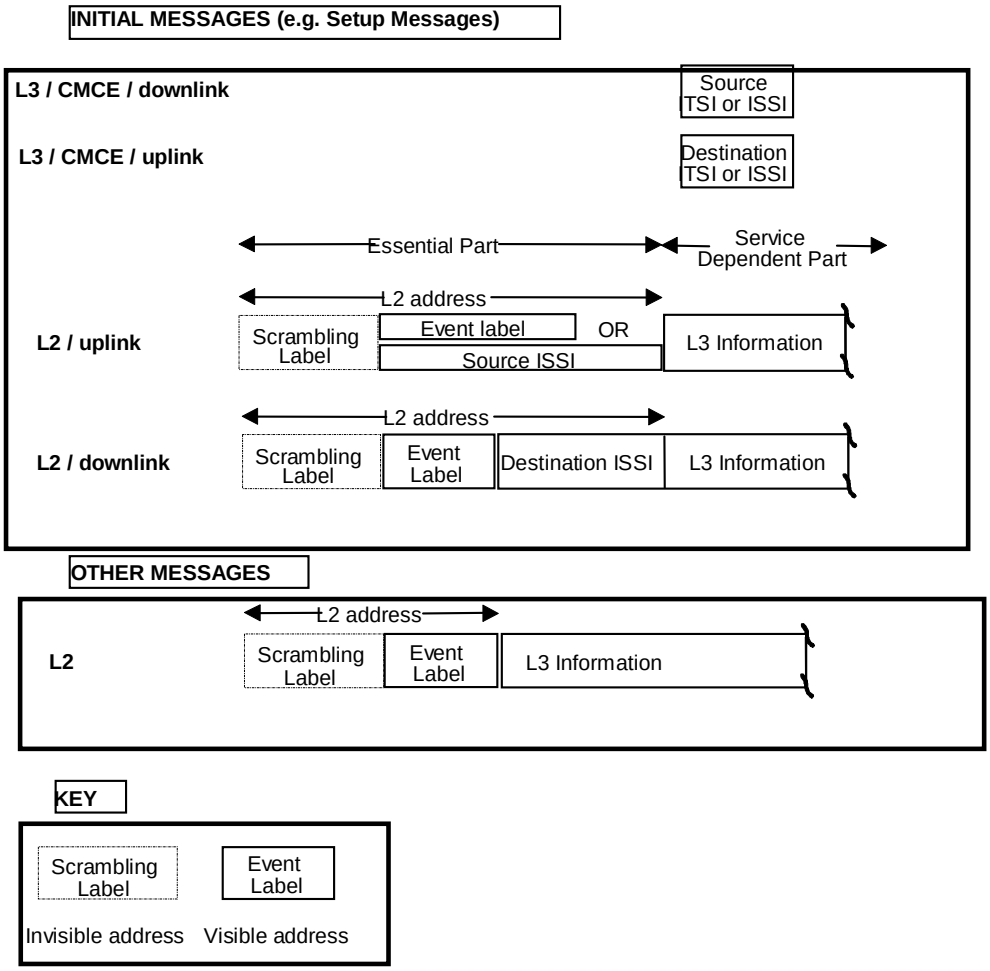


Figure 7: Message addressing for initial messages

A call set-up message using random access in V+D shall use the SSI.

7.8.2.2 Use of ITSI/ISSI at layer 3

7.8.2.2.1 Void

7.8.2.2.2 Use of ITSI/ISSI by CMCE

The ITSI, ISSI and GSSI shall be used as the routing address for CMCE, where the call routing shall be defined by the source and destination ITSI, ISSI or GSSI, and/or the call identifier.

The ISSI shall be used for all intra-TETRA calls for both source and destination. The ITSI shall be used for inter-TETRA calls as destination address. As usual, alias identities shall replace individual addresses when appropriate.

For external calls, the message shall contain gateway address ITSI/ISSI and the external subscriber address.

When migrating, the CMCE shall retain its home network ITSI, and calls to this subscriber shall continue to use the ITSI as the layer 3 destination address. The visitors (V)ASSI shall be used for all air interface PDUs in the visited network, and translation between the home ITSI and the visitors (V)ASSI shall be performed by the visited network.

NOTE: The (V)ASSI is a temporary exchanged address, and the association to a given subscriber may be changed at any time by the visited network.

The CMCE header over the air interface is designed to be as short as possible. As a result, different PDUs have been defined for CMCE using the different addresses described in this clause. The CMCE PDUs are further described in EN 300 392-2 [4], clause 14.

For the ISI, the PDU shall contain the full addresses (TSI) for both source and destination.

There shall only be one address field in the uplink and downlink PDUs at layer 3, respectively destination and source, to remove the duplication with the MAC layer address (the other ISSI address shall appear in the layer 2 primitives as described above). These air interface PDUs shall use SSI (instead of the full ITSI) for addressing within one TETRA sub-domain. Refer to figure 9.

The infrastructure shall convert between these different PDUs as appropriate.

Figure 8: Void

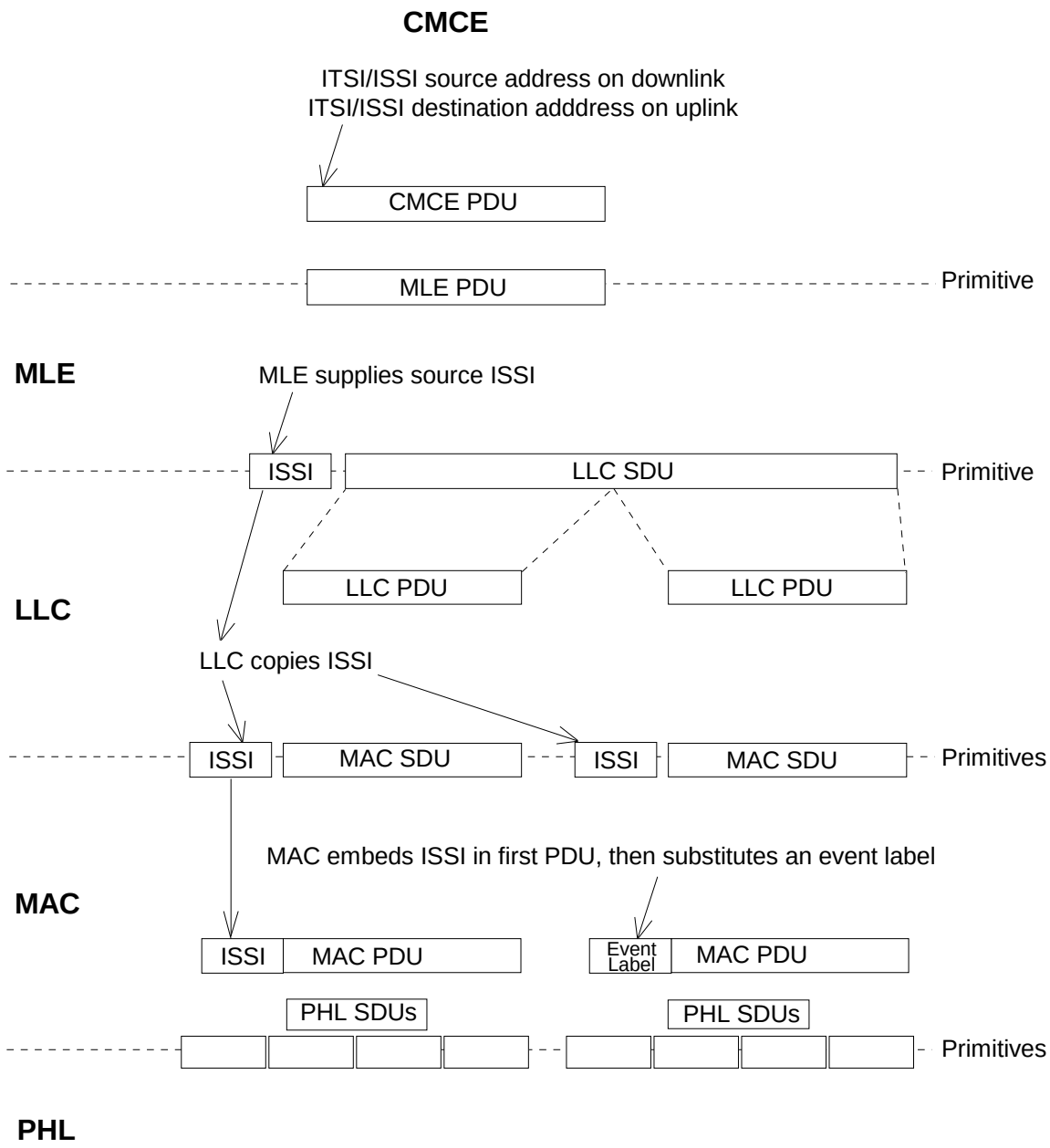


Figure 9: CMCE V+D air interface addressing

7.8.3 Routing principles

7.8.3.1 Routing of intra-TETRA calls (within one TETRA network)

Within one TETRA network, packet data routing may use NSAP or SSI.

SSI alone should be sufficient for intra-TETRA call routing and SSI-only operation should be used for V+D calls. Dual addressing (SSI plus NSAP) should be used as a V+D option for "telephony access". However, dual addresses (SSI and NSAP) may be used for all intra-network routing as an operator choice.

7.8.3.2 Routing of inter-TETRA calls (between two TETRA networks)

Between two TETRA networks, packet data routing may use NSAP or TSI.

TSI alone should be sufficient, and TSI-only operation should be used for most V+D calls. However, dual addresses (TSI and NSAP) may be used as an operator choice.

7.8.3.3 Routing of external calls (to/from non-TETRA networks)

External to a TETRA network routing shall only use NSAP addresses.

The ISSI (or ASSI) shall still appear in the set-up message for access to support the TETRA procedures.

7.8.4 Address and identity comparison

TETRA addresses and identities are compared in table 2 to the ones used in other systems.

Table 2: Comparison of addresses and identities between TETRA and other systems

TETRA	GSM	NA7/ UPT	Notes
ITSI	IMSI		
GTSI			4
ISSI	MSIN	Personal Identity	1, 2 and 3
ASSI	TMSI		
GSSI			4
TMI			2 and 3
TEI	IMEI	Terminal Identity	2 and 3
NSAP	MS-ISDN	Personal or Terminal Number	3

NOTE 1: Refer also to ITU-T Recommendation E.218 [2].
NOTE 2: Both the ITSI and the IMSI may be removable (transferable) identities. The TMI, the TEI and the IMEI are not removable.
NOTE 3: NA7/ UPT makes an important distinction between Identities and Numbers.
NOTE 4: Only TETRA recognizes group addressing.

7.9 Addressing in interworking and roaming with other telecommunication networks

TETRA users can be identified outside TETRA domain using E.164 addresses, when TETRA users have E.164 numbers (MS-ISDN numbers) allocated. Allocation of the E.164 numbers may limited to a sub-set of all users and may be in that case implemented by using e.g. ISDN supplementary service Direct Dial In.

TETRA PSTN and ISDN gateway standards also support two stage dialling possibility where only the gateway address belongs to the E.164 number domain and the additional dialling (sub-address) belongs to the TETRA domain. If the TETRA network provides or is interconnected with another TETRA network that provided roaming (migration) to other mobile networks and using the TETRA domain address reveals the ITSI of the users, then ITSI addressing shall not be used.

Roaming TETRA users can be identified outside TETRA domain by ITSI for roaming purposes, refer to clause 7.2.4. It is assumed that TETRA networks supporting roaming between technologies will adapt the roaming signalling used by the other technology. Roaming users shall have E.164 addresses telecommunication purposes.

8 Circuit mode basic services

Annex C gives an overview of circuit mode services used as a basis for TETRA standardization.

Annex D gives individual call scenarios and annex E group call scenarios as used as basis for TETRA air interface standardization.

Annex F gives priority scenarios as used as basis for TETRA supplementary services standardization.

9 Mobility Management (MM) in MS

Annex G as used as basis for TETRA air interface standardization.

10 MLE mobility scenarios and functionalities

Annex H gives scenarios on MLE mobility as used in the TETRA air interface standardization.

11 Technical realization of SDS

Annex J gives information of the scenarios used in the standardization of Short Data Service for TETRA.

12 Void

13 Void

14 General on supplementary services

Annex K gives background information what was used in the supplementary services standardization for TETRA.

Annex A (informative): Circuit mode reference points

A.1 Introduction

This annex is based on the principle of reference configurations presented in ITU-T Recommendation I.411 [i.2].

The TETRA LMN supports various speech and data services. This annex defines the general reference configuration and the circuit mode reference points for TETRA MSs, LSs, and the inter system interface. An overview of circuit mode services and examples of protocol configurations are described in annex C.

NOTE 1: Definition of Line connected Station (LS) is outside of the present document.

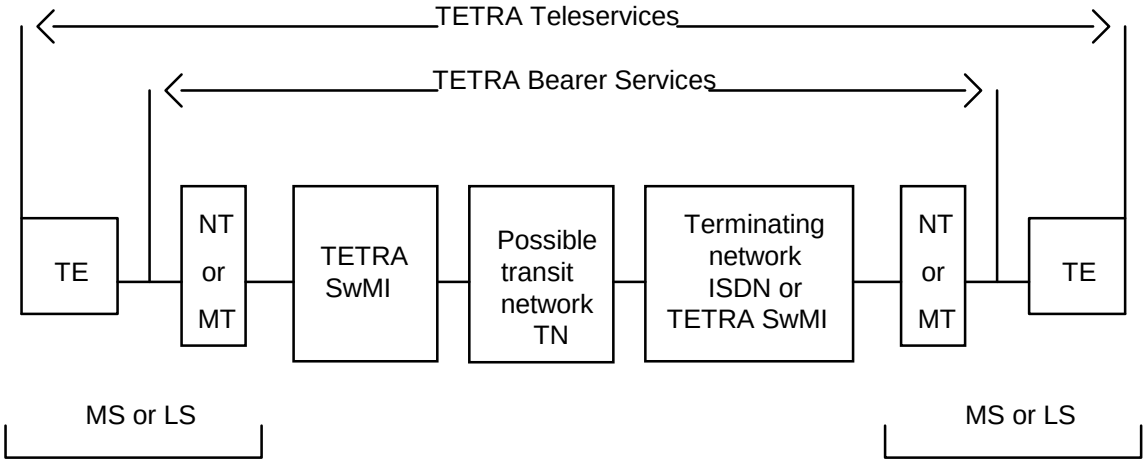
In order to enable data services in the TETRA LMN there is a need to connect different Terminal Equipment (TE) to a Mobile Termination (MT) or a Network Termination (NT).

NOTE 2: Network Termination (NT) is outside the scope of the present document.

A.2 Reference configuration

A general TETRA LMN configuration may comprise MSs or LSs which are connected to a terminating network. The terminating network may be a TETRA network (TETRA SwMI) or an ISDN network. A Transit Network (TN) may used for communication between different terminating networks. A MS includes a MT and may include a TE.

A TETRA LMN can offer various telecommunication services at different Service Access Points (SAPs). The general TETRA LMN, and the access for teleservices and bearer services supported by a TETRA LMN is shown in figure A.1.



NOTE: The terminating network may include a TETRA LMN, either the originating one or another one.

Figure A.1: Bearer services and teleservices supported by a TETRA LMN

A.2.1 Configuration examples of TETRA LMNs

General configuration examples of TETRA LMNs using one ore more TETRA SwMI are shown in figure A.2. Figure A.3 shows the direct mode connection between MSs.

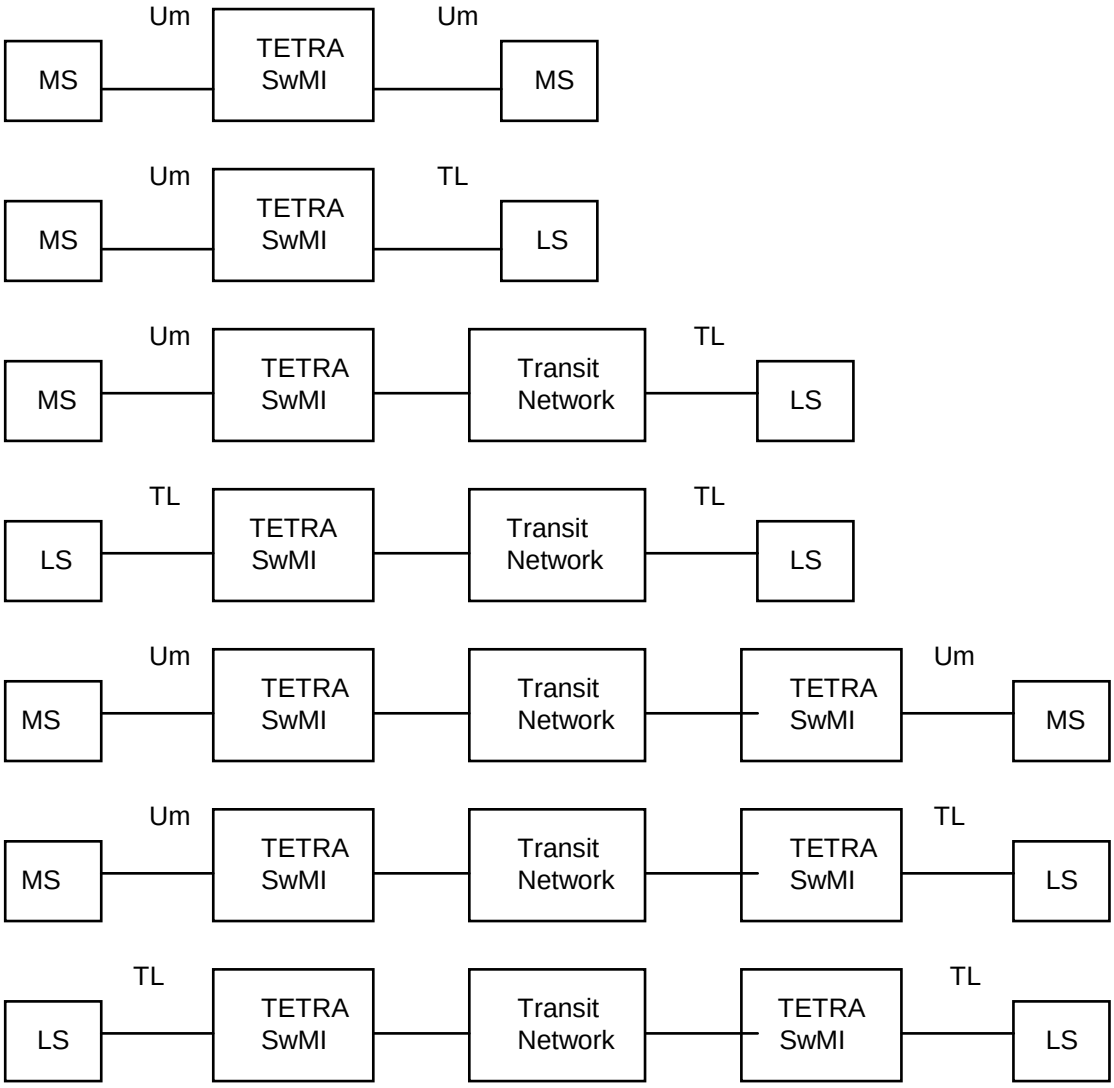


Figure A.2: TETRA LMN configuration examples using a TETRA SwMI

The examples shown in figure A.2 are not exhaustive, but only illustrate possible network configurations.

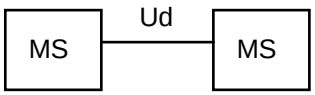


Figure A.3: MS connected to MS via direct mode interface

A.3 TETRA LMN access

A.3.1 MS access

A MS includes a MT and may include a TE. The MS access to services supported by a TETRA LMN is shown in figure A.4.

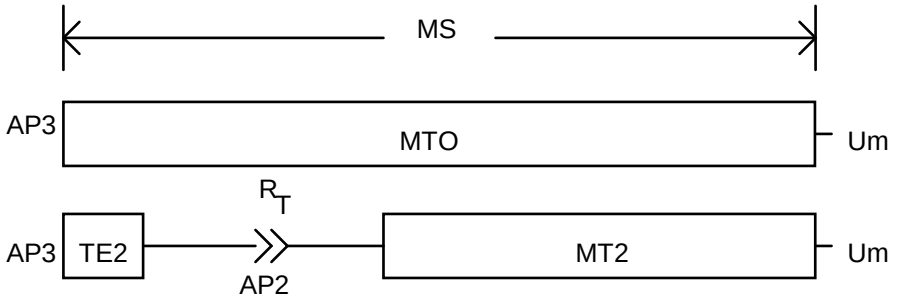


Figure A.4: MS access to a TETRA LMN

A.3.1.1 MS functional groups

The mobile termination functional group, MT, may support the following general functions:

- air interface termination (Um);
- radio channel management;
- Mobility Management (MM);
- speech and data encoding/decoding;
- error protection/correction for all information (speech, signalling, user data) sent across the radio path;
- mapping of signalling and user data;
- rate adaption between user data and radio channel rate;
- support of TE.

There are two types of MT defined:

- MT0 includes functions belonging to the functional group MT, with support of non-standard terminal interfaces that provide TE functionality;
- MT2 includes functions belonging to the functional group MT, with a terminal interface that complies with a TETRA recommended interface.

The terminal equipment functional group, TE, supports Man Machine Interface (MMI) to the user (access point AP3) and supports a TETRA terminal interface to MT2 functional group (access point AP2).

There is one type of TE defined:

- TE2 represents an asynchronous (start/stop) serial TETRA specific ITU-T Recommendation V.24 [i.14] and V.28 [i.15] series interface or some higher speed interface, refer to EN 300 392-5 [i.10].

A.3.1.2 MS access points and reference points

The RT reference point defines the boundary between the TE2 and MT2 functional groups. AP2 is the access point for TETRA bearer services at this reference point.

A.3.2 Void

A.3.3 Inter System Interface (ISI) access

The functional groups and reference points of an ISI are based on ISO/IEC 11572 [i.11] and repeated in figure A.5. Refer to EN 300 392-3-1 [i.12] for further details how PSS1 model is adapted to TETRA Inter-System Interface (ISI).

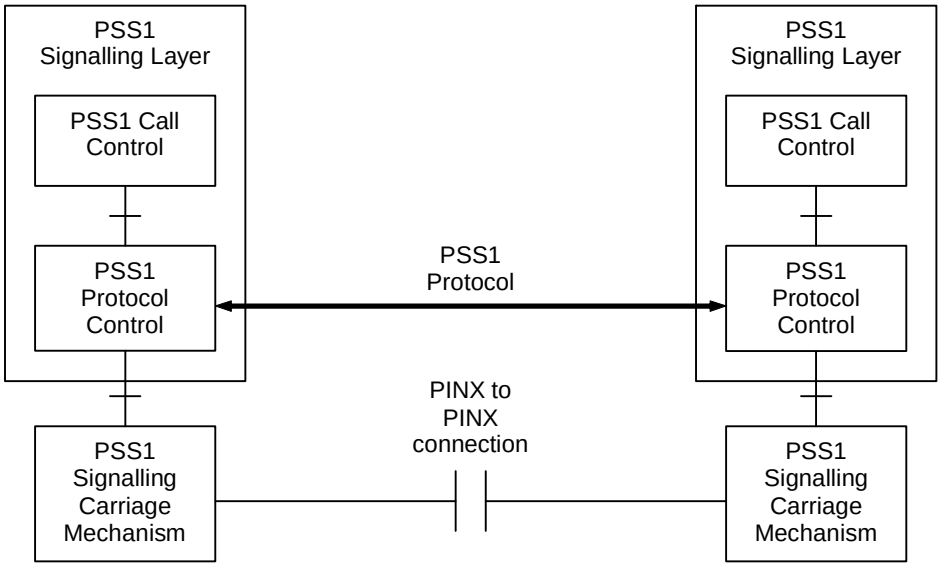


Figure A.5: Control Plane Protocol Model

A.3.4 Location of TETRA functionality

In the MS, the TETRA functionality resides in the MT0 terminal or in the TE2 terminal together with the MT2 mobile termination.

A.3.5 TETRA terminals

The Um or Ud access point may be used by the mobile termination MT0 or the terminal equipment TE2. TE2 is connected to Um or Ud via RT reference point on access point AP2 and mobile termination MT2. The TETRA terminals connected to Um or Ud access point are shown in figure A.6.

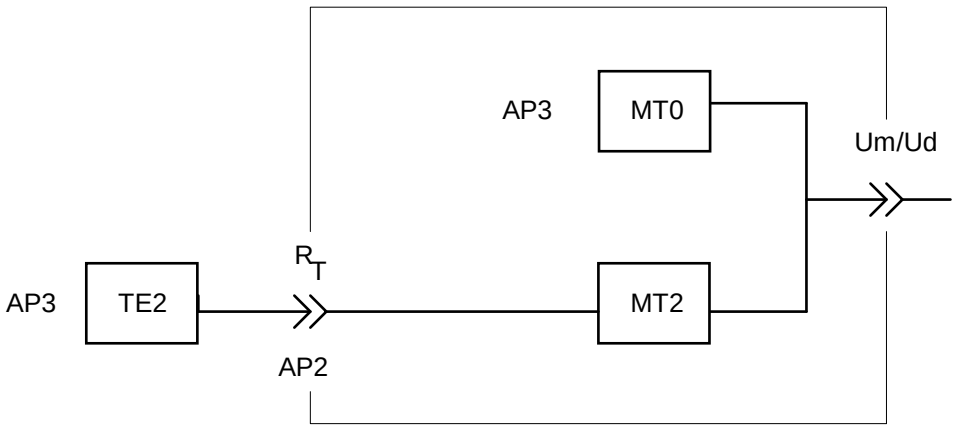


Figure A.6: TETRA terminals connected to Um/Ud

Annex B (informative): Protocol architecture for V+D

B.1 Introduction

The purpose of this protocol architecture is to be a model where the different functions and processes are identified in the different layers in the mobile and base protocol stacks.

NOTE: The protocol stacks are used to define the functionality of the TETRA protocols for interfaces. The protocol stacks in other parts of the document are normative when used to describe functionality of interfaces, but these stacks and sub-division of protocol layers does not imply or restrict any implementation.

B.2 Mobile/base protocol architecture

B.2.1 Overview

The base of the protocol stack rests on the physical layer.

The data link layer is composed of two sub-layer entities as described hereafter (MAC and LLC).

An explicit Medium Access Control (MAC) sub-layer is introduced to handle the problem of sharing the medium by a number of users. At the MAC, the protocol stack is divided into two parts, the user plane (U-plane) for transporting information without addressing capability and the control plane (C-plane) for signalling and user data with addressing capability.

A Logical Link Control Entity (LLCE) resides above the MAC and is responsible for controlling the logical link between a MS and a BS over a single radio hop.

An explicit Mobile/Base Control Entity (MLE/BLE) sub-layer resides above the LLCE for handling establishment and maintaining the connection to the BS. The MLE/BLE also acts as a convergence, so the same layer 3 entities could be used on top of different layer 2 entities.

At the top of the protocol stack (layer 3), several entities may be present: Mobility Management (MM), Circuit Mode Control Entity (CMCE) and TETRA packet data protocol (PDP).

A conceptual Lower Layer Management Entity (LLME) contains the databases. The required layer management functionalities is contained in the layers. The interactions between layers go through SAPs (see the model in clause B.3.1).

Figure B.2 shows the protocol layering for the MS and the BS. Clauses B.2.2 to B.2.5 describe the major functions handled by each layer.

B.2.2 Air interface layer 1

The air interface layer 1 is the physical interface. It deals with the physical burst, composed of bits and symbols (= association of 2 bits), which is to be sent and/or received.

The air interface layer 1 contains the following functions:

- radio oriented:

    1) modulation/demodulation as defined in EN 300 392-2 [4], clause 5.

    2) transmitter/receiver switching as defined in EN 300 392-2 [4], clause 6.

3) RF characteristics: as defined in EN 300 392-2 [4], clause 10:

   - frequency (or channel) setting;
   - outputs Radio-Signal-Strength-Indicator (RSSI).

4) fine adjustments of radio parameters:

   - frequency correction: the synchronization on to the BS frequency using a specific frequency correction sequence located inside the Synchronization burst as defined in EN 300 392-2 [4], clauses 7 and 9;
   - power control: MS power level adjustment according to BS broadcast parameters and signal strength measurements in the MS or optionally BS may control MS transmission power using closed loop power control as described in EN 300 392-2 [4], clause 23;
   - broadcast parameters related to power control part of the MAC block and hence decoded at the MAC level (see EN 300 392-2 [4], clause 21).

- bits and symbol oriented:

  - symbol synchronization: a specific training sequence, located inside the burst, precisely determines the occurrence of the symbols. For first time synchronization acquisition, an extended training sequence (longer than the normal one) is available on the synchronization burst (see EN 300 392-2 [4], clause 7). The physical layer is then able to determine the burst boundaries (i.e. the beginning and the end).

- burst building:

  1) receiving/submitting data from and to the MAC sub-layer: because the physical layer is able to determine the starting and ending points of the burst, at the emission, it maps the MAC block onto the physical burst and adds its specific information (layer 1 only) at the correct place. At the reception, it extracts its specific information (layer 1 only) from the burst and rebuilds MAC block(s), see EN 300 392-2 [4], clause 9. The MAC block(s) are then passed to the MAC;

  2) slot flag coding/de-coding using two distinct training sequences, see EN 300 392-2 [4], clause 9. The use of the slot flag is described in EN 300 392-2 [4], clause 19;

  3) scrambling/de-scrambling: both BS and MS scrambles frames prior to sending them. Scrambling is done according to the base station address, known as colour code. So, the frame will be decoded correctly only by the receiving station having that colour code (de-scrambling). Refer to EN 300 392-2 [4], clause 8.

B.2.3 Air interface layer 2

The air interface layer 2 handles logical connections and hides the physical medium from the upper layers. An overview can be found in EN 300 392-2 [4], clause 19.

B.2.3.1 Medium Access Control (MAC)

The MAC handles radio channel access and radio resource management. For a detailed description of the services and protocol, see EN 300 392-2 [4], clauses 20 and 23.

The main functions are as follows:

- channel coding:

  a) interleaving, de-interleaving and re-ordering the protected bits over 1,4 or 8 blocks allow spreading the errors instead of having them grouped as it is usually the case in radio systems (see EN 300 392-2 [4], clause 8);

b) channel coding see EN 300 392-2 [4], clause 8:

1) in order to protect bits transmitted on the radio path, Forward Error Correction (FEC) using convolutional coding adds some redundancy (e.g. 2/3 coding, which encodes 2 bits of information into 3 transmitted bits) so that errors may be corrected afterwards;

2) a Cyclic Redundancy Check (CRC) is performed on the incoming block of information so that errors may be detected up to a certain amount, depending on the size of the CRC. 16 bits CRC will ensure a protection against undetected errors. The receiving MS calculates the CRC on the received bit stream using the same algorithm and compares the result to the received CRC. The actions taken in case of error are described in EN 300 392-2 [4], clause 23.

- radio channel access control:

  - the performed functions are as follows:

    a) frame synchronization:

       - keeps track of the frame number within a multiframe;

    b) random access procedure:

       - contention control on a particular physical channel;

       - flow control of up-link random access.

    c) fragmentation/re-association:

       - this splits the content of one single SDU into several PDUs. On the other side, parts are be re-associated together in order to re-constitute the original SDU;

    d) multiplexing/de-multiplexing of the logical channels: creates all layer 2 parts of the burst (see EN 300 392-2 [4], clause 9 and clause 23);

    e) multiframe building and synchronization: this is where the frames are assembled to form a multiframe or a hyper-frame which repeat according to a cyclic law. They are numbered explicitly i.e. on the downlink, a synchronization block contains information about time slot, frame and multiframe number, colour code information of the BS, and network code (see EN 300 392-2 [4], clause 9).

- radio resource management:

  - this part is unique to one mobile or base station. It enables powerful control of the radio resources to be available at any time without explicit involvement of layer 3. The following functions are provided:

    a) Bit Error Ratio (BER) and BLock Error Rate (BLER) measurements: independently or under control of other layers;

    b) path loss calculation: monitoring of the serving cell and monitoring and scanning of adjacent cells (see EN 300 392-2 [4], clause 23);

    c) address management for individual, group or broadcast calls. Two MAC addresses can be used:

       - a copy of the ISSI, ASSI, USSI or GSSI (passed as a parameter from layer 3); and

       - an event label (see clause 7 and EN 300 392-2 [4], clause 19);

    d) power control management (execution is in the physical layer);

    e) radio path establishment: frequency, time slot and colour code selection according to the MLE (layer 3) indications. Refer to EN 300 392-2 [4], clauses 11, 14 and 23;

    f) radio resource allocation. Channel allocation (frequency and time slot) may depend on the system mode of operation, i.e. message trunking, quasi-transmission trunking, transmission trunking, discontinuous transmission. This functionality enables efficient and fast channel access and drop time;

g) buffering of control information and speech frames until transmitted;

h) circuit mode applications (e.g. speech and circuit mode data) interface with MAC layer as represented in figure B.1 (U-Plane) and described in more detail in EN 300 392-2 [4], clause 20.

B.2.3.2 Logical Link Control (LLC)

The LLC handles the point-to-point logical links between the MS and the BS. It is used only for C-plane operation. Two different services may be provided:

- a basic link, which does not need any establishment phase; and
- on request, an advanced link for better grade of service (see EN 300 392-2 [4], clauses 20 and 22 for details).

The functions are as follows:

- exchanging control and/or user data with the Mobile/Base Link control Entity sub-layer (MLE);
- logical link handling (basic link and advanced link);
- scheduling data transmission;
- re-transmissions (single in basic link and selective in advanced link);
- segmentation/re-assembly (advanced link only);
- error measurement (extended error detection in advanced link);
- flow control (advanced link only);
- acknowledgement of received data (basic link and advanced link);
- logical channel allocation negotiation with the MAC (advanced link only).

B.2.4 Air interface layer 3

The air interface layer 3 handles network procedures.

B.2.4.1 Mobile/Base Link control Entity (MLE/BLE)

This sub-layer, which is applicable to the C-plane, is a platform for the services offered in the network layer (see EN 300 392-2 [4], clause 17 and clause 18 for further details).

The functions are as follows:

- protocol discrimination;
- management of the mobile-base association (connection);
- identity management;
- quality of service selection;
- mobility within a Registered Area (RA).

The MLE also handles common broadcast information. Through the C-SAP it interacts with all layers.

The functions are as follows:

- broadcast and receive network information;
- pass channel information to the layers below via C-SAP.

B.2.4.2 Sub-Network Access Functions (SNAF)

This layer have SAPs for circuit-switched voice and data call control services, packet data services, Short Data Service (SDS), Mobility Management (MM) and supplementary services. The functions for these different services are listed in clauses B.2.4.2.1 to B.2.4.3.

B.2.4.2.1 Mobility Management (MM)

MM handles functions that are necessary due to MS mobility (see EN 300 392-2 [4], clauses 15 and 16 for further details).

The functions are as follows:

- selection of LA;
- registration;
- authentication;
- user attachment;
- network selection.

B.2.4.2.2 Circuit Mode Control Entity (CMCE)

The CMCE is subdivided into three sub-entities, i.e. SDS, Call Control (CC) and supplementary services control (see EN 300 392-2 [4], clauses 11, 12, 13, and 14 for further details).

- SDS:
- SDS handles connectionless data messages with the following capabilities:
  - minimize the number of transmissions required to send the short data as signalling message;
  - source and destination address associated with the short data;
  - service available independent of whether a circuit switched call is in progress;
  - point-to-point and point-to-multipoint;
  - efficient coding of user messages (pre-defined and user-defined).

Refer to EN 300 392-2 [4], clauses 13 and 29 for further details.

- CC:
  - the call control handle circuit mode calls with the following functions:
    - establishing, maintaining and clearing basic service calls;
    - addressing (destination);
    - call identity.
- supplementary services control:
  - supplementary services control handles the processes associated with supplementary services (see EN 300 392-2 [4], clause 12 for further details and EN 300 392-10 [i.9] for supplementary services).
  - The functions may be as follows:
    - provision and withdrawal;
    - activation/deactivation;
    - definition;

- registration;
- invocation and operation;
- interrogation;
- cancellation.

B.2.4.2.3 Packet data handling

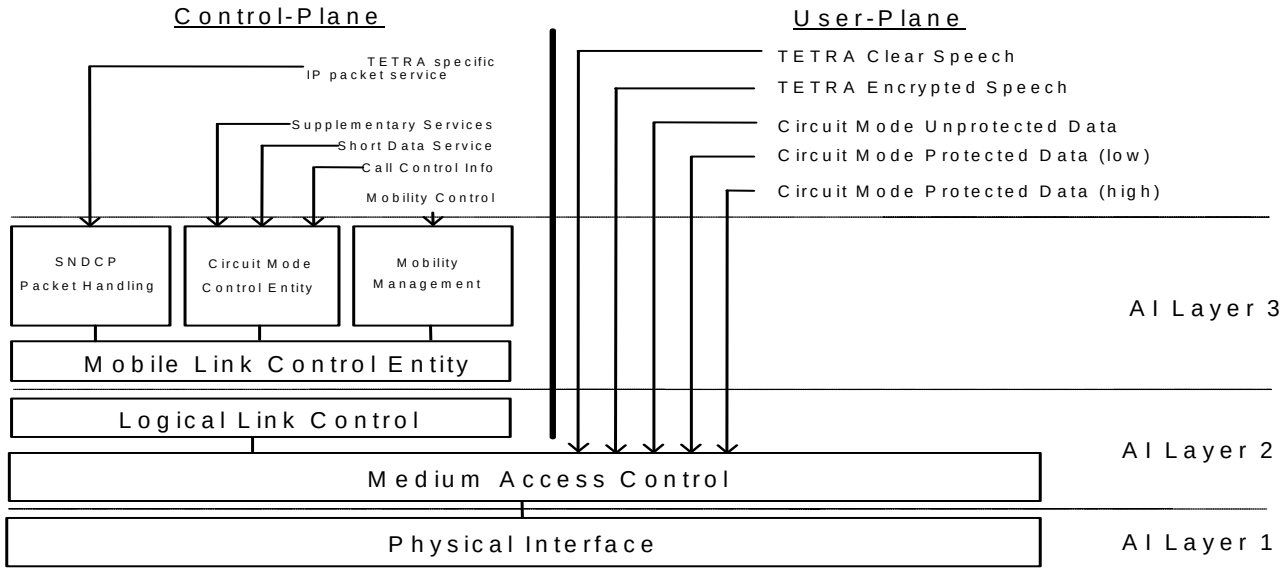
The packet handling entity handles the packet data services offered by TETRA.

B.2.4.2.4 TETRA packet data protocol (PDP)

The TETRA packet data protocol handles the Internet Protocol (IP), versions 4 and 6 using SNDCP, refer to EN 300 392-2 [4], clause 28.

B.2.4.2.5 Void

B.2.5 Mobile/base protocol stack



- | Service Access Point (SAP);
- AI-1 Air Interface layer 1;
- AI-2 Air Interface layer 2;
- AI-3 Air Interface layer 3;
- C-plane Control-plane, control information available;
- CMCE Circuit Mode Control Entity;
- LLC Logical Link Control;
- MM Mobility Management;
- SNAF Sub-Network Access Functions;
- SNDCP Sub-Network Dependent Control Protocol;
- U-plane User-plane, control information not available.

Figure B.1: Mobile/base station protocol stack

B.3 Lower Layer Management Entity (LLME) and other layers interaction

B.3.1 General description

The LLME is a conceptual vertical entity through which layers exchange information. It enables access to measured values, status, and to general information. Its interaction with the layers may be represented as shown in figure B.2.

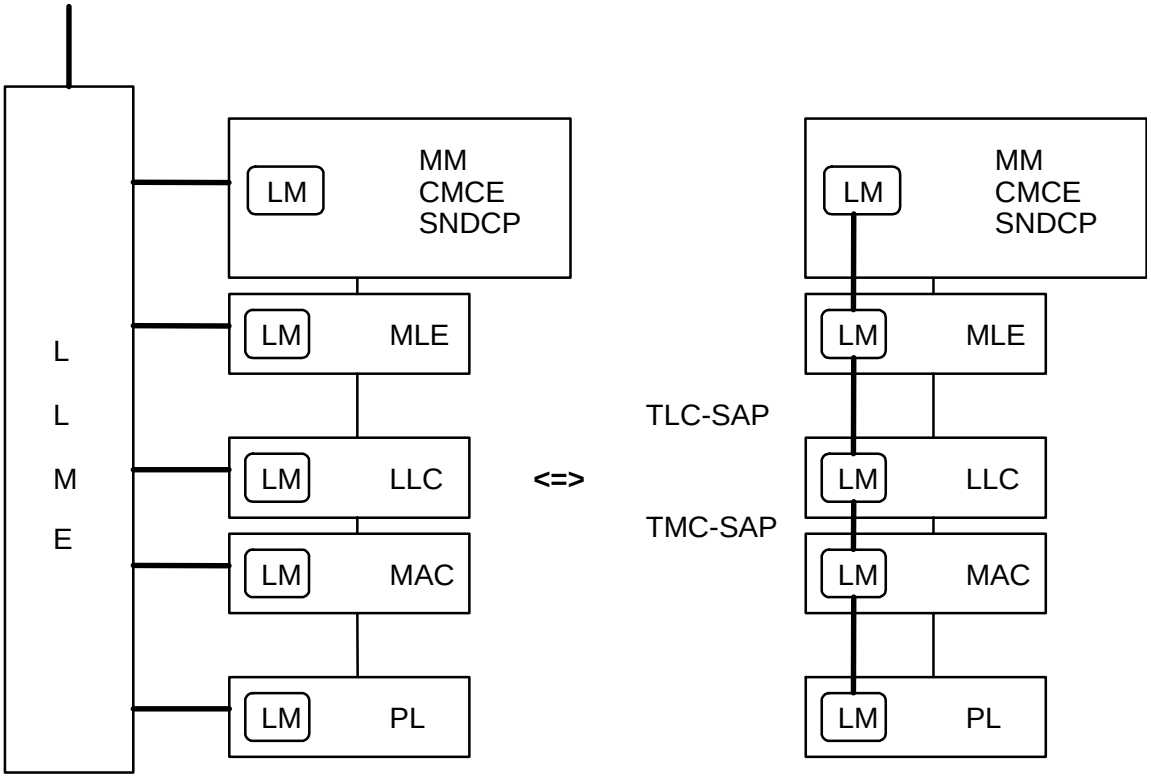


Figure B.2: TETRA protocol stack with LLME interaction

Each layer has its own set of functions and measured values. The functions related to the management of a particular layer are described inside that layer. These parameters are exchanged with the LLME (stored and retrieved) using a set of service primitives and are standardized and described in appropriate clauses of EN 300 392-2 [4].

Annex C (informative): Overview of circuit mode basic services

C.1 Introduction

This clause identifies a technical realization for the circuit mode services showing signalling between users on the U-plane and C-plane.

C.2 Functional groupings in circuit switched mode calls

C.2.1 Circuit switched call control, C-plane

Functions exist in the TETRA SwMI that are accessed for setting up a basic service or performing a supplementary service process. The circuit mode applications invoke these services through SAPs at the top of the CMCE.

In the case of a circuit switched call, the C-plane controls the U-plane after the SwMI has given permission for the call to be set-up, and user data may be transferred, (this may be in the form of speech or data depending upon the application).

C.2.2 Circuit switched call, user data, U-plane

The propagation of circuit mode data, which does not include control information, from point-to-point and point-to-multipoint is done on the U-plane. Examples of such data can be TETRA encoded speech, circuit mode speech and circuit mode data.

C.3 Protocols

Different types of protocols are required to convey information from different entities in one unit to another entity in another unit. The different protocols are described in the clauses C.3.1 to C.3.8.

C.3.1 TNP1

The TETRA specific layer 3 protocol between peers within a MS or LS over the RT reference point to external TE.

NOTE: This interface is also known as the Peripheral Equipment Interface (PEI) defined in EN 300 392-5 [i.10].

C.3.2 Void

C.3.3 TNP3

The TNP3 protocol is used to convey the CMCE and the MM protocol over the ISI.

NOTE: TNP3 terminology is not used in the actual TETRA ISI standards, refer to EN 300 392-3-1 [i.12].

C.3.4 TNP4

The TNP4 protocol is used to convey the TETRA specific CMCE protocol between the MS and the SwMI over the air interface (Um).

NOTE: TNP4 terminology is not used in the actual TETRA air interface standard, refer to EN 300 392-2 [4].

C.3.5 AI1

The TETRA specific layer 1 protocol is conveyed between the MS and the SwMI over the air interface (Um).

C.3.6 AI2

The TETRA specific layer 2 protocol is conveyed between the MS and the SwMI over the air interface (Um).

C.3.7 TLC1

The TLC1 protocol is used as the layer 2 protocol on the C plane, between an external terminal and an MS over the RT reference point.

NOTE: Terminology TLC1 is not used in the Peripheral Equipment Interface standard EN 300 392-5 [i.10].

C.3.8 V.24T

The V.24T protocol is used to manage the physical layer between an external terminal and an MS or LS over the RT reference point.

C.4 Example configuration

C.4.1 MS to MS

Figure C.1 shows how CMCE data is exchanged between MSs and SwMI.

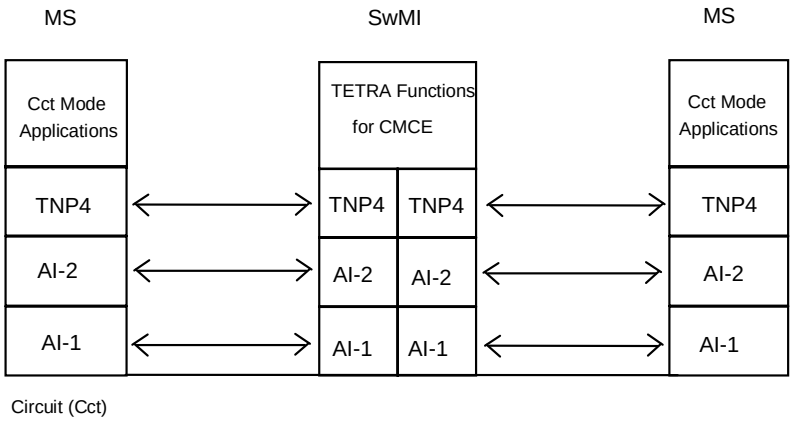
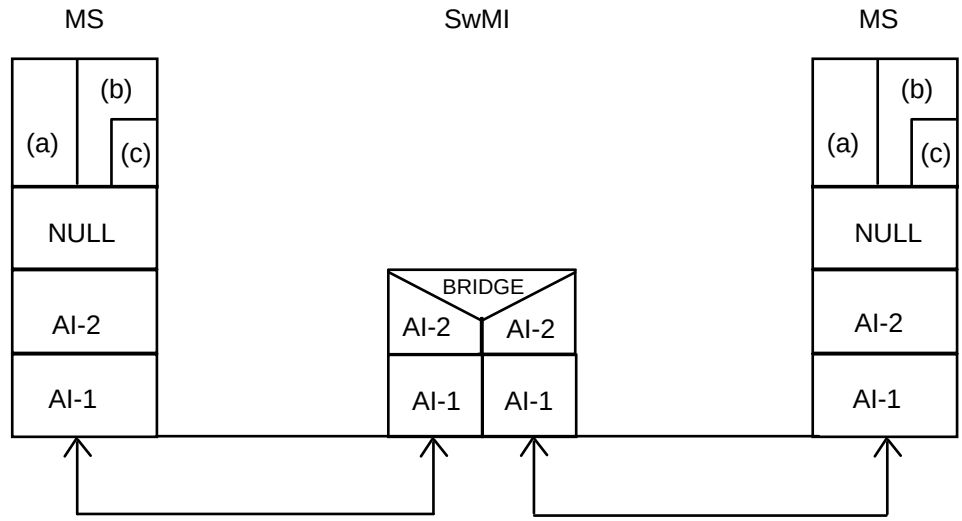


Figure C.1: MS connected to MS, exchange of CMCE information, C-plane

Figure C.2 shows how user data on the U-plane may be exchanged between two MSs over a LLC bridge in the SwMI.



(a) Circuit Mode applications
(b) TETRA encoded speech
(c) Encryption

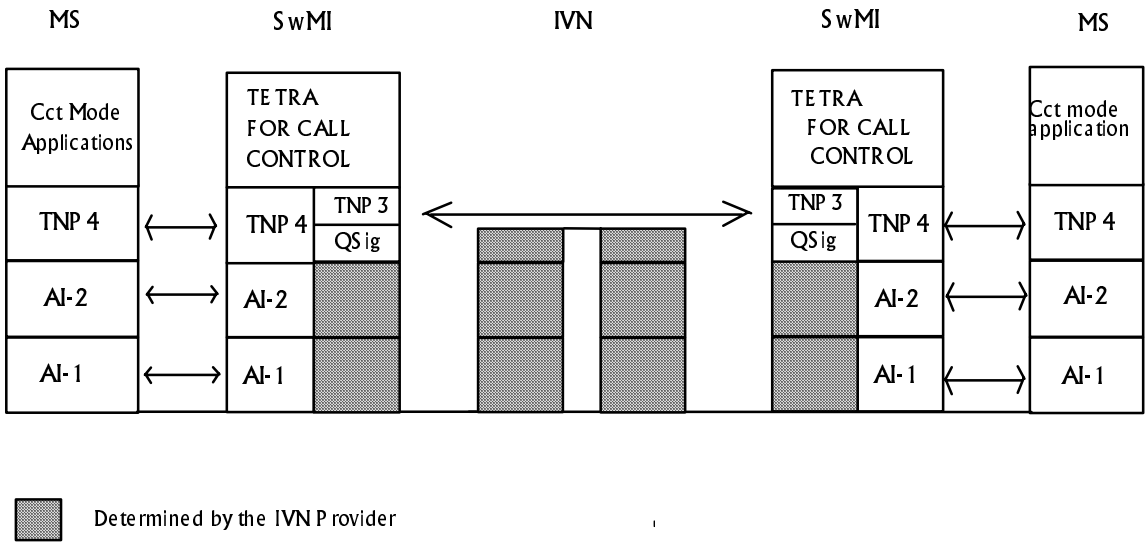
Figure C.2: MS connected to MS, exchange of user data, U-plane

C.4.2 Void

C.4.3 Void

C.4.4 MS to MS over ISI

Figure C.3 shows how CMCE data is exchanged between SwMIs by means of the TNP3 protocol.



Circuit (Cct)

Figure C.3: MS connected to MS via ISI - exchange of CMCE data, C-plane

Figure C.4 shows how TETRA encoded speech and circuit mode data on the U-plane is exchanged between MSs over ISI.

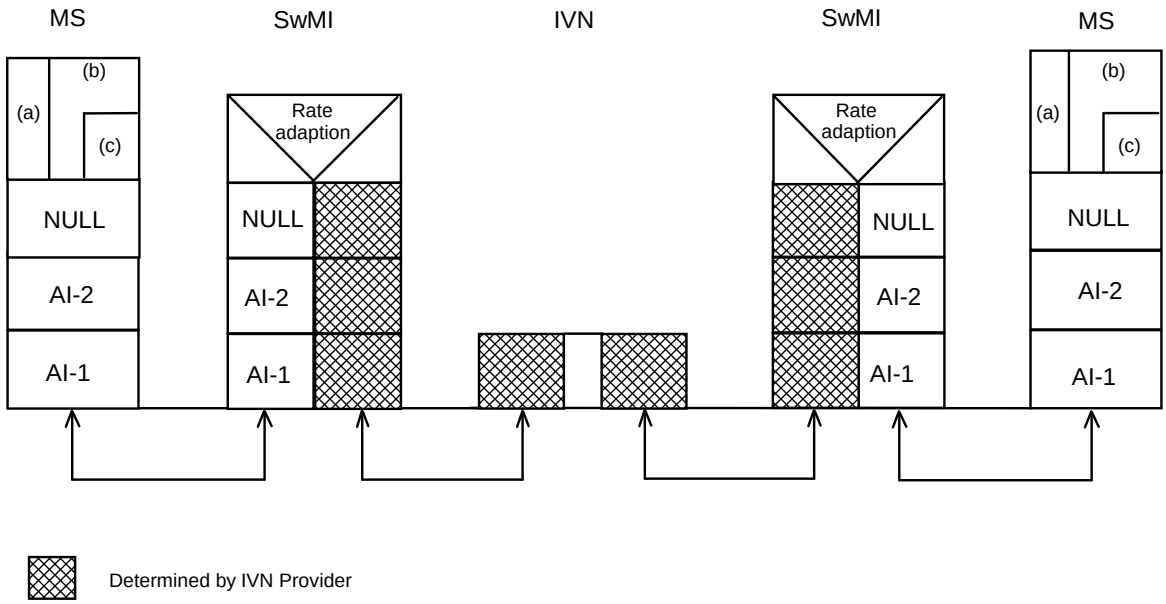


Figure C.4: MS connected to MS via ISI - exchange of user data, U-plane

Annex D (informative): Individual circuit mode call scenarios

D.1 Introduction

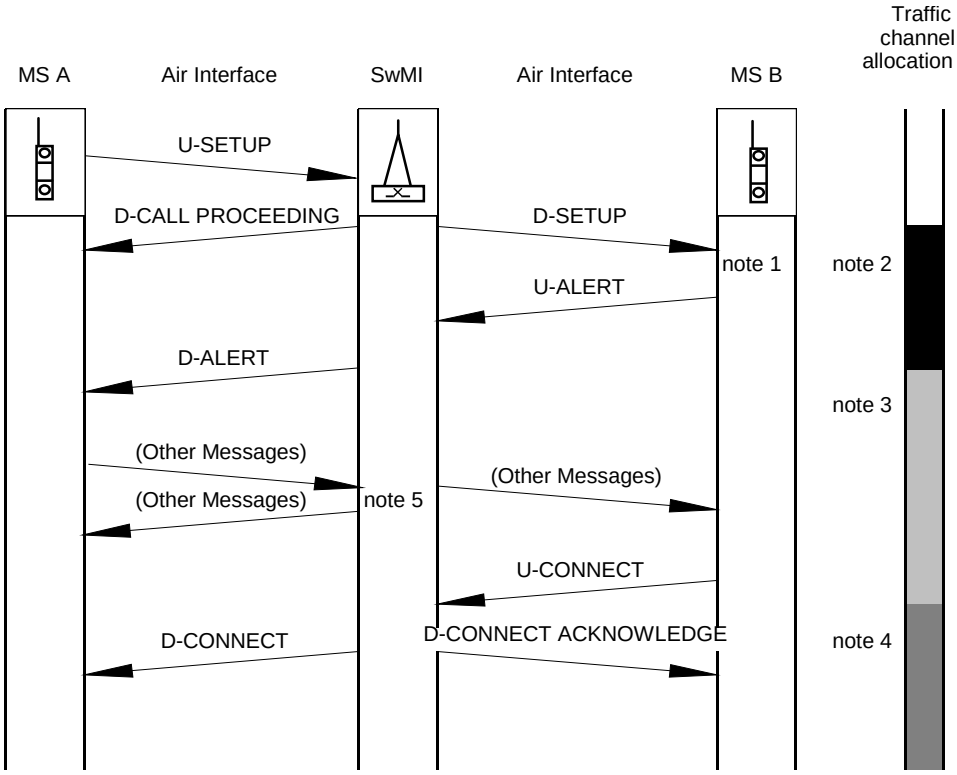
This annex shows the typical scenarios and time-sequence diagrams for individual calls. The annex is split into three parts dealing with message trunked procedures (see clause D.2), transmission trunked procedures (see clause D.3) and quasi transmission trunked procedures (see clause D.4).

D.2 Procedures - message trunked systems

D.2.1 Call set-up - on/off hook signalling

D.2.1.1 Call set-up - on/off hook signalling flow

Referring to figure D.1; the call set-up request can be started by an up-link message <U-SETUP> from the MS. The SwMI may acknowledge the call set-up request by sending a down-link message <D-CALL PROCEEDING> and to indicate that the call is being processed.



NOTE 1: The indication of on/off hook signalling is indicated in the D-SETUP message.
NOTE 2: Early assignment, i.e. the traffic channel is allocated at earliest possible point.
NOTE 3: Medium assignment, i.e. the traffic channel is allocated when the called mobiles presence is established.
NOTE 4: Late assignment, i.e. the traffic channel is allocated when the called user has answered.
NOTE 5: Example of other signalling.

Figure D.1: Call set-up, on/off hook signalling, message trunked system

If following the receipt of a <U-SETUP> message, the SwMI determines that for some reason the call cannot be supported, or if it is indicated to the SwMI that the call cannot be supported by the called user, then the SwMI should initiate call clearing as defined in clause D.2.9.

If the call can be supported, the SwMI should send a down-link message <D-SETUP> to the called MS to start the alerting process at the called mobile. It should be indicated to the called MS that on/off hook signalling is being used for this call. This message may be acknowledged by a <U-ALERT> to indicate that the called mobile has begun the alerting process.

Upon receiving an indication that the called party is alerting (<U-ALERT>), the SwMI should send a <D-ALERT> to the calling party.

When the called MS answers, a <U-CONNECT> message should be sent from the called MS to the SwMI.

Upon receipt of the <U-CONNECT> message the SwMI should send a <D-CONNECT> message to the calling MS and a <D-CONNECT ACKNOWLEDGE> to the called MS.

Communication can commence.

NOTE: As an implementation option the network may support other signalling from the calling MS to the SwMI and visa versa during the call set-up phase, for the purposes of supplementary services et al. Similarly the network may support signalling to the called MS at this time.

D.2.1.2 Traffic channel assignment

There may be three methods for assigning a traffic channel:

1) **early assignment** the traffic channels can be assigned and indicated to the calling and called MS along with the <D-CALL PROCEEDING> and <D-SET-UP> messages respectively, (contained in the lower layer part of those messages). In this case the calling MS should move immediately to the traffic channel in anticipation of the call and should receive all call control messages on this channel;

2) **medium assignment** the traffic channels can be assigned and indicated to the calling MS along with (in the lower layers) the <D-ALERT> message. and indicated to the called MS in a layer 2 acknowledgement to the called MS <U-ALERT> message. In this case the calling MS should move to the traffic channel in anticipation of the call and should receive all call control messages on this channel;

3) **late assignment** the traffic channels cannot be assigned until the called MS sends a <U-CONNECT> message. Upon receipt of this message the traffic channels can be indicated to the calling and called MS along with the <D-CONNECT> and <D-CONNECT ACKNOWLEDGE> messages respectively, (contained in the lower layer part of those messages). In this case the calling MS should remain listening on the control channel until he is told to move to the traffic channel.

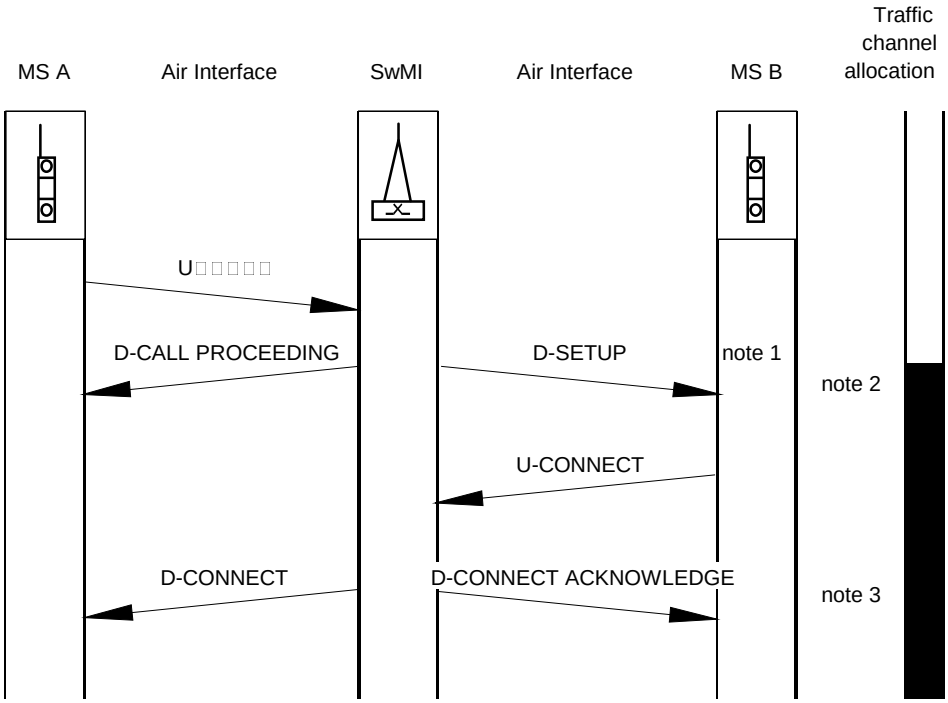
D.2.2 Call set-up - direct set-up signalling

D.2.2.1 Call set-up - direct set-up signalling flow

The call set-up request can be started by an up-link message <U-SETUP> from the MS, refer to figure D.2. The SwMI may acknowledge the call set-up request by sending a down-link message <D-CALL PROCEEDING> and to indicate that the call is being processed.

If following the receipt of a <U-SETUP> message, the SwMI determines that for some reason the call cannot be supported, then the SwMI should initiate call clearing as defined in clause D.2.9.

If the call can be supported, the SwMI should send a down-link message <D-SETUP> to the called MS and it should be indicated to the called MS that direct set-up signalling is being used. This message should be acknowledged by a <U-CONNECT> to indicate that the called mobile is able to receive the call.



NOTE 1: The request to send direct signalling is indicated in the D-SETUP message.
NOTE 2: Early assignment, i.e. the traffic channel is allocated at the earliest possible point.
NOTE 3: Late assignment, i.e. the traffic channel is allocated when the called user has answered.

Figure D.2: Call set-up, direct set-up signalling, message trunked system

Upon receipt of the <U-CONNECT> message the SwMI should send a <D-CONNECT> message to the calling MS and a <D-CONNECT ACKNOWLEDGE> to the called MS.

Communication can commence.

D.2.2.2 Traffic channel assignment

There can be two methods for assigning a traffic channel:

1) **early assignment:** the traffic channels can be assigned and indicated to the calling and called MS along with the <D-CALL PROCEEDING> and <D-SET-UP> messages respectively, (contained in the lower layer part of those messages). In this case the calling MS should move immediately to the traffic channel in anticipation of the call and should receive all call control messages on this channel;

2) **late assignment:** the traffic channels cannot be assigned until the called MS sends a <U-CONNECT> message. Upon receipt of this message the traffic channels should be indicated to the calling and called MS along with the <D-CONNECT> and <D-CONNECT ACKNOWLEDGE> messages respectively, (contained in the lower layer part of those messages). In this case the calling MS should remain listening on the control channel until he is told to move to the traffic channel.

D.2.3 Request-to-transmit

The SwMI should be in full control over which MS is allowed to transmit because the MS should request permission to transmit, and permission should be granted before the MS can do so.

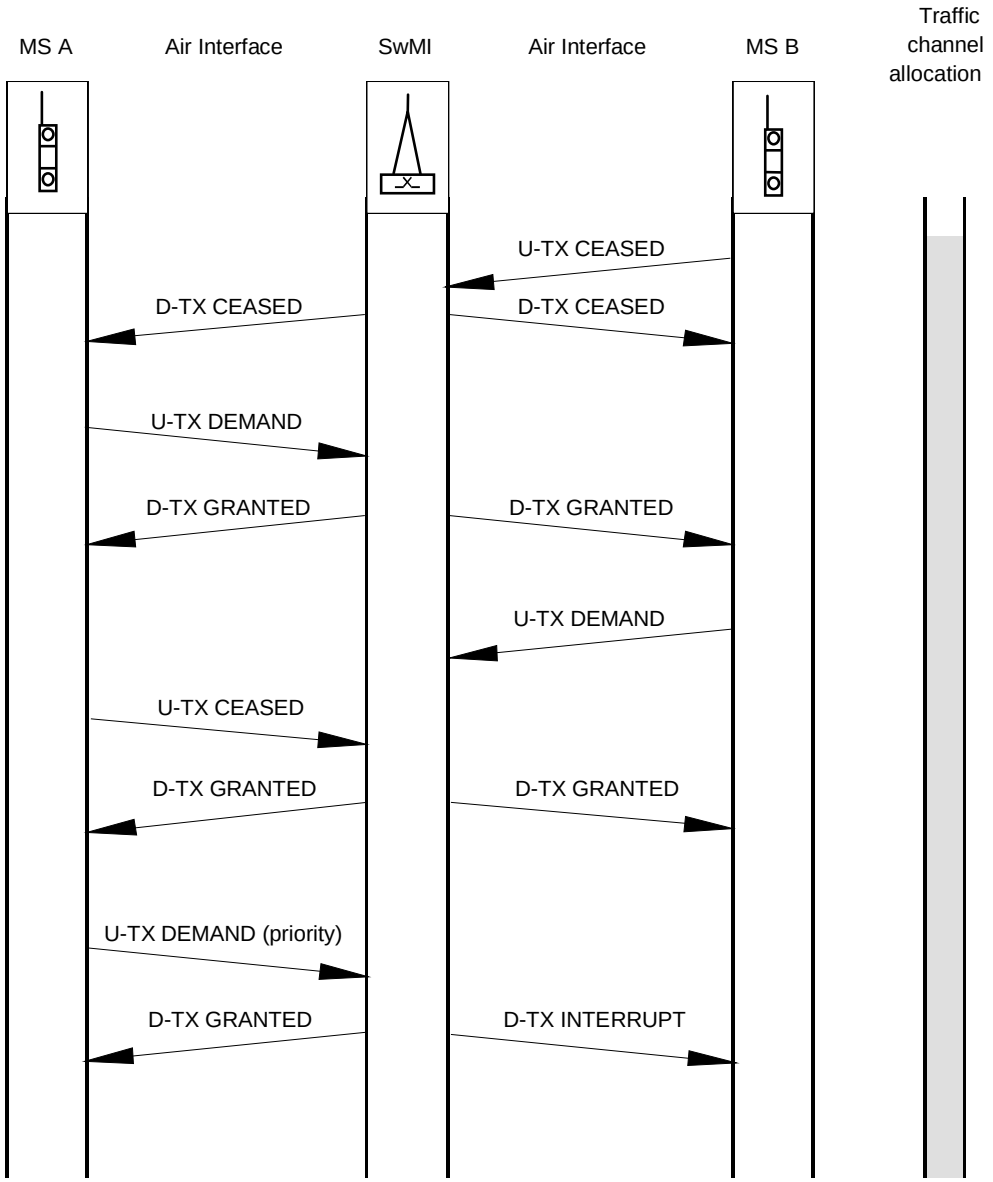


Figure D.3: Request to transmit, direct or on/off hook signalling, message trunked system

If on/off hook signalling is used, it should be normal system operation that the called MS is given permission to transmit by default in the <D-SET-UP> message and early, medium or late assignment should apply as appropriate. However, if desired, the calling MS can ask for permission to transmit in the <U-SETUP> message. The response to this request is dealt with in clause D.2.4, case (1).

If direct set-up signalling is used, it should be normal system operation that the calling MS should given the permission to transmit immediately upon call set-up. Traffic channel assignment should be as previously discussed in clause D.2.2.1.

For both signalling methods, when the awarded mobile has finished the communication it should send a <U-TX CEASED>. refer to figure D.3.

Upon receipt of the <U-TX CEASED> message, the SwMI should send a <D-TX CEASED> message to the "receiving" MS to inform him that the transmission from the other MS has now ceased. The SwMI should await further demands from the calling and called MSs. When either MS wishes to make a request to transmit, it should send a <U-TX DEMAND> message. The response to this request is dealt with in clause D.2.4, case (2).

D.2.4 Response to request-to-transmit

Case 1: if on/off hook signalling applies and the calling MS has asked for permission to transmit at the call set-up, the SwMI can award permission as appropriate and should respond to this request in the <D-CALL PROCEEDING> message. If permission is granted, then the SwMI should also inform the called MS in the <D-SET-UP> message that permission has not been granted to him.

Case 2: figure D.3 refers. During any call, a <U-TX DEMAND> message may be sent by either MS. If the other MS is not already transmitting then the SwMI response should be a <D-TX GRANTED> message sent to the awarded MS, and another <D-TX GRANTED> message sent to the other MS.

If a <U-TX DEMAND> message is sent and the other MS is already transmitting, then the SwMI should wait for that party to finish the transmission, (identified by the receipt of a <U-TX CEASED> message). Subsequently the SwMI should send a <D-TX GRANTED> message to the awarded MS and another <D-TX GRANTED> message to the other MS. Priority requests are dealt with under clause D.2.8.

D.2.5 Permission to transmit withdrawn

The SwMI may decide to interrupt transmission when resources are required for another call or that the SwMI requires that the call should temporarily pause. In this case the SwMI should send a <D-TX WAIT> message to both mobiles. Permission to transmit should be withdrawn, or should not be given to a requesting mobile. The MSs should obey channel allocation and await further instructions on the channel that they have been directed to. The <D-TX WAIT> should:

- confirm to the MSs that the call is in a queue;
- indicate to the MSs that they should not send further requests-to-transmit.

If the request-to-transmit is granted but queued, the MS may be allowed to withdraw its request-to-transmit by means of the message <U-TX CEASED>.

D.2.6 Permission to continue with withdrawn call

When the SwMI has decided that the call can continue, the SwMI may send a <D-TX GRANTED> message to the awarded mobile and a <D-TX CONTINUE> message to the other mobile and the mobiles may be told to go to the traffic channel. If no mobiles have been given permission to transmit then they should be sent a <D-TX CONTINUE> message and are free to make a request to the SwMI.

D.2.7 End of transmission

At the end of a communication, the MS should send <U-TX CEASED> and listen to the traffic channel. Figure D.3 refers. The SwMI should send a <D-TX CEASED> to the other participant.

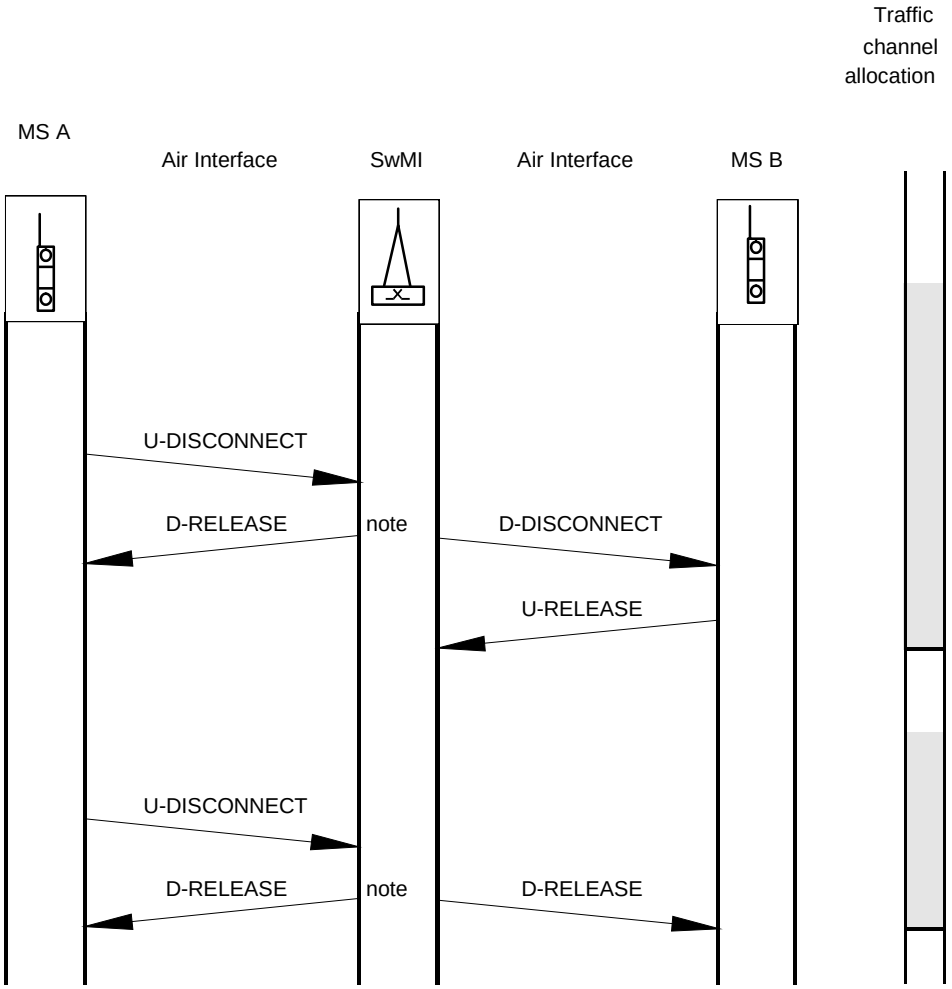
D.2.8 Stop-transmission order

Figure D.3 refers. If, during the course of a transmission, a MS wishes to interrupt the transmitting MS with a higher priority request, a <U-TX DEMAND> message should be sent indicating the level of priority, the SwMI should send a <D-TX INTERRUPT> message to the transmitting MS and a <D-TX GRANTED> message to the requesting MS. Both messages should indicate the permission to transmit has been re-awarded and should indicate the level of priority.

D.2.9 Call clearing

D.2.9.1 Mobile originated

Figure D.4 refers. The mobile originated call clearing procedure can be started by one of the MS sending an up-link <U-DISCONNECT> message. The SwMI should respond to this message by sending a down-link <D-RELEASE> message to that mobile and that mobile should be released from the call.



NOTE: The SwMI may start the CC-SS retention timer.

Figure D.4: Request to disconnect, direct or on/off hook signalling, message trunked system

The other MS should be informed of the call clearance by a <D-DISCONNECT> message. Its response may be one of the following:

1) the MS may respond by sending a <U-DISCONNECT ACKNOWLEDGE>. This should allow that mobile a time delay required for user interaction, such as the invoking of supplementary services. The MS should send a <U-RELEASE> when the user interaction has been completed and the mobile should be released;

2) the MS may respond by sending a <U-RELEASE> message. This should immediately release the mobile from the call.

Alternatively, the connected MS may be informed of the call clearance by a <D-RELEASE> message from the SwMI. This message should not be responded to.

D.2.9.2 SwMI originated

In the case where the SwMI cannot support a request for a call from the calling MS, the SwMI should send a <D-RELEASE> message, containing the reason for failure, to the calling MS.

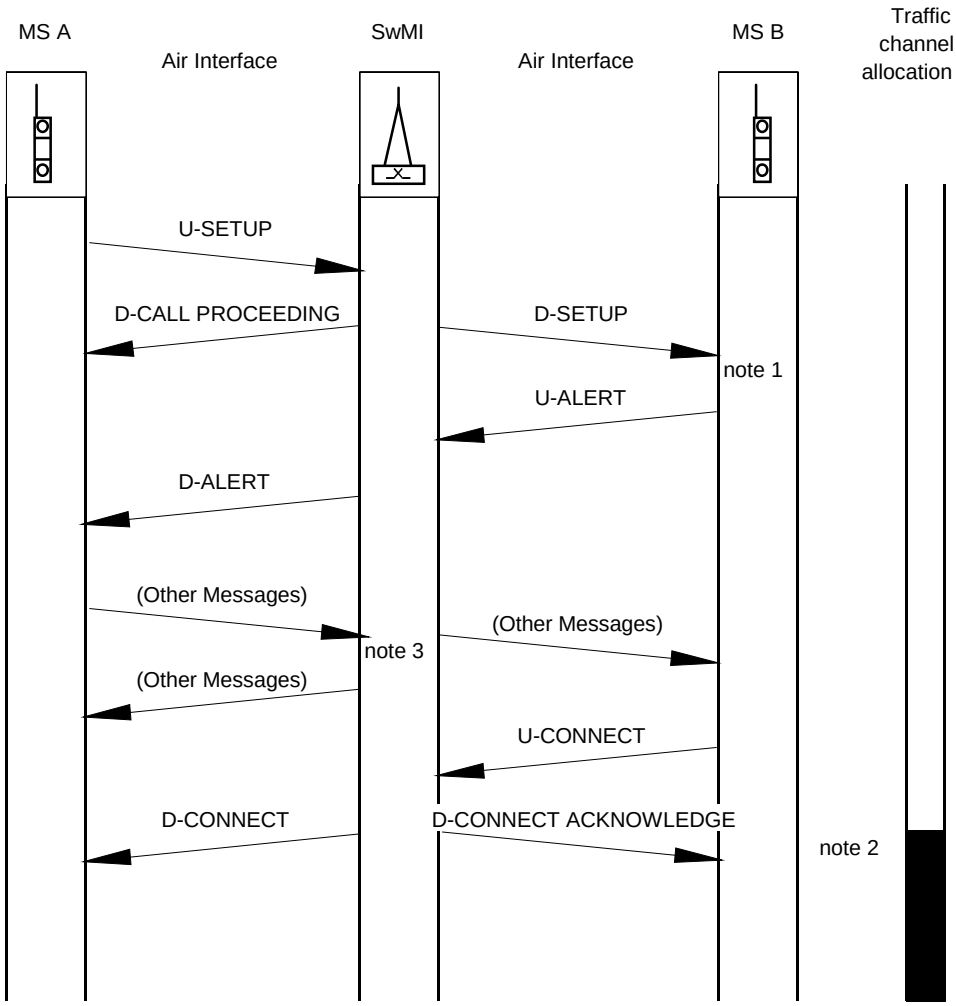
In the case where the SwMI can no longer support an established call, it should send a <D-RELEASE> message to the calling and called MSs containing the reason for disconnection, and should subsequently release the call.

D.3 Procedures - transmission trunked systems

D.3.1 Call set-up - on/off hook signalling

D.3.1.1 Call set-up - on/off hook signalling flow

Figure D.5 refers. The call set-up request can be started by an up-link message <U-SETUP> from the MS. The SwMI may acknowledge the call set-up request by sending a down-link message <D-CALL PROCEEDING> and to indicate that the call is being processed.



NOTE 1: The indication of on/off hook signalling is indicated in the D-SETUP message.
NOTE 2: Late assignment, i.e. the traffic channel is allocated when the called user has answered.
NOTE 3: Example of other signalling.

Figure D.5: Call set-up, on/off hook signalling, transmission trunked system

If following the receipt of a <U-SETUP> message, the SwMI determines that for some reason the call cannot be supported, then the SwMI should initiate call clearing as defined in clause D.3.9.

If the call can be supported, the SwMI should send a down-link message <D-SETUP> to the called MS to start the alerting process at the called mobile. It should be indicated to the called MS that on/off signalling is being used for this call. This message may be acknowledged by a <U-ALERT> to indicate that the called mobile has begun the alerting process.

Upon receiving an indication that the called party is alerting (<U-ALERT>), the SwMI should send a <D-ALERT> to the calling party.

When the called MS answers, a <U-CONNECT> message should be sent from the called MS to the SwMI.

Upon receipt of the <U-CONNECT> message the SwMI should send a <D-CONNECT> message to the calling MS and a <D-CONNECT ACKNOWLEDGE> to the called MS.

Communication can commence.

NOTE: As an implementation option the network may support intermediate signalling from the calling MS to the SwMI and visa versa during the call set-up phase, for the purposes of supplementary services et al. Similarly the network may support signalling to the called MS at this time.

D.3.1.2 Traffic assignment

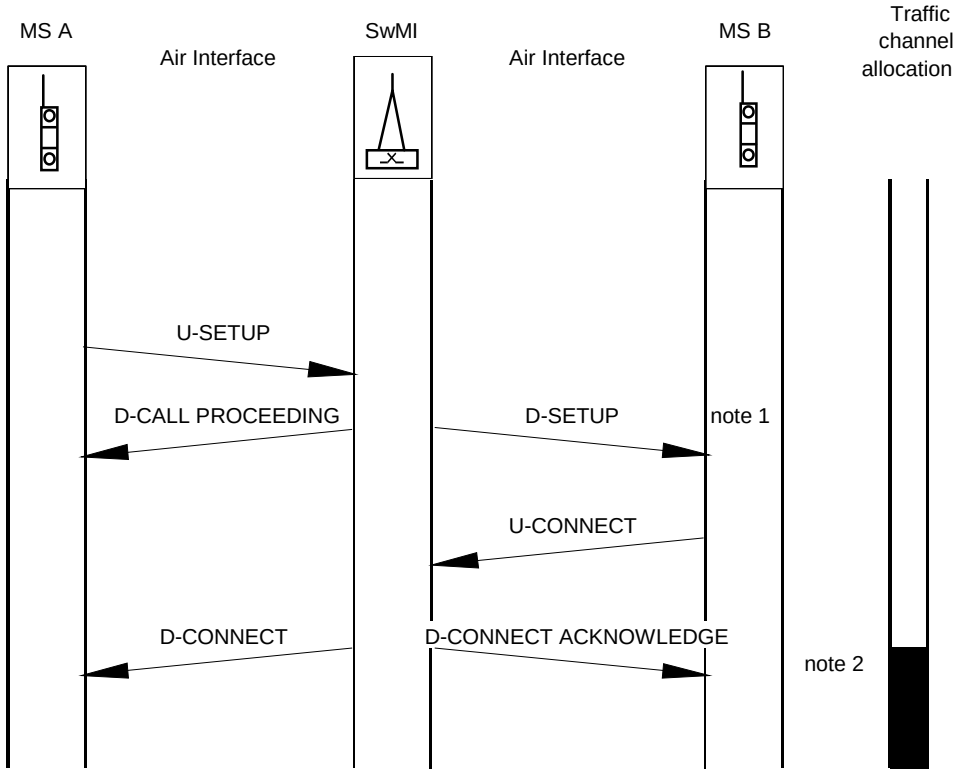
There should be one method for assigning a traffic channel:

1) **late assignment:** the traffic channels should not be assigned until the called MS sends a <U-CONNECT> message. Upon receipt of this message the traffic channels should be indicated to the calling and called MS along with the <D-CONNECT> and <D-CONNECT ACKNOWLEDGE> messages respectively, (contained in the lower layer part of those messages). In this case the calling MS should remain listening on the control channel until he is told to move to the traffic channel.

D.3.2 Call set-up - direct set-up signalling

D.3.2.1 Call set-up - direct set-up signalling flow

Figure D.6 refers. The call set-up request can be started by an up-link message <U-SETUP> from the MS. The SwMI may acknowledge the call set-up request by sending a down-link message <D-CALL PROCEEDING> and to indicate that the call is being processed.



NOTE 1: The request to send direct signalling is indicated in the D-SETUP message.
NOTE 2: Late assignment, i.e. the traffic channel is allocated when the called user has answered.

Figure D.6: Call set-up, direct set-up signalling, transmission trunked system

If following the receipt of a <U-SETUP> message, the SwMI determines that for some reason the call cannot be supported, then the SwMI should initiate call clearing as defined in clause D.3.9.

If the call can be supported, the SwMI should send a down-link message <D-SETUP> to the called MS and it should be indicated to the called MS that direct set-up signalling is being used. This message should acknowledged by a <U-CONNECT> to indicate that the called mobile is able to receive the call.

Upon receipt of the <U-CONNECT> message the SwMI should send a <D-CONNECT> message to the calling MS and a <D-CONNECT ACKNOWLEDGE> to the called MS.

Communication can commence.

D.3.2.2 Traffic channel assignment

There should be one method for assigning a traffic channel:

1) **late assignment:** the traffic channels should not assigned until the called MS sends a <U-CONNECT> message. Upon receipt of this message the traffic channels should be indicated to the calling and called MS in the <D-CONNECT> and <D-CONNECT ACKNOWLEDGE> messages respectively. In this case the calling MS should remain listening on the control channel until it is told to move to the traffic channel.

D.3.3 Request-to-transmit

The SwMI should be in full control over which MS is allowed to transmit because the MS should request permission to transmit, and permission should be granted before the MS can do so.

If on/off hook signalling is used, it should be normal system operation that the called MS should be given permission to transmit by default in the <D-SET-UP> message and late assignment may apply if appropriate. However, if desired, the calling MS can ask for permission to transmit in the <U-SETUP> message. The response to this request is dealt with in clause D.3.4, case (1).

If direct set-up signalling is used, it should be normal system operation that the calling MS should be given the permission to transmit. Traffic assignment is as previously discussed in clause D.3.2.1.

For both signalling methods, when the awarded mobile has finished transmitting it should send a <U-TX CEASED>. Figure D.7 refers.

Upon receipt of the <U-TX CEASED> message, the SwMI may send both MSs a <D-TX CEASED> message, the MSs should be cleared from the traffic channel and the SwMI can await further demands from the calling and called MSs. When either MS wishes to make a request to transmit, it should send a <U-TX DEMAND> message. The response to this request is dealt with in clause D.3.4, case (2).

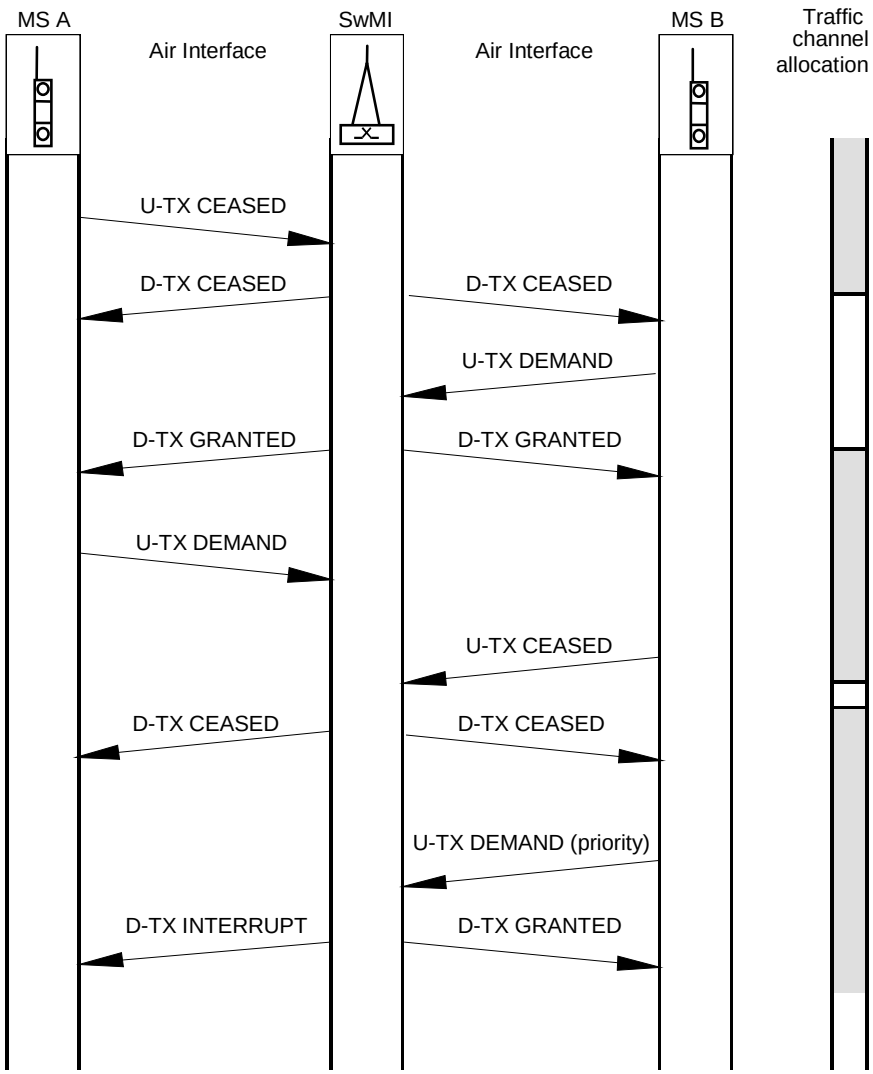


Figure D.7: Request to transmit, direct set-up or on/off hook signalling, transmission trunked system

D.3.4 Response to request-to-transmit

Case 1: if on/off hook signalling applies and the calling MS has asked for permission to transmit at the call set-up, the SwMI can award permission as appropriate and can respond to this request in the <D-CALL PROCEEDING> message. If permission is granted, then the SwMI should also inform the called MS in the <D-SET-UP> message that permission has not been granted to him.

Case 2: figure D.7 refers. During any call, a <U-TX DEMAND> message may be sent by either MS. If the other MS is not already transmitting then the SwMI response should be a <D-TX GRANTED> message sent to the awarded MS, and another <D-TX GRANTED> message sent to the other MS. The messages can be accompanied by the traffic channel allocation (contained in the lower layer parts). supplementary service information can also be appended to this message if appropriate.

If a <U-TX DEMAND> message is sent and the other MS is already transmitting, then the SwMI should wait for that party to finish the transmission, (identified by the receipt of a <U-TX CEASED> message). Subsequently the SwMI can send a <D-TX GRANTED> message to the awarded MS and another <D-TX GRANTED> message to the other MS. Priority requests are dealt with under clause D.3.8.

D.3.5 Permission to transmit withdrawn

The SwMI may decide to interrupt transmission when resources are required for another call or that the SwMI requires that the call should temporarily pause. In this case the SwMI should send a <D-TX WAIT> message to both mobiles. Permission to transmit should be withdrawn, or should not be given to a requesting mobile. The MSs should obey channel allocation and await further instructions on the channel that they have been directed to. The <D-TX WAIT> should:

- confirm to the MSs that the call is in a queue;
- indicate to the MSs that they should not send further requests-to-transmit.

If the request-to-transmit is granted but queued, the MS should be allowed to withdraw its request-to-transmit by means of the message <U-TX CEASED>.

D.3.6 Permission to continue with withdrawn call

When the SwMI has decided that the call can continue, the SwMI may send a <D-TX GRANTED> message to the awarded mobile and a <D-TX CONTINUE> message to the other mobile and the mobiles may be told to go to the traffic channel. If no mobiles have been given permission to transmit then they should be sent a <D-TX CONTINUE> message and should not be sent to the traffic channel. They are now free to make a request to the SwMI.

D.3.7 End of transmission

At the end of a transmission, the MS should send <U-TX CEASED>. The SwMI should send a <D-TX CEASED> to all concerned MSs to return them to the Control Channel. Figure D.6 refers.

D.3.8 Stop-transmission order

Figure D.7 refers. If, during the course of a transmission, a MS wishes to interrupt the transmitting MS with a higher priority request, a <U-TX DEMAND> message should be sent indicating the level of priority, the SwMI should send a <D-TX INTERRUPT> message to the transmitting MS and a <D-TX GRANTED> message to the requesting MS. Both messages should indicate the permission to transmit has been re-awarded and should indicate the level of priority. (If the SwMI wishes to change the traffic channel, then this instruction may also be appended to the <D-TX GRANTED> message).

D.3.9 Call clearing

D.3.9.1 Mobile originated

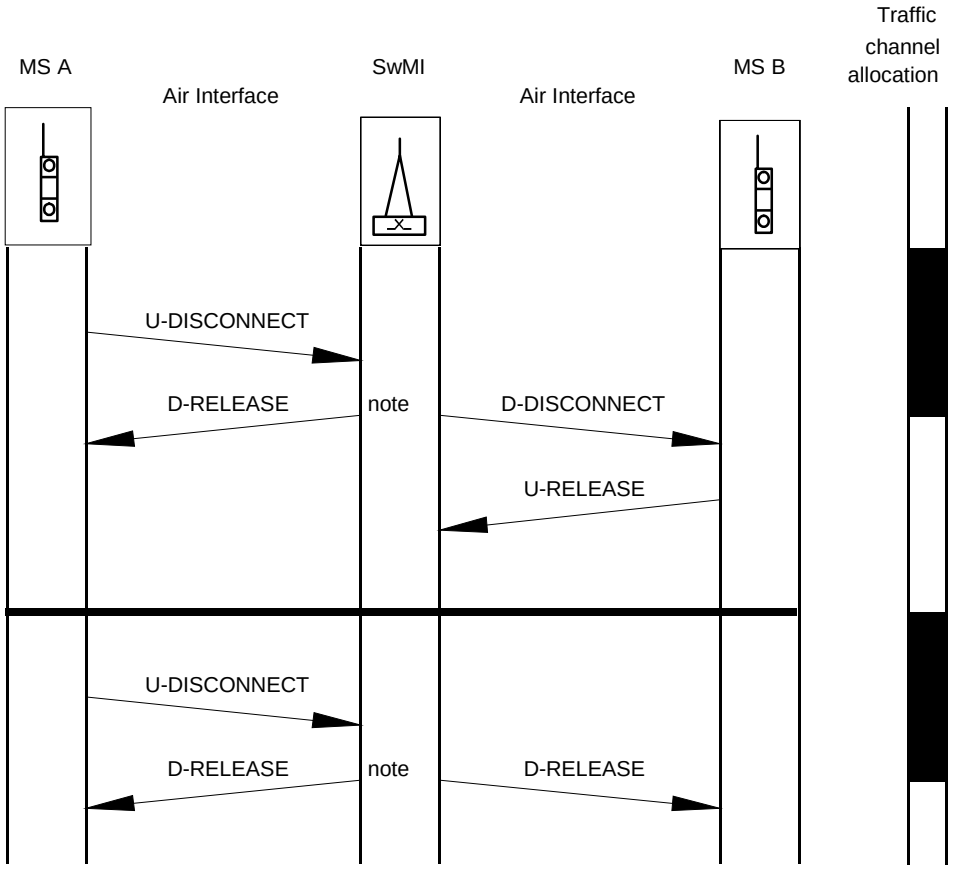
Figure D.8 refers. The mobile originated call clearing procedure can be started by one of the MS sending an up-link <U-DISCONNECT> message. The SwMI should respond to this message by sending a down-link <D-RELEASE> message to that mobile and that mobile should be released from the call.

The other MS is informed of the call clearance by a <D-DISCONNECT> message. Its response may be one of the following:

1) the MS may respond by sending a <U-DISCONNECT ACKNOWLEDGE>. This should allow that mobile a time delay required for user interaction, such as the invoking of supplementary services. The MS should send a <U-RELEASE> when the user interaction has been completed and the mobile should be released;

2) the MS may respond by sending a <U-RELEASE> message. This should immediately release the mobile from the call.

Alternatively, the connected MS may be informed of the call clearance by a <D-RELEASE> message from the SwMI. This message should not be responded to.



NOTE: The SwMI may start the CC-SS retention timer.

Figure D.8: Request to disconnect, direct set-up or on/off hook signalling, transmission trunked system

D.3.9.2 SwMI originated

In the case where the SwMI cannot support a request for a call from the calling MS, the SwMI should send a <D-RELEASE> message, containing the reason for failure, to the calling MS.

In the case where the SwMI can no longer support an established call, it should send a <D-RELEASE> message to the calling and called MSs containing the reason for disconnection, and should subsequently release the call.

D.4 Procedures - quasi-transmission trunked systems

D.4.1 Call set-up - on/off hook signalling

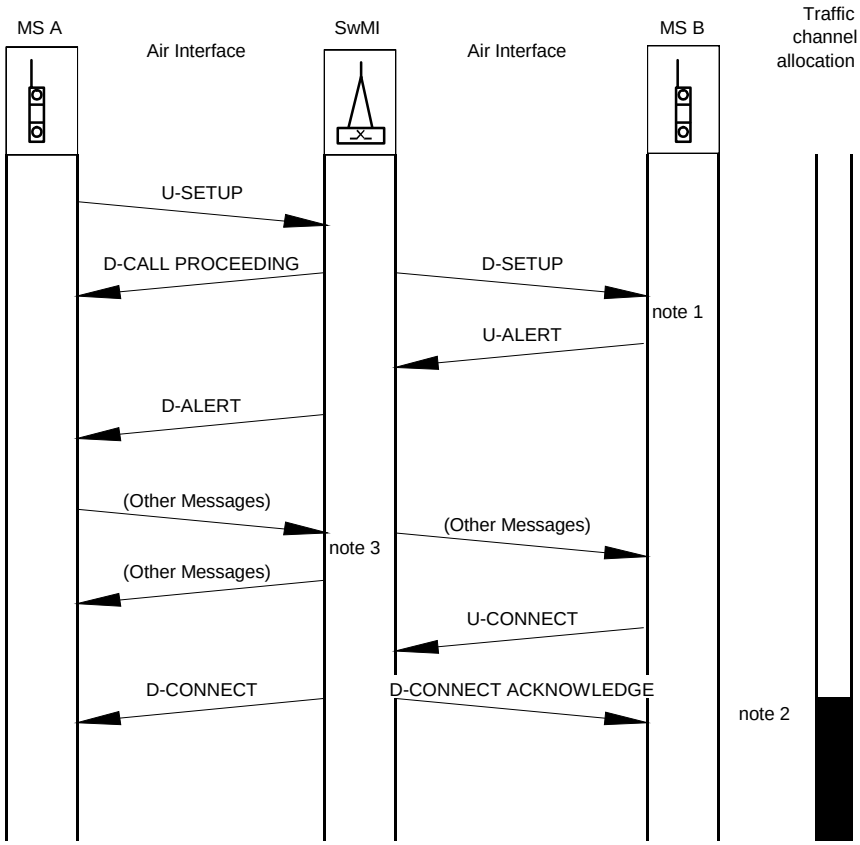
D.4.1.1 Call set-up - on/off hook signalling flow

Figure D.9 refers. The call set-up request can be started by an up-link message <U-SETUP> from the MS. The SwMI may acknowledge the call set-up request by sending a down-link message <D-CALL PROCEEDING> and to indicate that the call is being processed.

If following the receipt of a <U-SETUP> message, the SwMI determines that for some reason the call cannot be supported, then the SwMI should initiate call clearing as defined in clause D.4.9.

If the call can be supported, the SwMI should send a down-link message <D-SETUP> to the called MS to start the alerting process at the called mobile. It should be indicated to the called MS that on/off signalling is being used for this call. This message may be acknowledged by a <U-ALERT> to indicate that the called mobile has begun the alerting process.

Upon receiving an indication that the called party is alerting (<U-ALERT>), the SwMI should send a <D-ALERT> to the calling party.



NOTE 1: The indication of on/off hook signalling is indicated in the D-SETUP message.
NOTE 2: Late assignment, i.e. the traffic channel is allocated when the called user has answered.
NOTE 3: Example of other signalling.

Figure D.9: Call set-up, on/off hook signalling, quasi-transmission trunked system

When the called MS answers, a <U-CONNECT> message should be sent from the called MS to the SwMI.

Upon receipt of the <U-CONNECT> message the SwMI should send a <D-CONNECT> message to the calling MS and a <D-CONNECT ACKNOWLEDGE> to the called MS.

Communication can commence.

NOTE: As an implementation option the network may support intermediate signalling from the calling MS to the SwMI and visa versa between the <D-ALERT> message and the <D-CONNECT> message for the purposes of supplementary services et al. Similarly the network may support signalling to the called MS at this time.

D.4.1.2 Traffic assignment

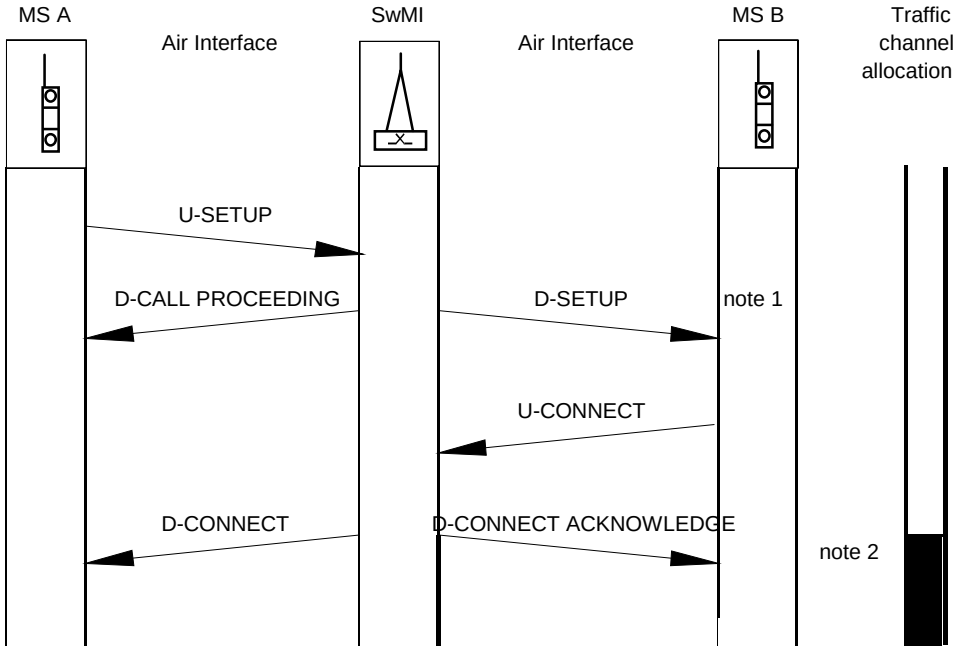
There should be one method for assigning a traffic channel:

1) **late assignment:** the traffic channels should not be assigned until the called MS sends a <U-CONNECT> message. Upon receipt of this message the traffic channels should be indicated to the calling and called MS along with the <D-CONNECT> and <D-CONNECT ACKNOWLEDGE> messages respectively, (contained in the lower layer part of those messages). In this case the calling MS remains listening on the control channel until he is told to move to the traffic channel.

D.4.2 Call set-up - direct set-up signalling

D.4.2.1 Call set-up - direct set-up signalling flow

Figure D.10 refers. The call set-up request can be started by an up-link message <U-SETUP> from the MS. The SwMI may acknowledge the call set-up request by sending a down-link message <D-CALL PROCEEDING> and to indicate that the call is being processed.



NOTE 1: The request to send direct signalling is indicated in the D-SETUP message.
NOTE 2: Late assignment, i.e. the traffic channel is allocated when the called user has answered.

Figure D.10: Call set-up, direct set-up signalling, quasi-transmission trunked system

If following the receipt of a <U-SETUP> message, the SwMI determines that for some reason the call cannot be supported, then the SwMI should initiate call clearing as defined in clause D.4.9.

If the call can be supported, the SwMI should send a down-link message <D-SETUP> to the called MS and it should be indicated to the called MS that direct set-up signalling is being used. This message should be acknowledged by a <U-CONNECT> to indicate that the called mobile is able to receive the call.

Upon receipt of the <U-CONNECT> message the SwMI should send a <D-CONNECT> message to the calling MS and a <D-CONNECT ACKNOWLEDGE> to the called MS.

Communication can commence.

D.4.2.2 Traffic assignment

There should be one method for assigning a traffic channel:

1) **late assignment:** the traffic channels should not be assigned until the called MS sends a <U-CONNECT> message. Upon receipt of this message the traffic channels should be indicated to the calling and called MS along with the <D-CONNECT> and <D-CONNECT ACKNOWLEDGE> messages respectively, (contained in the lower layer part of those messages). In this case the calling MS should remain listening on the control channel until he is told to move to the traffic channel.

D.4.3 Request-to-transmit

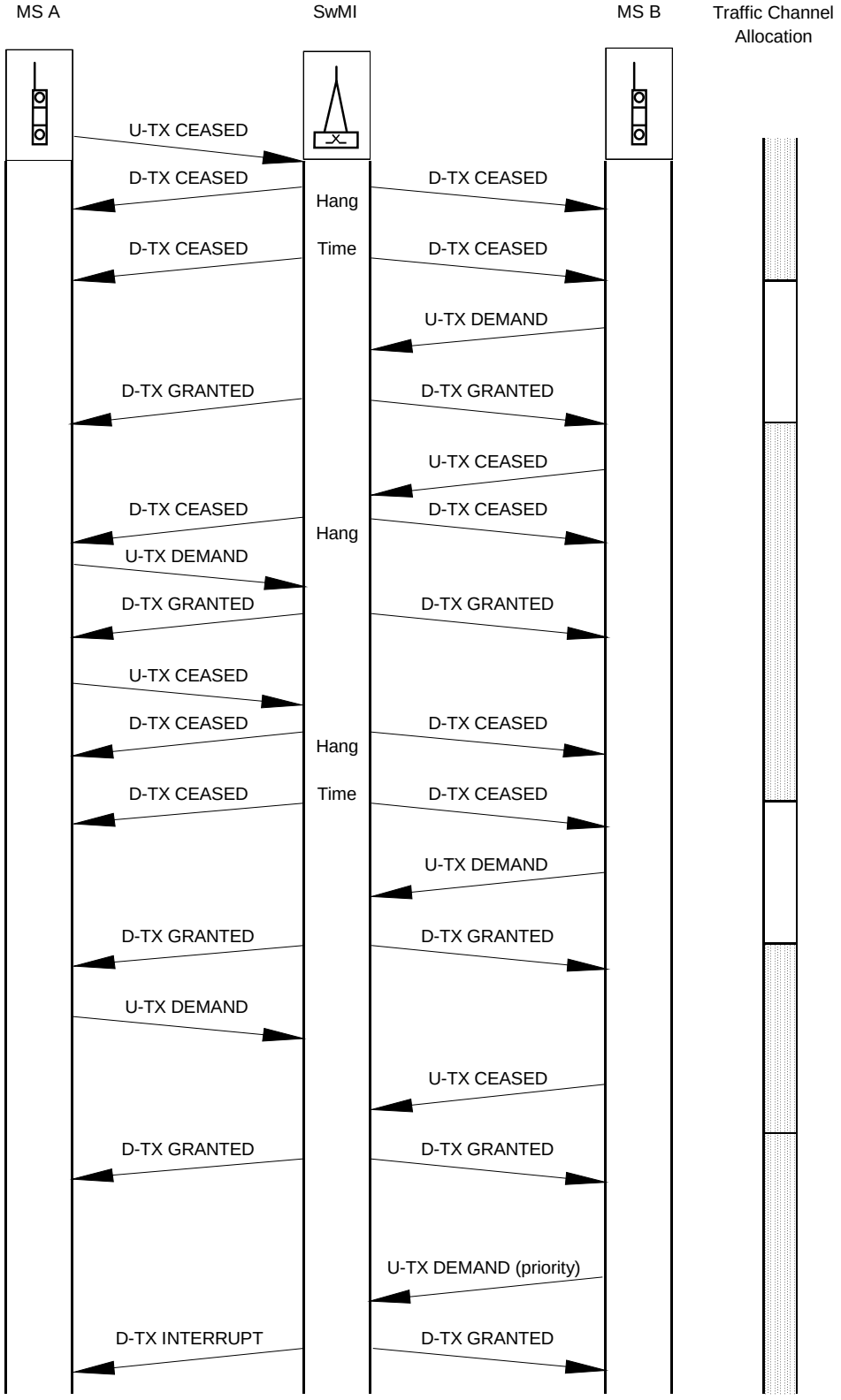


Figure D.11: Request to transmit, direct set-up or on/off hook signalling, quasi-transmission trunked system

The SwMI should be in full control over which MS is allowed to transmit because the MS should request permission to transmit, and permission should be granted before the MS can do so.

If on/off hook signalling is used, it should be normal system operation that the called MS should be given permission to transmit by default in the <D-SET-UP> message and early, medium or late assignment should apply as appropriate. However, if desired, the calling MS can ask for permission to transmit in the <U-SETUP> message. The response to this request is dealt with in clause D.4.4, case 1.

If direct set-up signalling is used, it should be normal system operation that the calling MS should be given the permission to transmit. Traffic assignment should as previously discussed in clause D.4.2.1.

For both signalling methods, when the awarded mobile has finished transmitting it should send a <U-TX CEASED>. Figure D.11 refers.

Upon receipt of the <U-TX CEASED> message, the SwMI should start a timer (hang time) and should send the receiving MS a <D-TX CEASED> to inform that the transmission from the other MS has now ceased. After expiry of the timer, and no MSs have sent any messages, the SwMI should send both mobiles the <D-TX CEASED> message which informs both mobiles to leave the traffic channel and that they are able to request permission to transmit. Any MS may explicitly request for permission to transmit by sending a <U-TX DEMAND> message. The response to this request should be determined by whether the Timer has expired or not and is dealt with in clause D.4.4, case 2.

If the hang-time is infinite the TETRA may become message trunked.

D.4.4 Response to request-to-transmit

Case 1: if on/off hook signalling applies and the calling MS has asked for permission to transmit at the call set-up, the SwMI can award permission as appropriate and should respond to this request in the <D-CALL PROCEEDING> message. If permission is granted, then the SwMI should also inform the called MS in the <D-SET-UP> message that permission has not been granted to him.

Case 2: figure D.11 refers. During any call, a <U-TX DEMAND> message may be sent by either MS. If the other MS is not already transmitting and the timer has expired, then the SwMI response should be a <D-TX GRANTED> message sent to the awarded MS, and another <D-TX GRANTED> message sent to the other MS. The messages should contain the traffic channel assignment. Supplementary service information can also be appended to this message if appropriate.

If a <U-TX DEMAND> message is sent when no MS is transmitting but the hang timer has not expired, then the SwMI response may be a <D-TX GRANTED> message sent to the awarded MS and another <D-TX GRANTED> message to the other MS. The MSs are assumed to be still on the traffic channel and a new assignment need not be given.

If a <U-TX DEMAND> message is sent and the other MS is already transmitting, then the SwMI should wait for that party to finish the transmission, (identified by the receipt of a <U-TX CEASED> message). Subsequently the SwMI should send a <D-TX GRANTED> message to the awarded MS and another <D-TX GRANTED> message to the other MS. The MSs are assumed to be still on the traffic channel and a new assignment need not be given. Priority requests are dealt with under clause D.4.8.

D.4.5 Permission to transmit withdrawn

The SwMI may decide to interrupt transmission when resources are required for another call or that the SwMI requires that the call should temporarily pause. In this case the SwMI should send a <D-TX WAIT> message to both mobiles. Permission to transmit should be withdrawn, or should not be given to a requesting mobile. The MSs should obey channel allocation and await further instructions on the channel that they have been directed to. The use of this message is optional. Figure D.11 refers. The <D-TX WAIT> should:

- confirm to the MSs that the call is in a queue;
- indicate to the MSs that they should not send further requests-to-transmit.

If the request-to-transmit is granted but queued, the MS is allowed to withdraw its request-to-transmit by means of the message <U-TX CEASED>.

D.4.6 Permission to continue with withdrawn call

When the SwMI has decided that the call can continue, the SwMI may send a <D-TX GRANTED> message to the awarded mobile and a <D-TX CONTINUE> message to the other mobile and the mobiles may be told to go to the traffic channel. If no mobiles have been given permission to transmit then they should be sent a <D-TX CONTINUE> message and are free to make a request to the SwMI.

D.4.7 End of transmission request

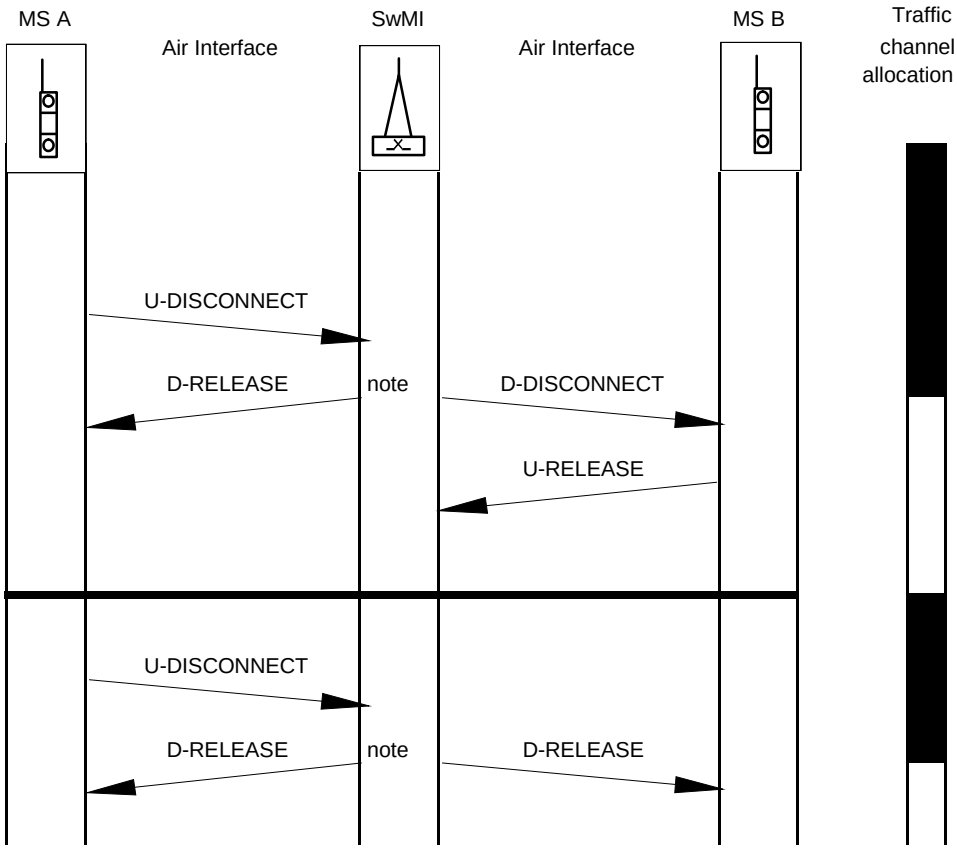
At the end of a transmission, the MS should send <U-TX CEASED> and should listen to the traffic channel. Upon receipt of the <U-TX CEASED> message, the SwMI should start a timer (hang time) and should send a <D-TX CEASED> message to the other MS to indicate that the transmission has ceased. After expiry of the timer, and no MSs have sent any messages, the SwMI should send both mobiles the <D-INFO> message which should inform both mobiles to leave the traffic channel and go to the control channel. Figure D.11 refers.

D.4.8 Stop-transmission order

If, during the course of a transmission, the other mobile wishes to interrupt the transmitting mobile with a higher priority request and sends a <U-TX DEMAND> message indicating the level of priority, the SwMI should send a <D-TX CEASED> message to both mobiles followed by a <D-TX GRANTED> message to both mobiles re-awarding permission to the requesting mobile and indicating the level of priority to both mobiles.

D.4.9 Call clearing

D.4.9.1 Mobile originated



NOTE: The SwMI may start the CC-SS retention timer.

Figure D.12: Request to disconnect, quasi-transmission trunked system

Figure D.12 refers. The mobile originated call clearing procedure can be started by one of the MS sending an up-link <U-DISCONNECT> message. The SwMI should respond to this message by sending a down-link <D-RELEASE> message to that mobile and that mobile should be released from the call.

The other MS should be informed of the call clearance by a <D-DISCONNECT> message. Its response may be one of the following:

1) the MS may respond by sending a <U-DISCONNECT ACKNOWLEDGE>. This should allow that mobile a time delay required for user interaction, such as the invoking of supplementary services. The MS should send a <U-RELEASE> when the user interaction has been completed and the mobile should be released;

2) the MS may respond by sending a <U-RELEASE> message. This should immediately release the mobile from the call.

Alternatively, the connected MS may be informed of the call clearance by a <D-RELEASE> message from the SwMI. This message should not be responded to.

D.4.9.2 SwMI originated

In the case where the SwMI cannot support a request for a call from the calling MS, the SwMI should send a <D-RELEASE> message, containing the reason for failure, to the calling MS.

In the case where the SwMI can no longer support an established call, it should send a <D-RELEASE> message to the calling and called MSs containing the reason for disconnection, and should subsequently release the call.

Annex E (informative): Group voice call scenarios

E.1 Procedures for message trunked systems

E.1.1 General

All group calls are considered as employing only direct set-up signalling procedures. This procedure allows immediate communication to take place between the calling and called users without the necessity of having an alerting process and without an explicit response from the called user that he has answered. The called users normally go straight to the traffic channel.

For acknowledged group calls, it is an operator option if the call is to proceed immediately by giving the originator permission to transmit. Alternatively, the operator may choose to poll the MS on the traffic channel and act according upon the receipt of a response from the polled MS.

NOTE 1: This procedure is known as presence checking.

According to a predefined criteria the call may be allowed to proceed.

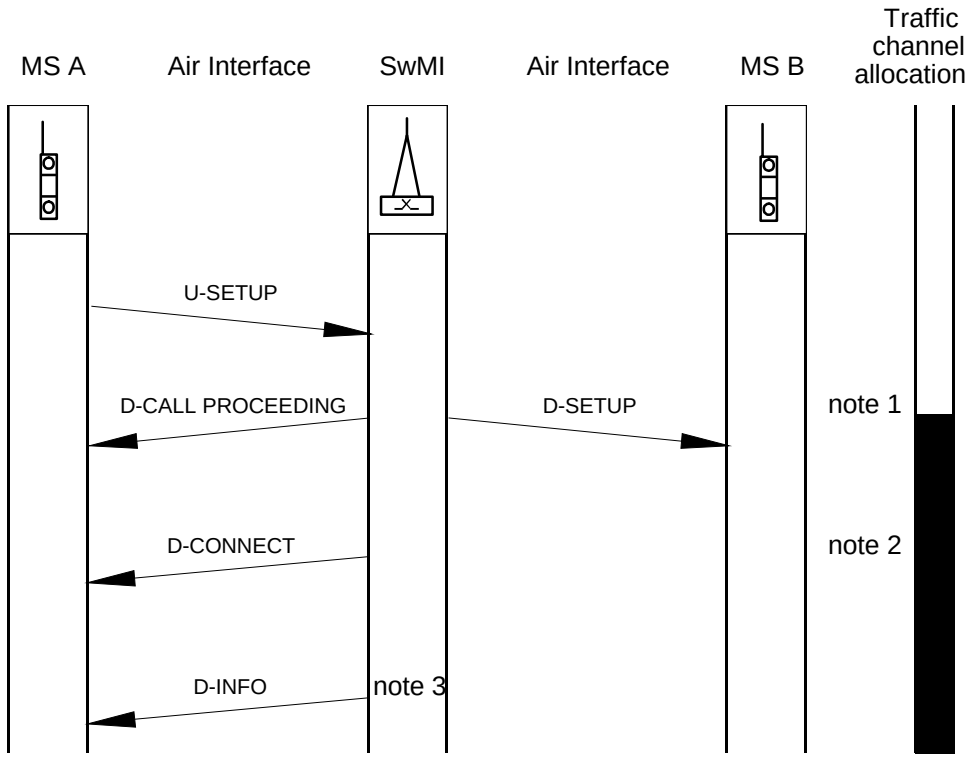
It is an operator option to disconnect the call if insufficient members are present, and the right to transmit has not yet been given.

It is an operator option to continue with presence checking beyond the point where the originator has been given permission to transmit.

NOTE 2: For clarity, the time sequence diagrams in this clause only show two participating members of the group call.

E.1.2 Call set-up

E.1.2.1 Call set-up flow



NOTE 1: Early assignment, i.e. the calling MS and the called MS may be sent to the traffic channel at this stage.
NOTE 2: Late assignment, i.e. the calling MS may be sent to the traffic channel at this stage.
NOTE 3: For acknowledged group calls, the presence of the members of the group may be indicated here.

Figure E.1: Call set-up phase for a group call in a message trunked system

The call set-up request is started by an up-link message <U-SETUP> from the MS. The SwMI may optionally acknowledge the call set-up request by sending a down-link message <D-CALL PROCEEDING> to indicate that the call is being processed, (see figure E.1).

If, following the receipt of a <U-SETUP> message, the SwMI determines that for some reason the call cannot be supported, then the SwMI initiates call clearing as defined in clause E.1.9.

If the call can be supported, the SwMI sends a down-link message(s) <D-SETUP> to the called MS.

During, or as an option upon completion of, the transmission of the <D-SETUP> message, the SwMI may send a <D-CONNECT> message to the calling MS.

On completion of this procedure communication can commence.

The option depends upon whether the group call is an acknowledged one. If it is acknowledged, the SwMI may delay the transmission of the <D-CONNECT> message to the calling MS, and wait for acknowledgements from the called MS before proceeding. If at this stage the SwMI decides that the call cannot be supported it initiates call clearing as defined in clause E.1.9.

If the group call is acknowledged, the call owner may be informed of the presence of the other members of the group in the <D-INFO> message.

E.1.2.2 Traffic channel assignment

For the called MS, the traffic channel assignment is always given in the <D-SET-UP> message.

There are two methods for assigning a traffic channel to the calling MS:

1) early assignment: the traffic channel is assigned and indicated to the calling MS along with the <D-CALL PROCEEDING>, (contained in the lower layer part of that message). In this case the calling MS moves immediately to the channel that has been made available as the future traffic channel, and receives all further call control messages on this channel in anticipation of the call; or

2) late assignment: the traffic channel is not assigned until appropriate conditions are met.

NOTE: These conditions may be as a result of the finite time required to locate group members, or as a result of the call being acknowledged. In this case the calling MS remains listening on the control channel (or other if instructed by the SwMI), until it is told to move to the traffic channel. The traffic channel is indicated to the calling MS along with the <D-CONNECT> message, (contained in the lower layer part of that message).

E.1.3 Request-to-transmit

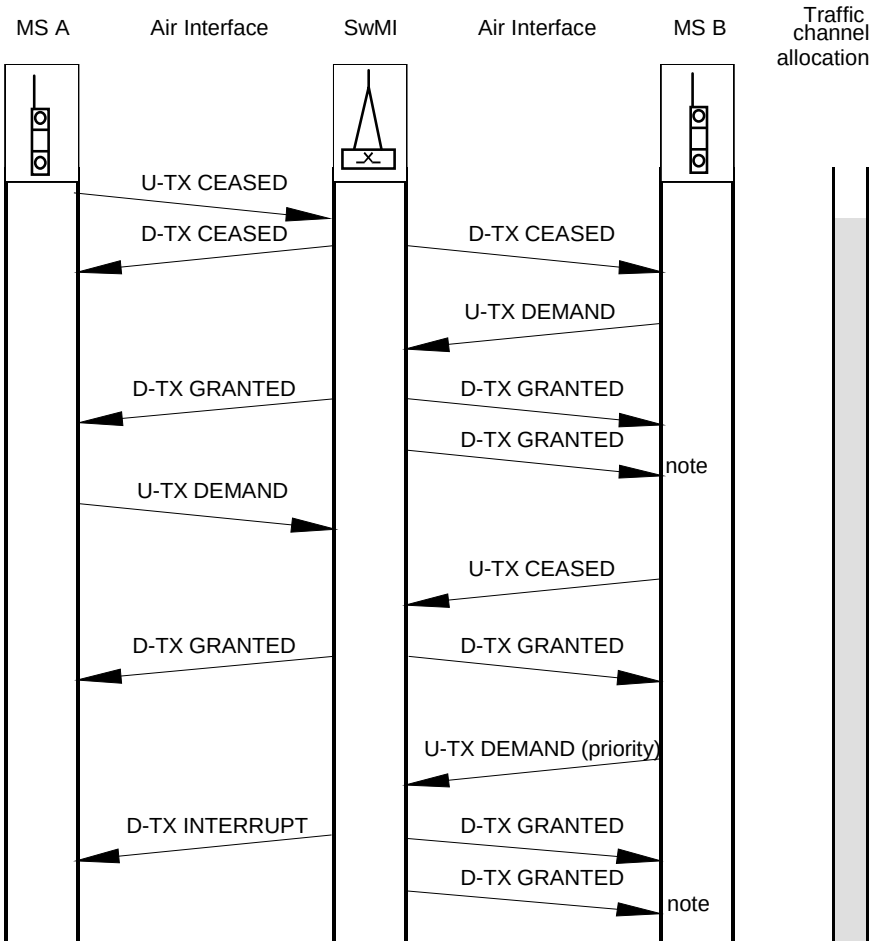
The SwMI is in full control over which MS is allowed to transmit because the MS is obliged to request permission to transmit, and the MS can only do so if permission has been granted.

The SwMI is in full control over which MS is allowed to transmit because the MS is obliged to request permission to transmit, and permission must be granted before the MS can do so.

It is normal system operation that the calling MS will be given the permission to transmit immediately upon call set-up. Traffic channel assignment is as previously discussed in clause E.1.2.

When the awarded MS has finished the communication it sends a <U-TX CEASED>, (see figure E.2).

Upon receipt of the <U-TX CEASED> message, the SwMI sends a <D-TX CEASED> message to the "receiving" MS to inform them that the transmission has now ceased. The SwMI awaits further demands from the calling and called MS. When any MS wishes to make a request to transmit, it sends a <U-TX DEMAND> message. The response to this request is dealt with in clause E.1.4.



NOTE: D-TX granted is sent to the remaining members of the group upon awarding permission to MS B.

Figure E.2: Request to transmit for a group call in a message trunked system

E.1.4 Response to request-to-transmit

During any call, a <U-TX DEMAND> message may be sent by any MS. If any other MS is not already transmitting, then the SwMI may response with a <D-TX GRANTED> message sent to the awarded MS addressed by his Individual TETRA Subscriber Identity (ITSI), and a D-<INFO> sent to the remaining MS addressed by the Group TETRA Subscriber Identity (GTSI), (see figure E.2).

If a <U-TX DEMAND> message is sent and another MS is already transmitting, then the SwMI sends <D-TX GRANTED> with "transmission request queued" and waits for that MS to finish its transmission, (identified by the receipt of a <U-TX CEASED> message). Subsequently the SwMI sends a <D-TX GRANTED> message to the requesting MS addressed by his ITSI, awarding permission to transmit, and another <D-TX GRANTED> message to the remaining MS, addressed by the GTSI. Priority requests are dealt with under clause E.1.8.

E.1.5 Permission to transmit withdrawn

The SwMI may decide to interrupt transmission when resources are required for another call or that the SwMI requires that the call should temporarily pause. In this case the SwMI sends a <D-TX WAIT> message to all MS. Permission to transmit is be withdrawn, or is not given to a requesting MS. The MS should obey channel allocation and await further instructions on the channel that they have been directed to. The <D-TX WAIT> will:

- confirm to the MS that the call is in a queue;
- indicate to the MS that they may not send further requests-to-transmit.

If the request-to-transmit is granted but queued, the MS is allowed to withdraw its request-to-transmit by means of the message <U-TX CEASED>.

E.1.6 Permission to continue with withdrawn call

When the SwMI has decided that the call can continue, the SwMI sends a <D-TX GRANTED> message to the awarded MS, addressed by his ITSI, and a <D-TX CONTINUE> message to all remaining MS, addressed by the GTSI. The MS are told to go to the traffic channel.

If no MS have been given permission to transmit then they are sent a <D-TX CONTINUE> message and are free to make a request to the SwMI.

E.1.7 End of transmission

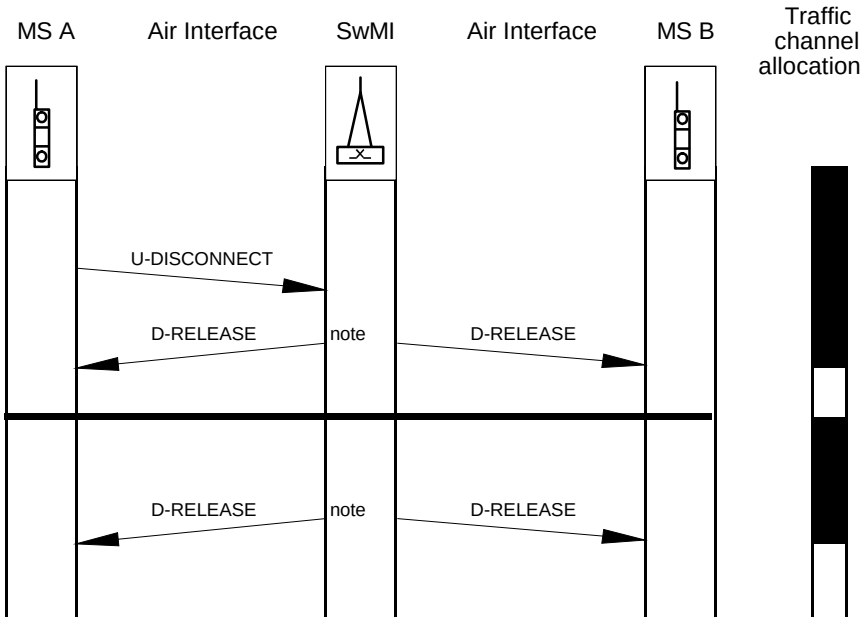
At the end of a communication, the MS sends <U-TX CEASED> and listens to the traffic channel, (see figure E.2). The SwMI sends <D-TX CEASED> to all participants addressed by the GTSI to inform them that the transmission has now ceased.

E.1.8 Stop-transmission order

If, during the course of a transmission, a MS wishes to interrupt the transmitting MS with a higher priority request, a <U-TX DEMAND> message is sent indicating the level of priority, the SwMI sends a <D-TX INTERRUPT> message to the transmitting MS addressed by his ITSI, a <D-TX GRANTED> message to the awarded MS, addressed by his ITSI and another <D-TX GRANTED> message to all other MS, addressed by the GTSI. All messages indicate that the permission to transmit has been re-awarded and should indicate the level of priority, (see figure E.2).

E.1.9 Call clearing

E.1.9.1 Mobile originated



NOTE: The SwMI may start the CC-SS retention timer.

Figure E.3: Call clearing for a group call in a message trunked system

The call owner may disconnect the call at any stage of the call, (see figure E.3). Only the call owner can complete this operation. The MS originated call clearing procedure is started by the call owner sending an up-link <U-DISCONNECT> message. The SwMI responds to this message by sending a down-link <D-RELEASE> message to all MS and they are released from the call.

E.1.9.2 SwMI originated

In the case where the SwMI cannot support a request for a call from the calling MS, the SwMI sends a <D-RELEASE> message, containing the reason for failure, to the calling MS.

In the case where the SwMI can no longer support an established call, it sends a <D-RELEASE> message to all MS, containing the reason for disconnection, and subsequently releases the call.

E.2 Procedures for transmission trunked systems

E.2.1 General

All group calls are considered as employing only direct set-up signalling procedures. This procedure allows immediate communication to take place between the calling and called users without the necessity of having an alerting process and without an explicit response from the called user that he has answered. The called users normally go straight to the traffic channel.

For acknowledged group calls, it is an operator option if the call is to proceed immediately by giving the originator permission to transmit. Alternatively, the operator may choose to poll the MS on the traffic channel and act according upon the response from the polled MS.

NOTE 1: This procedure is known as presence checking.

According to a predefined criteria the call may be allowed to proceed.

It is an operator option to disconnect the call if insufficient members are present, and the right to transmit has not yet been given.

It is an operator option to continue with presence checking beyond the point where the originator has been given permission to transmit.

NOTE 2: For clarity, the time sequence diagrams in this clause only show two participating members of the group call.

E.2.2 Call set-up

E.2.2.1 Call set-up flow

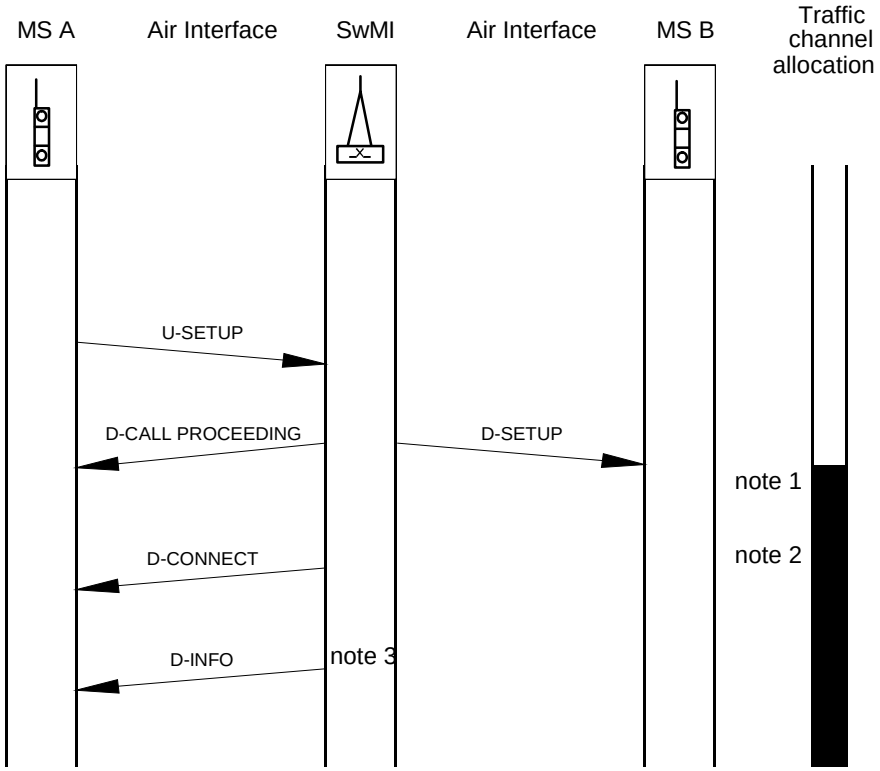
The call set-up request is started by an up-link message <U-SETUP> from the MS. The SwMI may optionally acknowledge the call set-up request by sending a down-link message <D-CALL PROCEEDING> and to indicate that the call is being processed, (see figure E.4).

If following the receipt of a <U-SETUP> message, the SwMI determines that for some reason the call cannot be supported, then the SwMI may initiate call clearing as defined in clause E.1.9.

If the call can be supported, the SwMI sends a down-link message <D-SETUP> to the called MS.

During, or as an option upon completion of, the transmission of the <D-SETUP> message, the SwMI sends a <D-CONNECT> message to the calling MS.

On completion of this procedure communication can commence.



NOTE 1: Late assignment, i.e. the called MS is sent to the traffic channel at this stage.
NOTE 2: The calling MS is sent to the traffic channel at this stage.
NOTE 3: For acknowledged group calls, the presence of the members of the group may be indicated here.

Figure E.4: Call set-up phase for a group call in a transmission trunked system

The option depends upon whether the group call is an acknowledged one. If it is acknowledged, the SwMI may delay the transmission of the <D-CONNECT> message to the calling MS, and wait for acknowledgements from the called MS before proceeding. If at this stage the SwMI decides that the call cannot be supported it may initiate call clearing as defined in clause E.1.9.

If the group call is acknowledged, the call owner may be informed of the presence of the other members of the group in the <D-INFO> message.

E.2.2.2 Traffic channel assignment

For the called MS, the traffic channel assignment is given in the <D-SET-UP> message.

There is one method for assigning a traffic channel to the calling MS:

- late assignment: the traffic channel is not assigned until appropriate conditions are met. (These conditions may be as a result of the finite time required to locate group members, or as a result of the call being acknowledged.) The traffic channel is indicated to the calling MS along with the <D-CONNECT> message, (contained in the lower layer part of that message). In this case the calling MS remains listening on the control channel (or other channel if instructed by the SwMI) until he is told to move to the traffic channel.

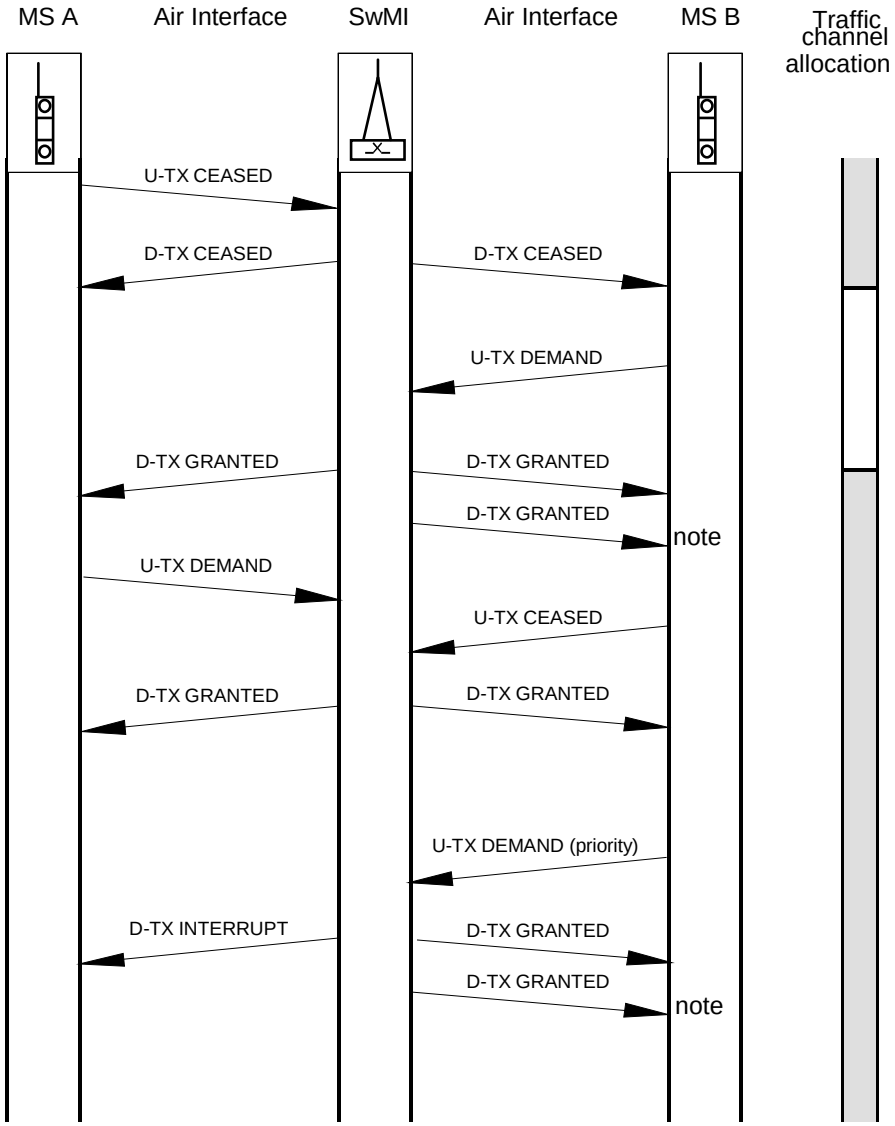
E.2.3 Request-to-transmit

The SwMI is in full control over which MS is allowed to transmit because the MS is obliged to request permission to transmit, and permission must be granted before the MS can do so.

It is normal system operation that the calling MS is given the permission to transmit immediately upon call set-up. Traffic channel assignment is as previously discussed in clause E.2.2.1.

When the awarded MS has finished the communication it sends a <U-TX CEASED>, (see figure E.5).

Upon receipt of the <U-TX CEASED> message, the SwMI sends all MS a <D-TX CEASED> message, the MS obey channel allocation and the SwMI awaits further demands from the calling and called MS. When any MS wishes to make a request to transmit, it sends a <U-TX DEMAND> message. The response to this request is dealt with in clause E.2.4.



NOTE: D-TX granted is sent to the remaining members of the group upon awarding permission to MS E.

Figure E.5: Request to transmit for a group call in a transmission trunked system

E.2.4 Response to request-to-transmit

During any call, a <U-TX DEMAND> message may be sent by any MS. If any other MS is not already transmitting, then the SwMI response should be a <D-TX GRANTED> message sent to the awarded MS addressed by his ITSI and another <D-TX GRANTED> message sent to the remaining MS addressed by the GTSI. The message may be accompanied by the traffic channel allocation (contained in the lower layer parts). Supplementary service information may also be appended to these messages if appropriate (see figure E.5).

If a <U-TX DEMAND> message is sent and another MS is already transmitting, then the SwMI should wait for that party to finish the transmission, (identified by the receipt of a <U-TX CEASED> message). Subsequently the SwMI sends a <D-TX GRANTED> message to the requesting MS, addressed by his ITSI, awarding permission to transmit to him and another <D-TX GRANTED> message to the remaining MS, addressed by the GTSI. (If the SwMI wishes to change the traffic channel, then this instruction may also be appended to the <D-TX GRANTED> and <D-TX GRANTED> messages.) Priority requests are dealt with in clause E.2.8.

E.2.5 Permission to transmit withdrawn

The SwMI may decide to interrupt transmission when resources are required for another call or that the SwMI requires that the call should temporarily pause. In this case the SwMI sends a <D-TX WAIT> message to all MS. Permission to transmit is withdrawn, or is not given to a requesting MS. The MS should obey channel allocation and await further instructions on the channel that they have been directed to.

If the request-to-transmit is granted but queued, the MS is allowed to withdraw its request-to-transmit by means of the message <U-TX CEASED>. The <D-TX WAIT> will:

- confirm to the MS that the call is in a queue;
- indicate to the MS that they may not send further requests-to-transmit.

E.2.6 Permission to continue with withdrawn call

When the SwMI has decided that the call can continue, the SwMI sends a <D-TX GRANTED> message to the awarded MS, addressed by his ITSI, and a <D-TX CONTINUE> message to all remaining MS addressed by the GTSI. The MS are then told to go to the traffic channel.

On the other hand, if no MS have been given permission to transmit then they may be sent a <D-TX CONTINUE> message and are not sent to the traffic channel. They are free to make a request to the SwMI.

E.2.7 End of transmission

At the end of a transmission, the MS sends <U-TX CEASED>. The SwMI sends a <D-TX CEASED> to all MSs to return them to the control channel, (unless another MS has asked for permission to transmit, see clauses E.2.4 and E.5).

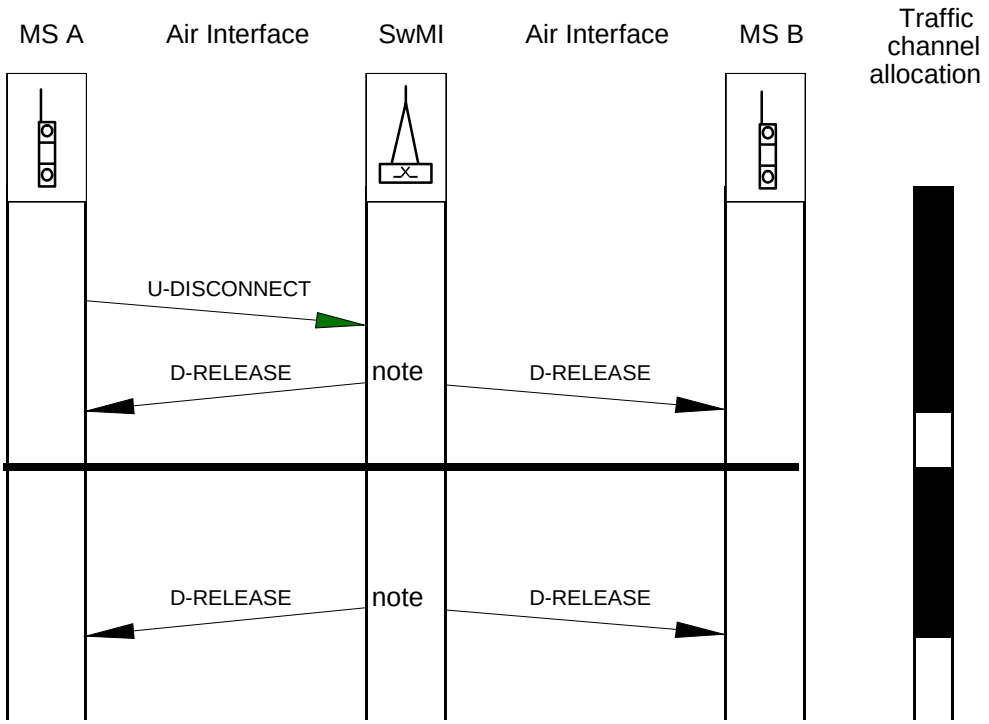
E.2.8 Stop-transmission order

If, during the course of a transmission, a MS wishes to interrupt the transmitting MS with a higher priority request, a <U-TX DEMAND> message is sent indicating the level of priority, the SwMI sends a <D-TX INTERRUPT> message to the transmitting MS addressed by his ITSI, a <D-TX GRANTED> message to the awarded MS, addressed by his ITSI and another <D-TX GRANTED> message to all other MS, addressed by the GTSI. All messages indicate that the permission to transmit has been re-awarded and indicate the level of priority. (If the SwMI wishes to change the traffic channel, then this instruction may also be appended to the <D-TX GRANTED>, <D-TX INTERRUPT> and <D-TX GRANTED> messages), (see figure E.5).

E.2.9 Call clearing

E.2.9.1 Mobile originated

The call owner may disconnect the call at any stage of the call, (see figure E.6). Only the call owner can complete this operation. The MS originated call clearing procedure is started by the call owner sending an up-link <U-DISCONNECT> message. The SwMI may respond to this message by sending a down-link <D-RELEASE> message to all MS and they are released from the call.



NOTE: The SwMI may start the CC-SS retention timer.

Figure E.6: Call clearing for a group call in a transmission trunked system

E.2.9.2 SwMI originated

In the case where the SwMI cannot support a request for a call from the calling MS, the SwMI may send a <D-RELEASE> message, containing the reason for failure, to the calling MS.

In the case where the SwMI can no longer support an established call, it may send a <D-RELEASE> message to all MS, containing the reason for disconnection, and subsequently release the call.

E.3 Procedures for quasi-transmission trunked systems

E.3.1 General

All group calls are considered as employing only direct set-up signalling procedures. This procedure allows immediate communication to take place between the calling and called users without the necessity of having an alerting process and without an explicit response from the called user that he has answered. The called users normally go straight to the traffic channel.

For acknowledged group calls, it is an operator option if the call is to proceed immediately by giving the originator permission to transmit. Alternatively, the operator may choose to poll the MS on the traffic channel and act according upon the receipt of a response form the polled MS.

NOTE 1: This procedure is known as presence checking.

According to a predefined criteria the call may be allowed to proceed.

It is an operator option to disconnect the call if insufficient members are present, and the right to transmit has not yet been given.

It is an operator option to continue with presence checking beyond the point where the originator has been given permission to transmit.

NOTE 2: For clarity, the time sequence diagrams in this clause only show two participating members of the group call.

E.3.2 Call set-up

E.3.2.1 Call set-up flow

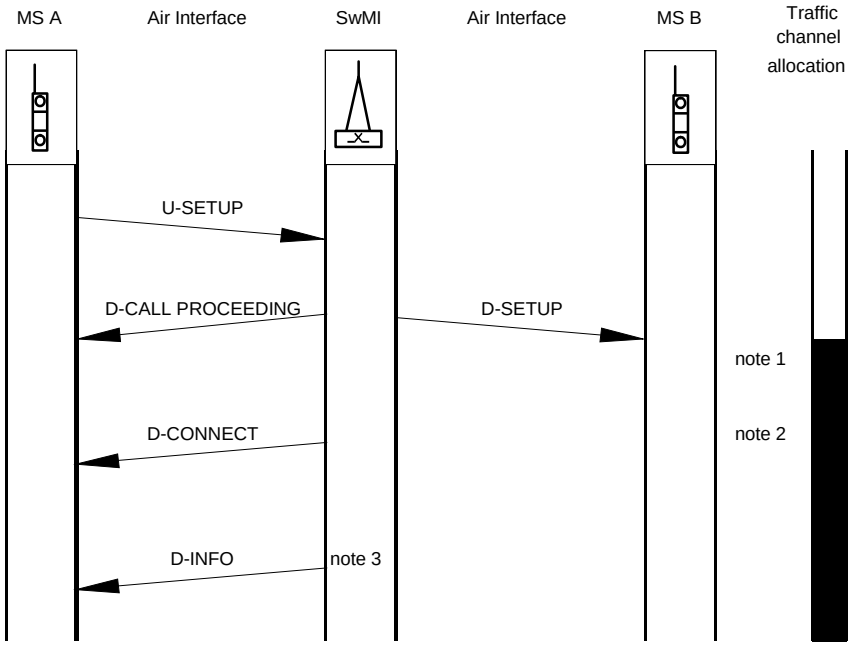
The call set-up request is started by an up-link message <U-SETUP> from the MS. The SwMI may optionally acknowledge the call set-up request by sending a down-link message <D-CALL PROCEEDING> and to indicate that the call is being processed, (see figure E.7).

If following the receipt of a <U-SETUP> message, the SwMI determines that for some reason the call cannot be supported, then the SwMI initiates call clearing as defined in clause E.3.9.

If the call can be supported, the SwMI sends a down-link message <D-SETUP> to the called MS.

During, or as an option upon completion of, the transmission of the <D-SETUP> message, the SwMI may send a <D-CONNECT> message to the calling MS.

On completion of this procedure communication can commence.



NOTE 1: Late assignment, i.e. the called MS is sent to the traffic channel at this stage.
NOTE 2: The calling MS is sent tot he traffic channel at this stage.
NOTE 3: For acknowledged group calls, the presence of the members of the group may be indicated here.

Figure E.7: Call set-up phase for a group call in a quasi-transmission trunked system

The option depends upon whether the group call is an acknowledged one. If it is acknowledged, the SwMI may delay the transmission of the <D-CONNECT> message to the calling MS, and wait for acknowledgements from the called MS before proceeding. If at this stage the SwMI decides that the call cannot be supported it initiates call clearing as defined in clause E.3.9.

If the group call is acknowledged, the call owner may be informed of the presence of the other members of the group in the <D-INFO> message.

E.3.2.2 Traffic channel assignment

For the called MS, the traffic channel assignment is always given in the <D-SET-UP> message. There is one method for assigning a traffic channel to the calling MS:

- late assignment: the traffic channel is not assigned until appropriate conditions are met. (These conditions may be as a result of the finite time required to locate group members, or as a result of the call being acknowledged.) The traffic channel is indicated to the calling MS along with the <D-CONNECT> message, (contained in the lower layer part of that message). In this case the calling MS remains listening on the control channel until he is told to move to the traffic channel.

E.3.3 Request-to-transmit

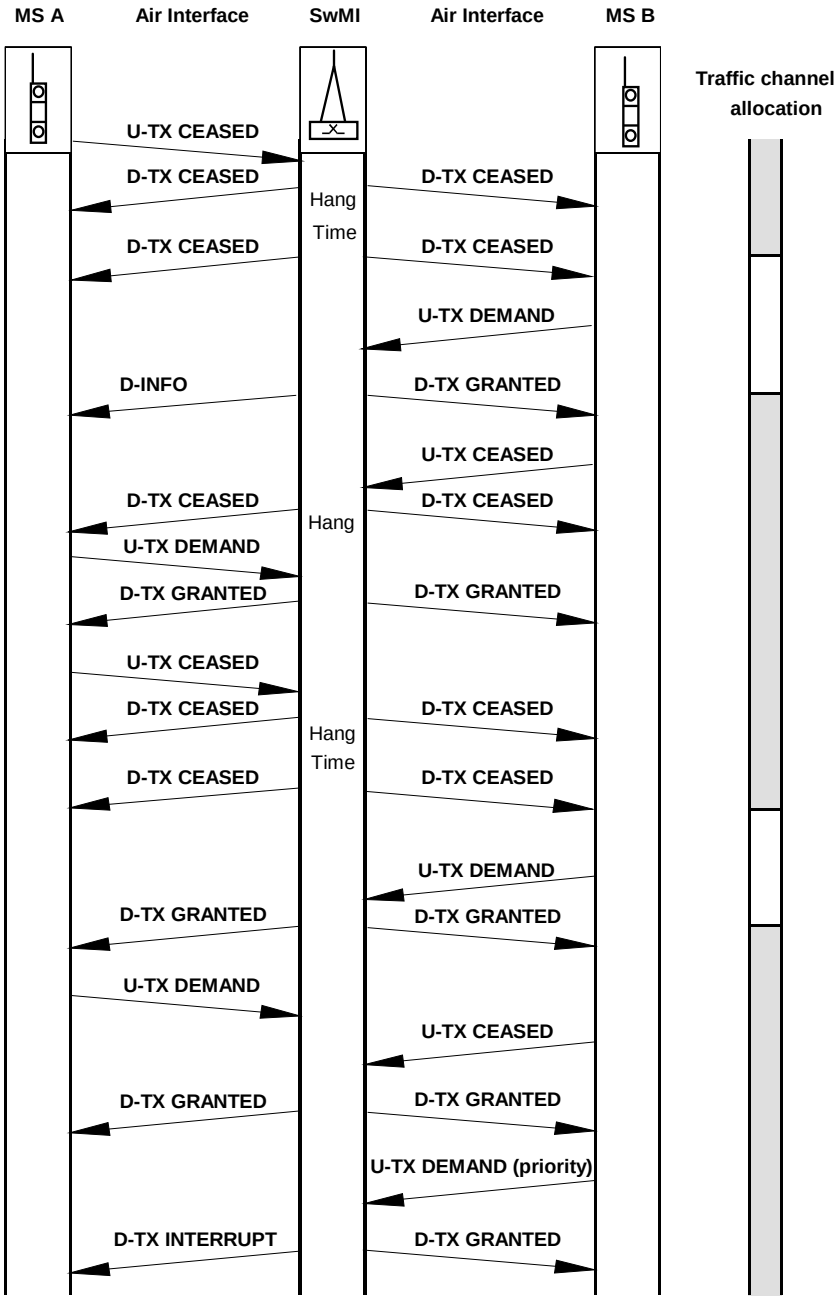


Figure E.8: Request to transmit for a group call in a quasi-transmission trunked system

The SwMI is in full control over which MS is allowed to transmit because the MS is obliged to request permission to transmit, and permission must be granted before the MS can do so.

It is normal system operation that the calling MS will be given the permission to transmit immediately upon call set-up. Traffic channel assignment is as previously discussed in clause E.3.2.1.

When the awarded MS has finished the communication it sends a <U-TX CEASED>, (see figure E.8).

Upon receipt of the <U-TX CEASED> message, the SwMI starts a timer (hang time) and sends a <D-TX CEASED> message to the "receiving" MS to inform them that the transmission has now ceased. After expiry of the timer, and no MS have sent any messages, the SwMI may send all MS a <D-TX CEASED> message, the MS should obey channel allocation and the SwMI awaits further demands from the calling and called MS. When any MS wishes to make a request to transmit, he sends a <U-TX DEMAND> message. The response to this request is dealt with in clause E.3.4.

If the hang time is infinite the TETRA system becomes message trunked.

E.3.4 Response to request-to-transmit

During any call, a <U-TX DEMAND> message may be sent by any MS. If any other MS is not already transmitting, and the hang timer has expired, then the SwMI response is a <D-TX GRANTED> message sent to the awarded MS addressed by his ITSI and another <D-TX GRANTED> message sent to the remaining MS addressed by the GTSI. The message should be accompanied by the traffic channel allocation (contained in the lower layer parts). Supplementary service information may also be appended to these messages if appropriate (see figure E.8).

If a <U-TX DEMAND> message is sent when no MS is transmitting, but the hang timer has not expired, then the SwMI response is a <D-TX GRANTED> message sent to the awarded MS addressed by his ITSI awarding permission to transmit to him, and another <D-TX GRANTED> message sent to the remaining MS addressed by the GTSI. The MS are assumed to be still on the traffic channel and a new assignment is not necessarily given.

If a <U-TX DEMAND> message is sent and another MS is already transmitting, then the SwMI should wait for that party to finish the transmission, (identified by the receipt of a <U-TX CEASED> message). Subsequently the SwMI sends a <D-TX GRANTED> message, to the requesting MS, addressed by his ITSI, awarding permission to transmit to him, and another <D-TX GRANTED> message to the remaining MS, addressed by the GTSI. (If the SwMI wishes to change the traffic channel, then this instruction may also be appended to the <D-TX GRANTED> and <D-TX GRANTED> messages.) Priority requests are dealt with under clause E.3.8.

E.3.5 Permission to transmit withdrawn

The SwMI may decide to interrupt transmission when resources are required for another call or that the SwMI requires that the call should temporarily pause. In this case the SwMI sends a <D-TX WAIT> message to all MS. Permission to transmit is withdrawn, or is not given to a requesting MS. The MS should obey channel allocation and should await further instructions on the channel that they have been directed to. The <D-TX WAIT> will:

- confirm to the MS that the call is in a queue;
- indicate to the MS that they may not send further requests-to-transmit.

If the request-to-transmit is granted but queued, the MS is allowed to withdraw its request-to-transmit by means of the message <U-TX CEASED>.

E.3.6 Permission to continue with withdrawn call

When the SwMI has decided that the call can continue, the SwMI should send a <D-TX GRANTED> message to the awarded MS, addressed by his ITSI, and a <D-TX CONTINUE> message to all remaining MS addressed by the GTSI. The MS are told to go to the traffic channel.

On the other hand, if no MS have been given permission to transmit then they are sent a <D-TX CONTINUE> message and are not sent to the traffic channel. They are free to make a request to the SwMI.

E.3.7 End of transmission

At the end of a transmission, the MS sends <U-TX CEASED> and listens to the traffic channel. Upon receipt of the <U-TX CEASED> message, the SwMI starts a timer (hang time) and sends a <D-TX CEASED> message to the "receiving" MS to inform them that the transmission has now ceased. After expiry of the timer, and no MS have sent any messages, the SwMI sends all MS, addressed by the GTSI, the <D-TX CEASED> message which informs the MS to obey channel allocation and await further instructions on the channel that they have been directed to, (see figure E.8).

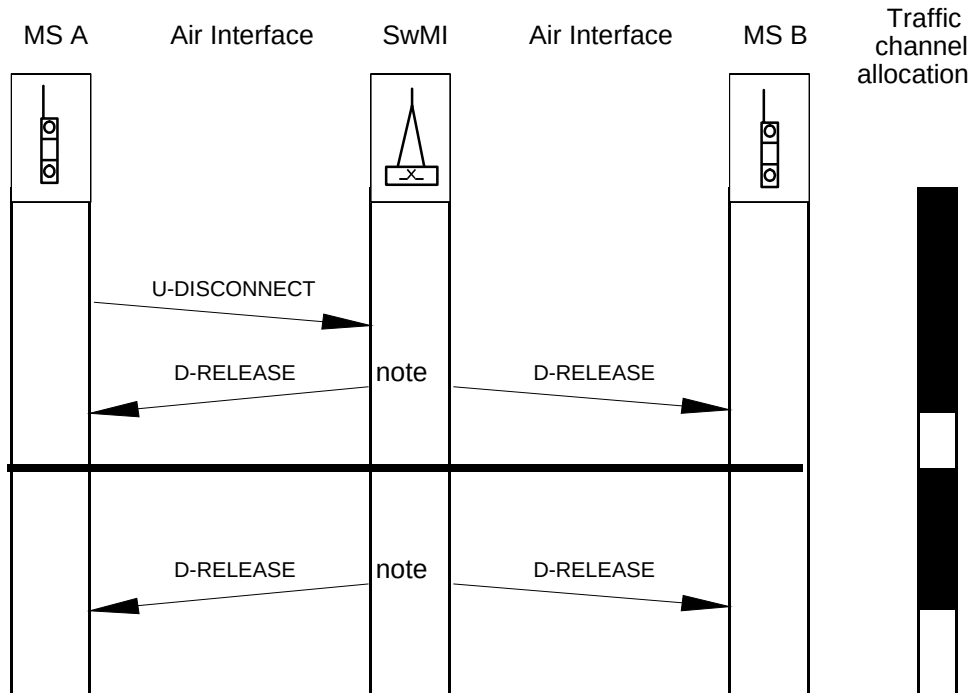
E.3.8 Stop-transmission order

If, during the course of a transmission, a MS wishes to interrupt the transmitting MS with a higher priority request, a <U-TX DEMAND> message is sent indicating the level of priority, the SwMI sends a <D-TX INTERRUPT> message to the transmitting MS addressed by his ITSI, a <D-TX GRANTED> message to the awarded MS, addressed by his ITSI, and another <D-TX GRANTED> message to all other MS addressed by the GTSI. All messages should indicate the permission to transmit has been re-awarded and should indicate the level of priority. (If the SwMI wishes to change the traffic channel, then this instruction may also be appended to the <D-TX GRANTED> and <D-TX GRANTED> messages), (see figure E.8).

E.3.9 Call clearing

E.3.9.1 Mobile originated

The call owner may disconnect the call at any stage of the call, (see figure E.9). Only the call owner can complete this operation. The MS originated call clearing procedure is started by the call owner sending an up-link <U-DISCONNECT> message. The SwMI responds to this message by sending a down-link <D-RELEASE> message to all MS and they are released from the call.



NOTE: The SwMI may start the CC-SS retention timer.

Figure E.9: Call clearing for a group call in a quasi-transmission trunked system

E.3.9.2 SwMI originated

In the case where the SwMI cannot support a request for a call from the calling MS, the SwMI should send a <D-RELEASE> message, containing the reason for failure, to the calling MS.

In the case where the SwMI can no longer support an established call, it should send a <D-RELEASE> message to all MS, containing the reason for disconnection, and subsequently release the call.

Annex F (informative): Priority functions for circuit mode services

F.1 Introduction

This annex covers only the priority functions for circuit mode calls in the TETRA voice and data standard. It describes the priority requirements. This annex identifies the mechanisms which can be available to TETRA users and operators in order to achieve their priority requirements. The TETRA supplementary services Access Priority (AP), Priority Call (PC) and Pre-emptive Priority Call (PPC) and Call Retention (CRT) define how priorities may be used in TETRA networks.

Priority information may be used by both the TETRA network operators and TETRA users in order to ensure that quality of service objectives can be met. This annex recognizes 6 identifiable priority requirements, any one of which or any combination of which may be requested in order to meet the demands of the users and networks. The selection of priority requirements may be seen as a network implementation.

The layers in the air interface protocol stack can exchange priority information with the following entities:

- the layer above;
- the layer below;
- the peer entity;
- the LLME.

This arrangement is shown schematically in figure F.1.

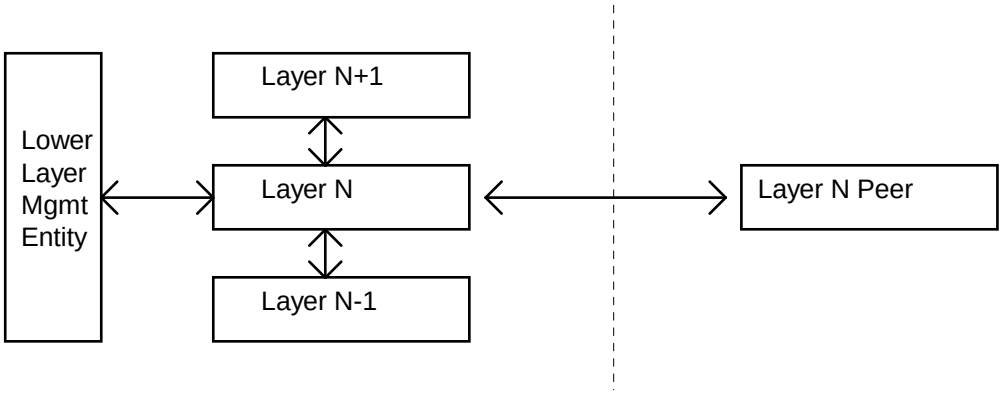


Figure F.1: Sources and destinations of priority information

F.2 Priority requirements

These should be the priority requirements of the TETRA system as perceived by the user and operator. Generally any individual user should only be aware of three levels of priority; normal, high and emergency.

F.2.1 Access priority

There can be methods of controlling the access of subscribers to the system during times of congestion. The controlling methods should allow favourable access on a pre-defined measure of quality.

F.2.2 Call type priority

The operator may elect to have equal or unequal priority attributed to the type of call.

EXAMPLE 1: A speech group call may take priority over an individual call, speech calls over data calls, etc.

Different subscribers on the same system may have different call type priority requirements.

EXAMPLE 2: Fleet 1 may elect secure voice to be a higher priority than fleet 1 data calls, however fleet 2 may have different requirements.

F.2.3 Queue priority

Queue priority can be related to queuing for any limited resource in the network (e.g. down-link air interfaces, leased lines, access to databases etc.). The attribution of a measure of quality can enable the limited resources to be allocated to the queuing subscribers on a priority basis rather than e.g. on a first come first served basis.

F.2.4 Pre-emptive priority

Pre-emptive priority allows any resource that is being used to be freed for a call of pre-emptive priority. The resource may be any resource controlled by the TETRA system.

EXAMPLE 1: During times of high system loading, existing calls may be cleared to provide resource for calls with priority to warrant this action.

EXAMPLE 2: Existing calls may be cleared to allow a pre emptive priority call to be made to a terminal that was engaged in the existing call.

F.2.5 Call retention priority

Call retention priority should define the relative level of protection of a call (once established) against the pre-emption of its network connection.

F.2.6 Subscriber priority

The priority of a call may be associated with the subscriber.

EXAMPLE: Within a fleet, certain subscribers by virtue of their position within that organization may automatically have a higher priority for their calls than other members of that fleet occupying a different position within the same organization.

F.3 Mechanisms for supporting priority

There can be a number of mechanisms available to the operator and to the user for supporting priority. Each mechanism can support several methods.

Those available to the operator are:

1) layer 2 access broadcast;

2) layer 3 system broadcast.

Those available to the user are:

- supplementary service activation and Invocation.

NOTE: There is no distinction made between CC message and supplementary service messages in the present document.

F.4 Supplementary service activation and invocation

The network operator may offer users the ability to activate and invoke supplementary services. Generally, TETRA supplementary services may be activated by the user only when he has subscribed to them, however some operators may wish to make the supplementary services available on a general basis. In the event where the user should firstly subscribe to the supplementary service, the service may be permanently activated, so that for example, when the user indicates to the network that he wishes to make a call, the supplementary service should be automatically invoked.

Alternatively a supplementary service may be invoked with a facility information element contained within a CC, call maintenance or facility message.

The supplementary services that are of interest to priority are:

1) access priority;

2) priority call;

3) pre-emptive priority call;

4) call retention.

Annex G (informative): Mobility Management (MM) in MS

G.1 Introduction

This annex deals with the network signalling aspects of registration, authentication, energy economy mode change signalling and enable/disable signalling.

G.2 Overview of MM relations and procedures

Figures G.1 and G.2 show the MM relations, stimulations and procedures on the MS side. The distinction between the MS MM and SwMI MM entities are presented in the scenarios.

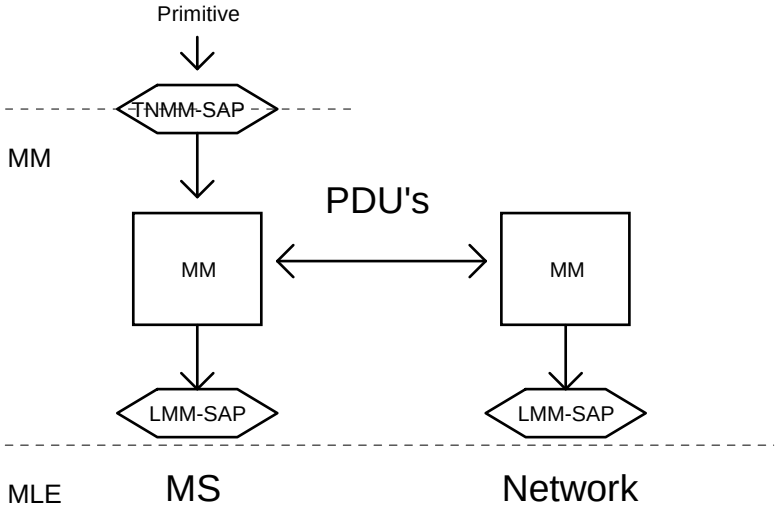


Figure G.1: MM relation

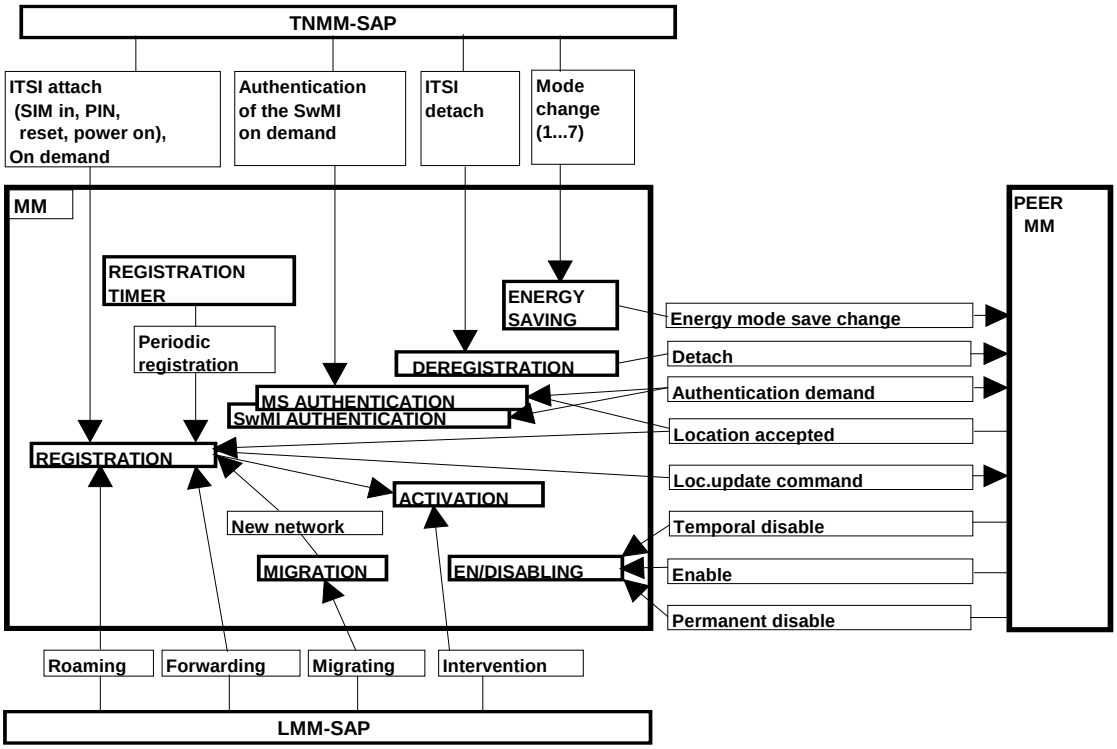


Figure G.2: MM stimulations (thin boxes) and procedures (thick boxes)

G.3 Stimuli of MM

G.3.1 Stimulation through TNMM-SAP

- **ITSI attach:** when an ITSI is attached after previously having been detached, this is reported to the MM. An ITSI may be attached by a registration request or at subscription.

  Examples of events that should cause an ITSI attach are:

  - entering of a SIM card containing the ITSI into the MS;
  - power up.

- **ITSI detach:** when an ITSI is detached after previously having been attached, this is reported to the MM. The way an ITSI is detached can be in a number of different ways.

  Examples of events that should cause an ITSI detach are:

  - removal of the SIM card containing the ITSI from the MS;
  - power down.

- **registration on demand:** registration may be requested by the user to force the registration and/or the authentication procedure. It is reported to the MM via the TNMM-SAP by a primitive request with cause "registration on demand".

- **network authentication on demand:** authentication may be requested by the user to force an authentication of the TETRA infrastructure (base station). A user interface for authentication is outside the scope of the present document.

- **energy economy mode change:** the change of an energy saving scheme may be requested by the user. It is reported to the mobility management peer in the infrastructure.

G.3.2 Stimulation through LMM-SAP

Stimulations through the LMM SAP are defined in EN 300 392-2 [4], clause 18 and may be any of the following:

- **intervention:** whenever the MM is required to take over control of the roaming or migration processes either by performing registration/authentication or by performing activation;
- **roaming:** the change of a LA within the TETRA network may require registration;
- **forwarding:** the change of a LA within the TETRA network while still using the previous may require registration;
- **migrating:** the change of a LA from one TETRA network to another requires registration.

G.3.3 Stimulation through peer MM

Stimulation through peer MM is achieved by sending PDU (messages) between the peer entities.

- **location update command:** the peer MM may force registration by the message <Location update command>;
- **location acceptance:** the peer MM may accept a location registration of a MS or refuse it;
- **network initiated user authentication:** the peer MM may start an authentication independent of registration by means of the message <Authentication Demand>;
- **temporary disable:** the peer MM may be able to temporary disable a MS by sending the <Disable> message;
- **enable:** the peer MM may be able to enable a MS temporary disabled by sending the <Enable> message;
- **permanent disable:** the peer MM may be able to permanently disable a MS by sending the <Disable> message.

G.3.4 Other stimulation

- **periodic registration:** registration may be ordered to be performed periodically when a timer expires. The value of the timer is stored in the MS data base.

G.4 Outputs from MM

G.4.1 Output through TNMM-SAP

- **registration and authentication result:** the result of the registration and authentication procedures will be reported via the TNMM-SAP by indication and confirm primitives:
  - for a successful registration;
  - for a successful authentication;
  - for an unsuccessful authentication;
  - for an unsuccessful registration;
  - for a successful detach;
  - for disabling/enabling.
- **temporary disabled:** the order to temporary disable the MS is reported via the TNMM-SAP by a primitive indication with cause "temporary";

- **temporary enabled:** the order to temporary enable the MS is reported via the TNMM-SAP by a primitive indication;
- **permanently disabled:** the order to permanently disable the MS may be reported via the TNMM-SAP by a primitive indication with cause "permanently".

G.4.2 Outputs through LMM-SAP

Outputs from the LMM SAP are defined in EN 300 392-2 [4], clause 17.

- **MM activates MLE:** MM controls the LAs wherein the MS may search for service by activating the MLE.

G.4.3 Output to peer MM

The messages to the MM peer entity may be any of the following:

- **authentication demand:** when using the MS invoked authentication a message <authentication demand> is sent to the infrastructure;
- **authentication reply:** when using the network initiated authentication a message <authentication reply> is sent to the infrastructure;
- **ITSI detach:** when the ITSI detach is reported to the MM by a request, and the operator option of ITSI detach report is invoked, a message <ITSI detach> is sent to the peer MM;
- **location update demand:** MS may request the infrastructure to update the location information of the MS with a message <location update demand>;
- **status:** MS requests the energy saving mode from the infrastructure with either message <U-LOCATION UPDATE DEMAND> or <U-MM STATUS>.

G.5 Database requirement

The identified data base requirements in the mobile for MM use are:

- **authentication parameters:** the keys for authentication parameters are stored in the data base;
- **ITSI detach report:** it may be stored in the MS data base whether ITSI detach will be reported to MM in the infrastructure or not;
- **the search area:** the total area in which the mobile may search for service.

G.6 MM procedures

G.6.1 Registration

G.6.1.1 Registration at roaming

G.6.1.1.1 Implicit registration

A network can be run so that no registration is needed. To keep track of where the MSs are situated, implicit registration may be used. This registration can be performed when a MS is sending, e.g. a CC message, or is responding, e.g. to a CC message.

G.6.1.1.2 Registration area

Registration area (RA) may be enlarged when a MS keeps its registration (for a finite or infinite time period) to a LA when it moves to and registers in a new LA.

G.6.1.1.3 Registration procedure

The process starts in the MS when another LA is preferred or when the MS is activated. The message <Location Update Demand> is sent to the infrastructure (see figure G.3). If the request is granted, and if authentication is not performed together with the registration, the message <Location Update Accept> will be returned.

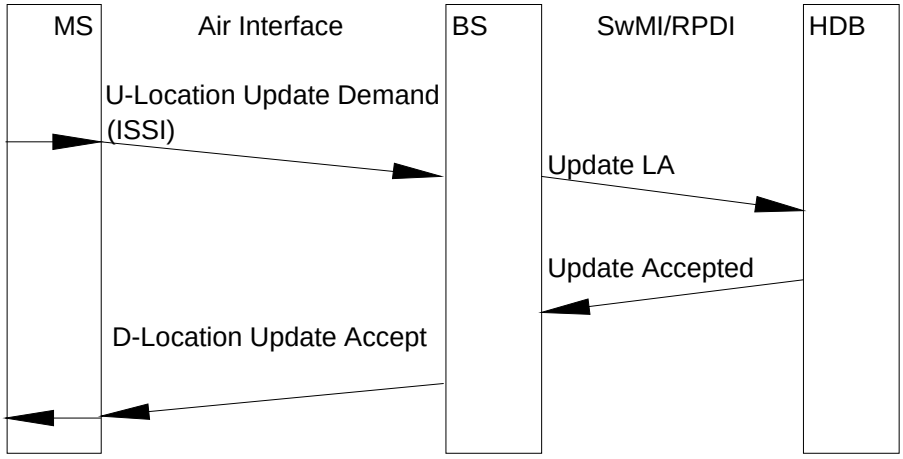
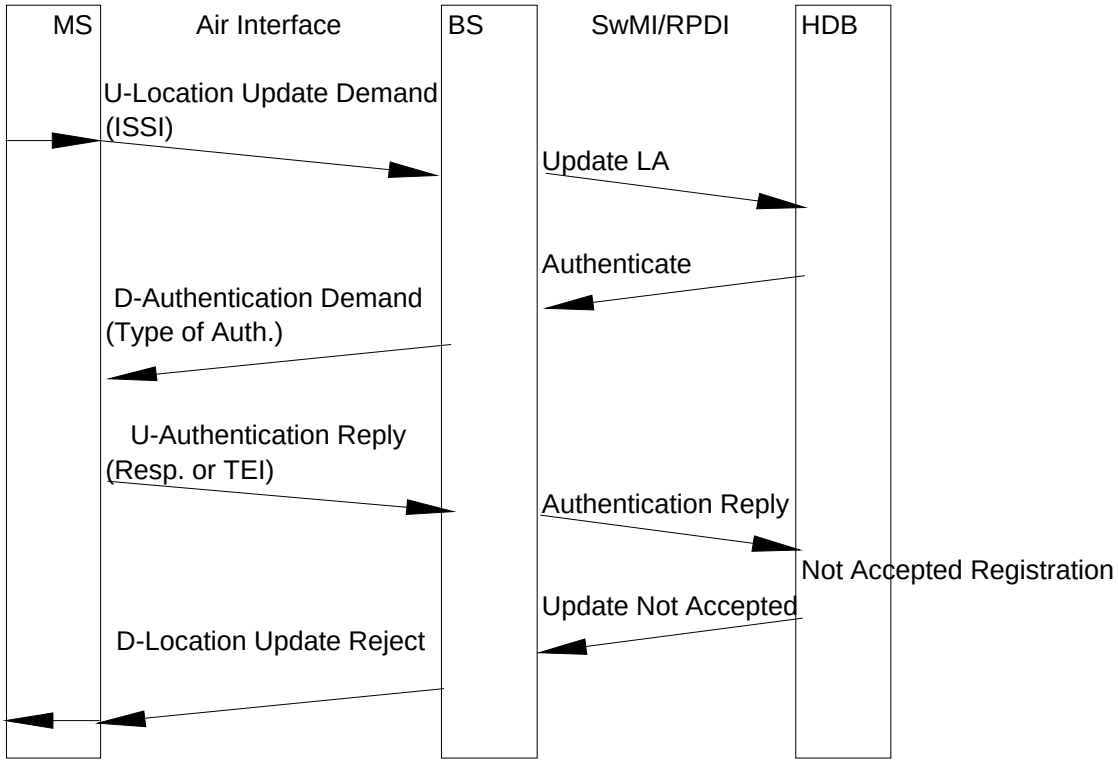


Figure G.3: Registration at accepted roaming, with no authentication nor identity exchange

In the <Location Update Accept> message all LAs the MS may use without re-registering are included together with an indication of how long these LAs are valid. The MS may be registered in more than one LA.

If the registration is not granted for some reason, e.g. overload, network failure or MS access deny, the message <Location Update Reject> will be returned with the cause for the reject (see figure G.4).



NOTE: TEI is no more included into the U-Authentication Relay PDU.

Figure G.4: Registration at not accepted roaming, with authentication and no identity exchange

G.6.1.1.4 Registration with authentication

The network initiated authentication process (see clause G.6.2.1) may be included in the registration process (see figure G.5).

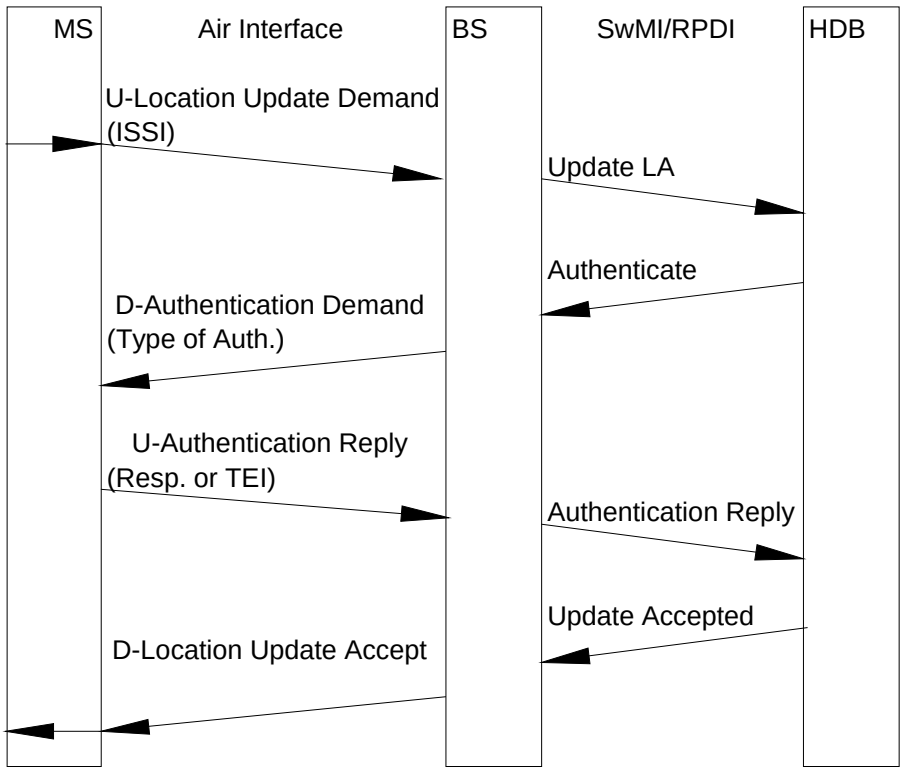


Figure G.5: Registration at accepted roaming, with authentication and no identity exchange

G.6.1.1.5 Registration with identity exchange

When the message <Location Update Demand> is sent to the infrastructure (see figure G.6), an ASSI if available, is used for sender identity. If ASSI is not available then ISSI is used in the home network in the <Location Update Demand>, Refer clause G.6.1.1.6 for actions in a visited network. The infrastructure may then return the new identity in the form of an ASSI. This new identity can now be used hereafter (see figure G.7).

The authentication process may be included as described in clause G.6.1.1.4.

If the demanded authentication and registration are granted, a new ASSI may be sent to the MS. This new ASSI can be used in subsequent communications with the network.

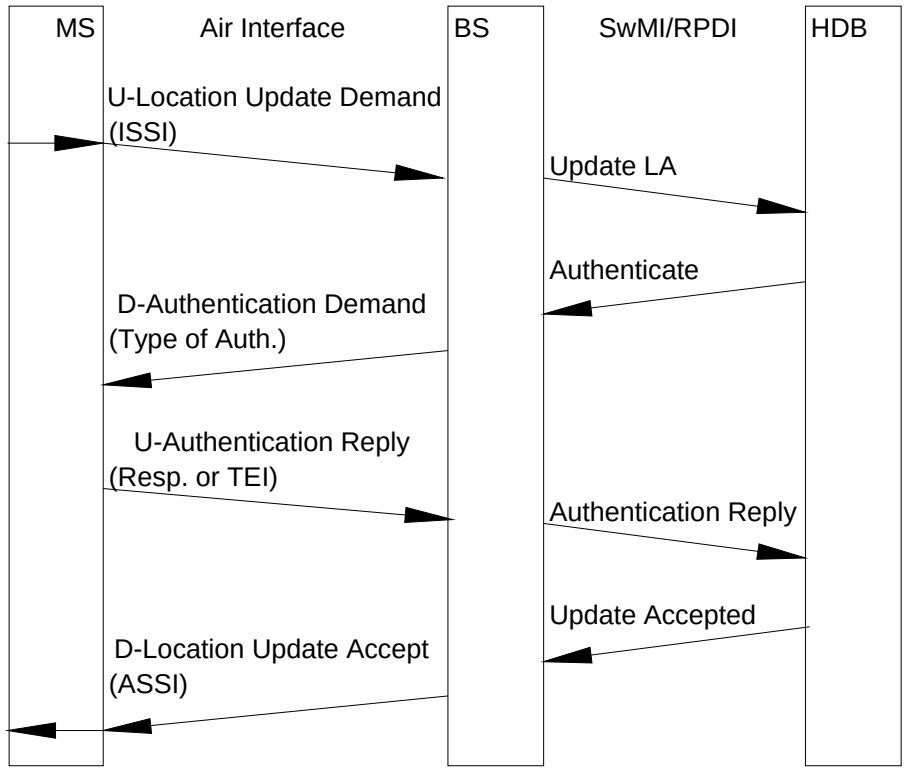


Figure G.6: Registration at accepted roaming, with authentication and first identity exchange

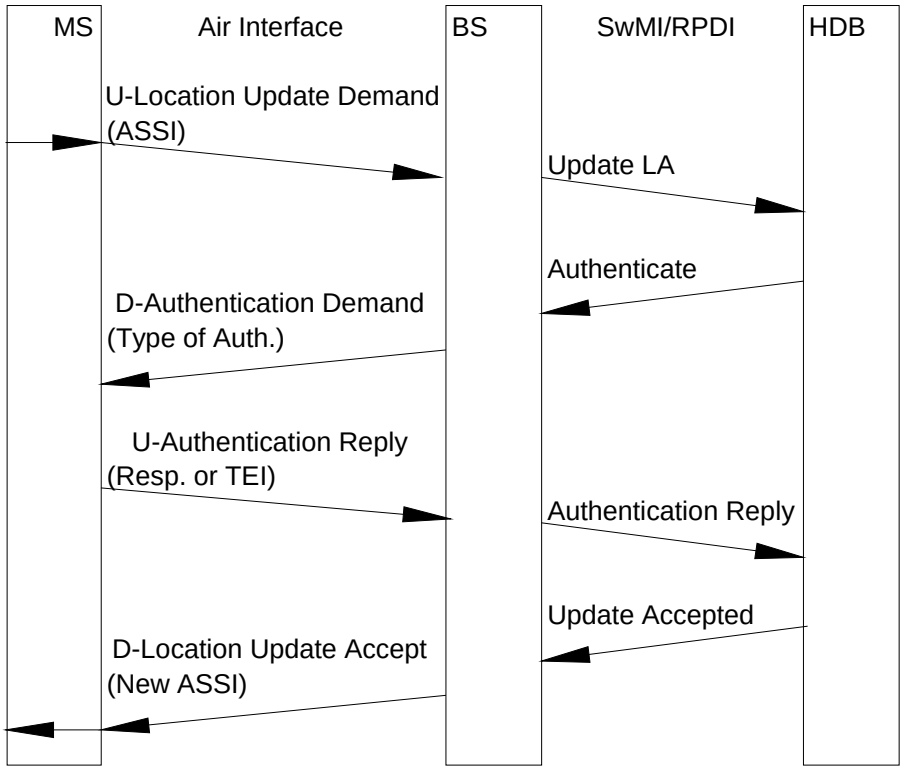


Figure G.7: Registration at accepted roaming, with authentication and subsequent identity exchange

G.6.1.2 Registration at migration

G.6.1.2.1 Registration with identity exchange

When roaming, the process starts in the MS when another LA, in another network, is selected preferred. Registration with identity exchange is performed also when the MS is activated. The message <Location Update Demand> is sent to the infrastructure (see figure G.8). In this case, the USSI is used for sender identity.

This USSI is identified by the visited infrastructure which then immediately will assign a (V)ASSI by sending a <Location Update Proceeding> message with the assignment of a (V)ASSI. The MS continues the information exchange with the SwMI with the (V)ASSI. The <Location Update Demand> is repeated with the new (V)ASSI and with the full TETRA subscriber identity (ITSI) as parameter.

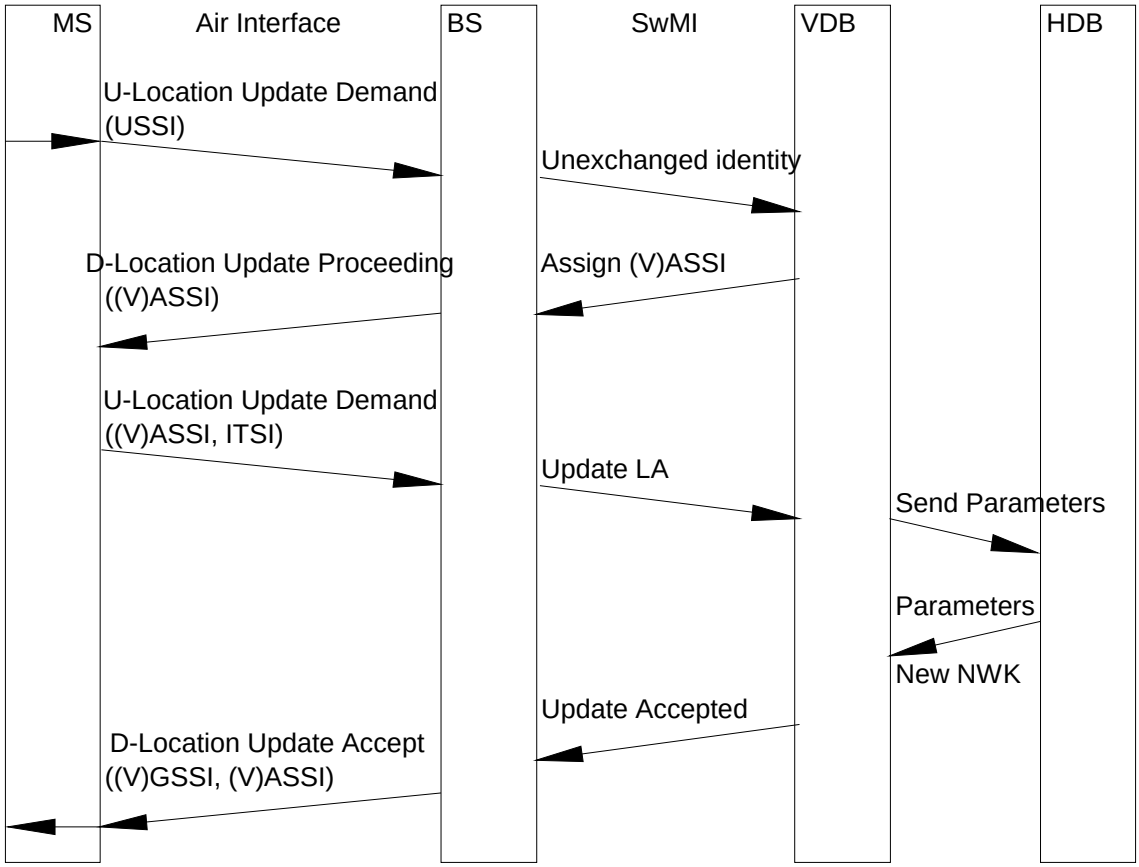


Figure G.8: Registration at accepted migration, with identity exchange and no authentication (V+D)

Figure G.9: Void

The visited infrastructure and possibly also the home infrastructure identifies the ITSI. After this identification procedure, the MS will have an entry in the Visited Data Base (VDB) which mirrors the Home Data Base (HDB) as closely as possible.

After registration is accepted, the HDB is updated. This update may include services not supported by the visited TETRA. Any entry in another VDB will be erased by the home system.

Furthermore after accepted registration, the <Location Update Accept> message including new (V)GSSIs and (V)ASSI parameters are sent to the MS. These new (V)GSSIs and (V)ASSI are used in subsequent communications with the network. Subsequent changes of LA in the same visited system are regarded as roaming, not migration.

G.6.1.2.2 Registration with authentication

There is only one type of identity exchange based upon the USSI as outlined in clause G.6.1.2.1, (see figure G.10).

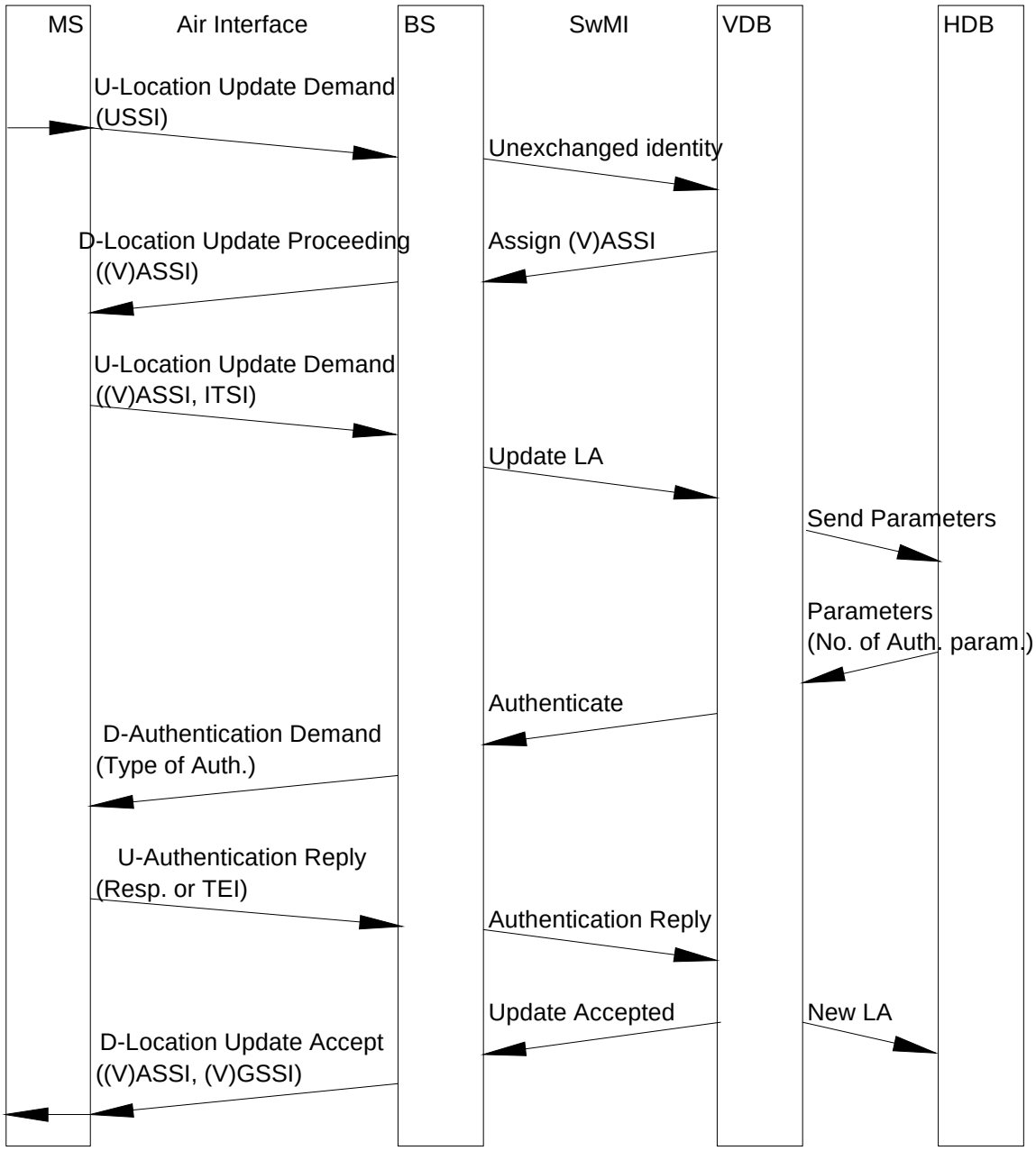


Figure G.10: Registration at accepted migration, with identity exchange and authentication (V+D)

If authentication and registration are granted new (V)ASSI and (V)GSSIs is sent to the MS. These new (V)ASSI and (V)GSSIs will be used in subsequent communications with the network.

G.6.1.3 Network initiated registration

The network may force the MS to initiate a location update procedure. This is activated by the <Location Update Command> message, (see figure G.11).

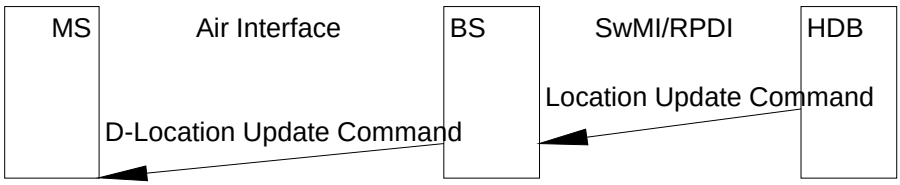


Figure G.11: Network initiated registration

G.6.1.4 TEI request

BS may as a part of registration request MS to provide TEI.

G.6.2 Authentication

NOTE: Authentication mechanisms to be used in TETRA are described in EN 300 392-7 [5] and are outside the scope of the present document.

G.6.2.1 Network initiated authentication

It is possible for the network to authenticate a mobile without any previous MS initiated registration. This is done by sending the message <Authentication Demand>, (see figure G.12).

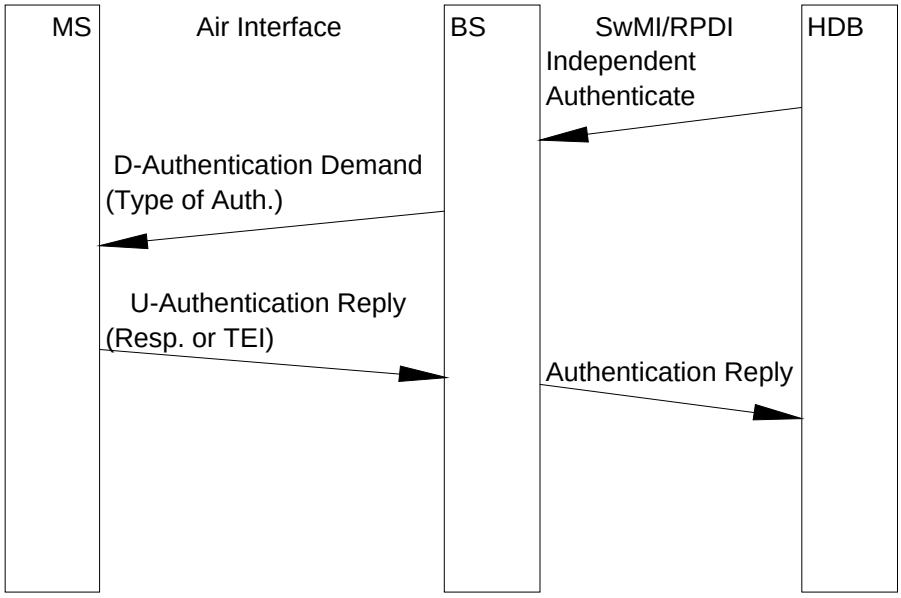


Figure G.12: Independent authentication initiated by the network

If the C/R method is selected, the network sends the challenge number to the MS in the <Authentication Demand> message and the MS calculates the response and returns it to the network in the <Authentication Reply> message.

If the authentication is not granted due to incorrect response, an <Authentication Reject> message is returned, (see figure G.13).

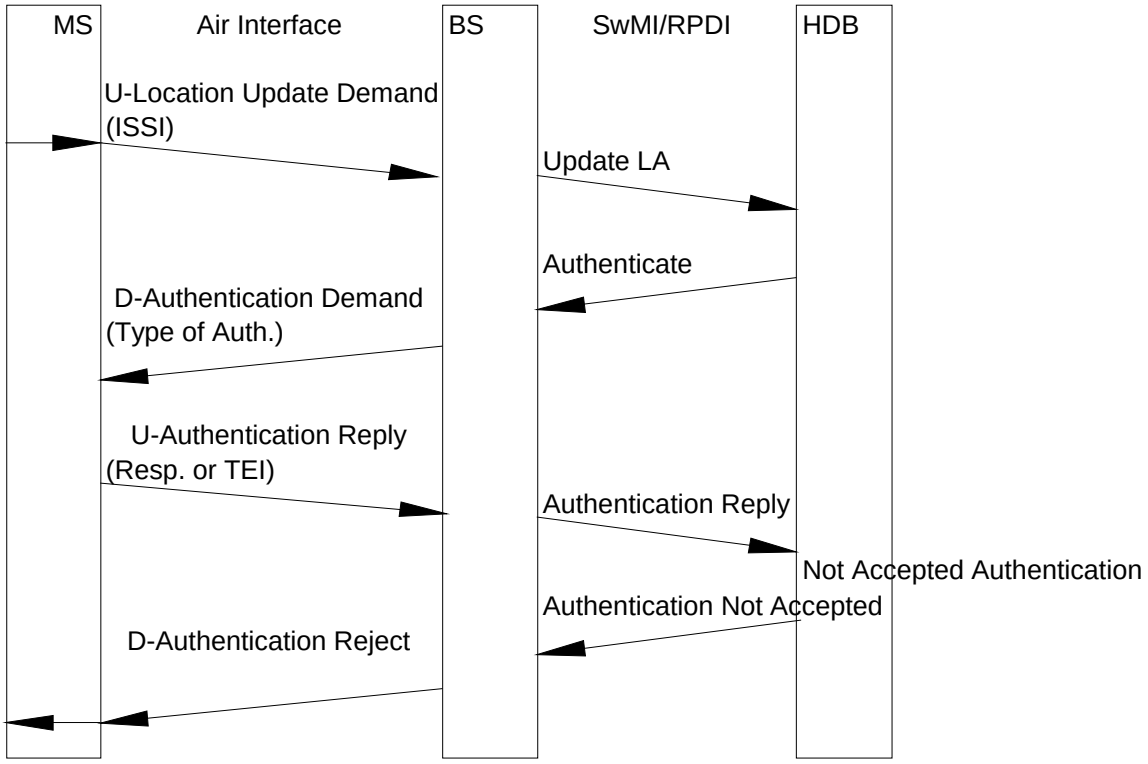


Figure G.13: Registration at not accepted authentication, with authentication and no identity exchange

In the <Location Update Accept> message, all LAs the MS may use without re-registering are included together with an indication of how long these LAs are valid.

G.6.2.2 MS initiated authentication

It is possible also for a MS to start the authentication by sending the message <Authentication demand> to the infrastructure, (see figure G.14).

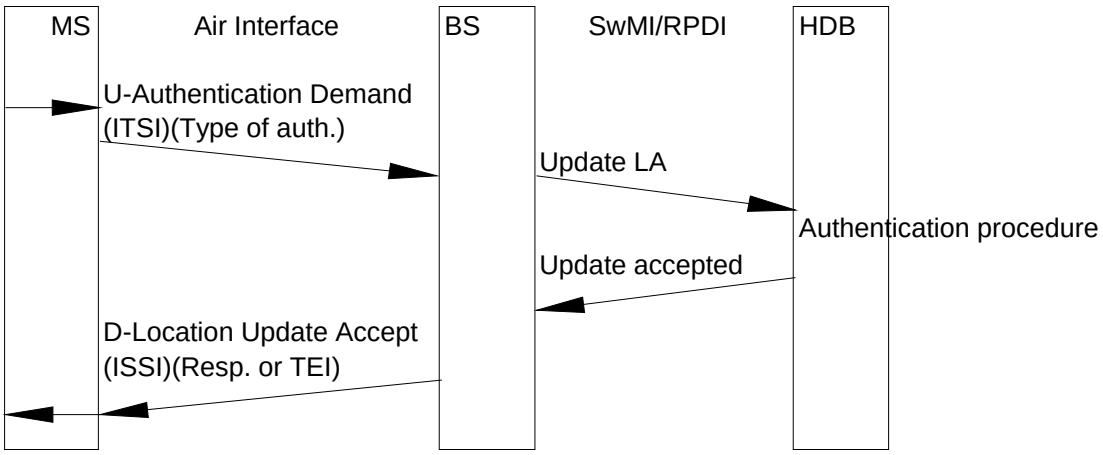


Figure G.14: Authentication initiated by the MS

If the C/R method is selected, the MS sends the challenge number to the infrastructure in the <Authentication Demand> message and the infrastructure calculates the response and returns it to the MS in the <Location Update Accept> message.

The MS will not accept the network if an incorrect response in the <Location Update Accept> message is returned.

In the <Location Update Accept> message, all LAs the MS may use without re-registering are included together with an indication of how long these LAs are valid.

G.6.3 De-registration

The individual (and group) TETRA subscriber identities (ITSI and GTSIs) may be stored in a card or as an application. If this identity is removed or the MS is powered down, as an operator option, an <ITSI Detach> message is sent to the infrastructure, (see figure G.15).

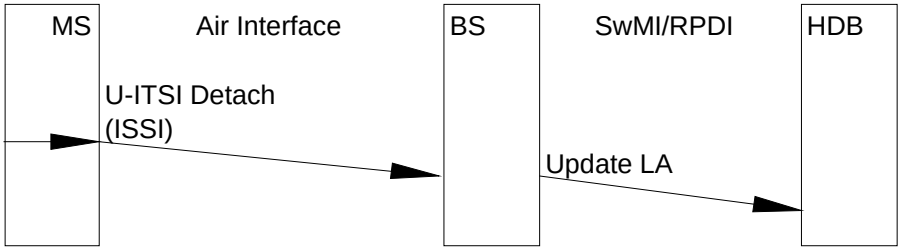


Figure G.15: De-registration (ITSI detach)

G.6.4 Periodic registration

Registration of the MS to the network can be initiated periodically by an internal MS timer, the procedure is the same as described in figures corresponding to registration.

G.6.5 Disable/enable

G.6.5.1 Temporary disable

It may be possible to temporarily disable an MS, (see figure G.16). The MS will on receipt of the message <Disable with parameter "Temporary"> be prohibited from sending any further messages than MM messages over the air interface. This state remains until the message <Enable> is received. Authentication may be performed before the disable order is executed. Refer to EN 300 392-7 [5], clause 5.

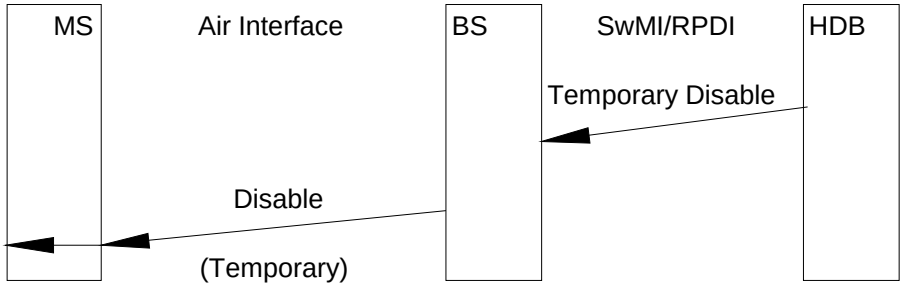


Figure G.16: Temporary disabling a MS

G.6.5.2 Enable

The message <Enable> is used to change an earlier "Temporary" <Disable> message, (see figure G.17). Refer to EN 300 392-7 [5], clause 5.

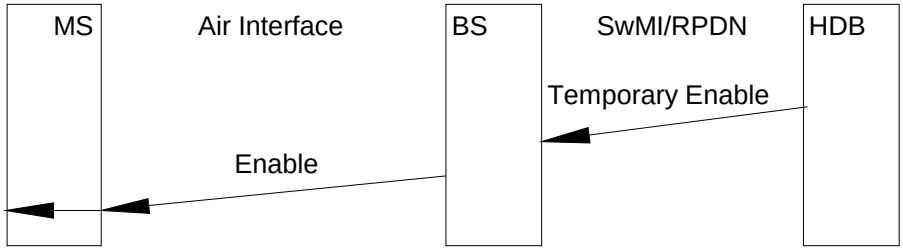


Figure G.17: Temporary enabling a MS

G.6.5.3 Permanently disable

It may be possible to permanently disable an MS, (see figure G.18). The MS will on receipt of the message <Disable with parameter "Permanently"> be prohibited from sending and receiving any further messages over the air interface. This state remains until the MS has been re-activated in an operator authorized service centre. Authentication may be performed before the disable order is executed. Refer to EN 300 392-7 [5], clause 5.

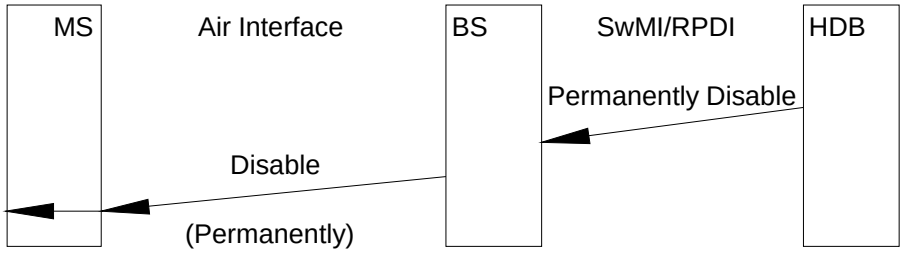


Figure G.18: Permanently disabling a MS

G.6.6 Energy economy mode change

The mode changes for MS energy saving mode are reported to the infrastructure, either in normal registration or as a separate action. One of the 8 different energy saving schemes (including <No energy> saving) is reported. The infrastructure controls the actual start time of the energy economy mode.

G.7 Downloading of group identities

MM entity controls attachment, detachment and reporting of group identities. In addition CMCE may allocate temporary group identity for duration of a single call.

Supplementary service Dynamic Group Number Assignment (SS-DGNA) may be used to download group identities for future usage, refer to EN 300 392-10-22 [6].

The examples in clauses G.7.1 to G.7.4 refer to the attachment, detachment and reporting of group identities. In those clauses "addition" means "attachment" and "deletion" means "detachment", refer to EN 300 392-2 [4] clause 16.8 for further details.

G.7.1 Add group identity

When the infrastructure wants to add one or more group identities to the ITSI family in the MS, a <Group Identity Command> message is sent to the MS with the command "add list" (see figure G.19). The MS either accepts the complete list or rejects the whole list or part of it. The accept or reject is sent to the infrastructure in a <Group Identity Acknowledge> message.

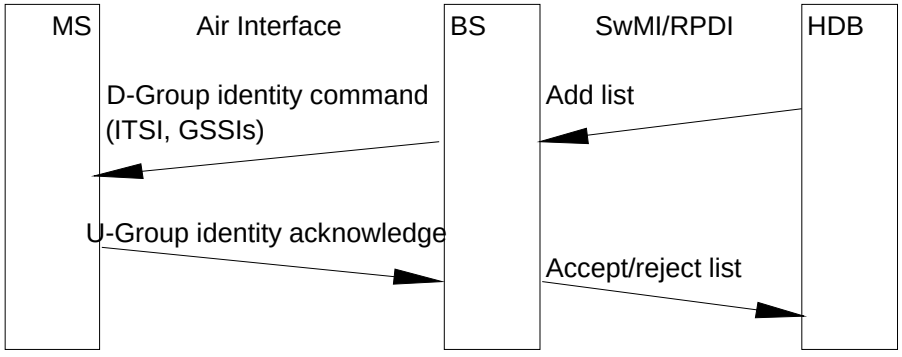


Figure G.19: Network group identity (GSSI) download

G.7.2 Delete group identity

When the infrastructure wants to delete one or more group identities in the ITSI family of the MS, a <Group Identity Command> message is sent to the MS with the command "delete list" (see figure G.20). The MS will then delete all GSSIs that can be found in the ITSI family and an acceptance of the command is sent to the infrastructure in a <Group Identity Acknowledge> message.

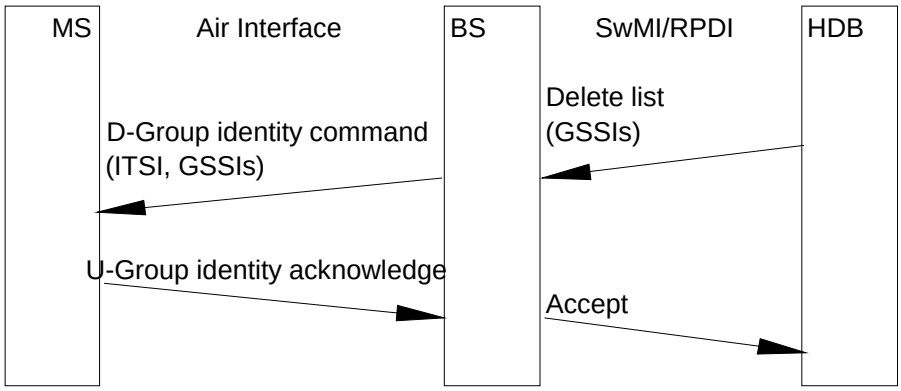


Figure G.20: Deletion of a list of group identities (GSSI) by the network

G.7.3 Delete all group identities

When the infrastructure wants to delete all group identities in an ITSI family of the MS, a <Group Identity Command> message is sent to the MS with the command "delete all" (see figure G.21). The MS then deletes all GSSI that belong to the ITSI family and an acceptance of the command is sent to the infrastructure in a <Group Identity Acknowledge> message.

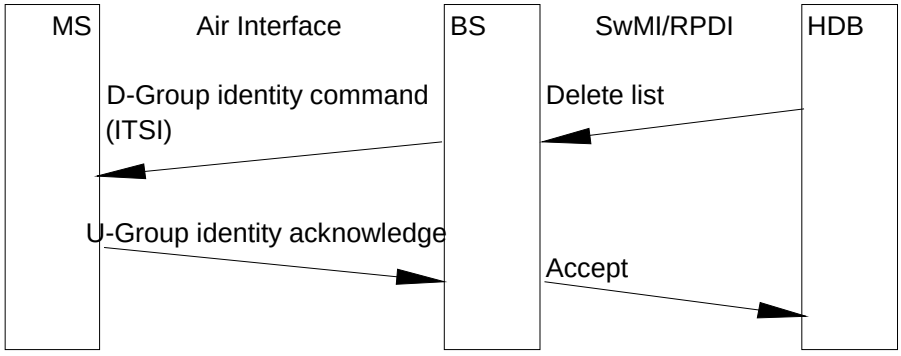


Figure G.21: Deletion of all group identities (GSSI) by the network

G.7.4 Report group identities

When the infrastructure wants a report on the current group identities belonging to the ITSI family of the MS, a <Group Identity Command> message is sent to the MS with the command "report" (see figure G.22). The MS then responds with a complete (or partial) list of GSSIs in the requested ITSI family. The list is sent to the infrastructure in a <Group Identity Acknowledge>.

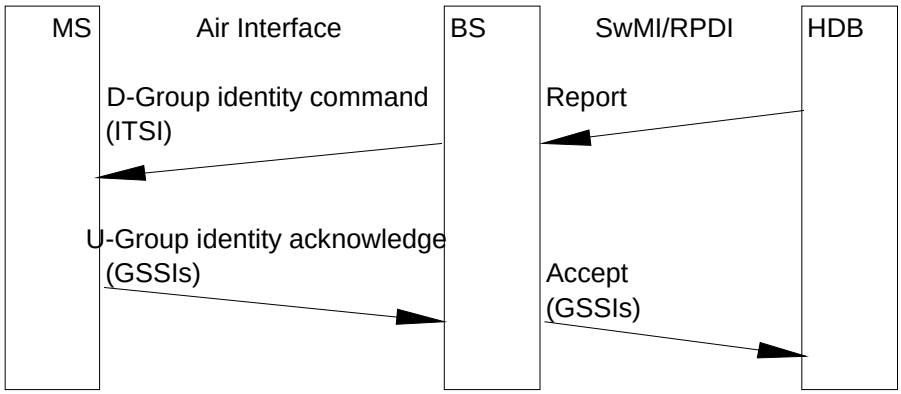


Figure G.22: Reporting current group identities (GSSI) to the network

Annex H (informative): MLE mobility scenarios and functionalities

H.1 Introduction

This annex deals with the functions which may be performed by the MLE sub-layer during mobility scenarios, both when roaming and migrating.

H.2 Overview

When a MS moves from cell-to-cell, the higher layer entities in the protocol stack may experience some interruption in the TETRA services. The MLE may perform certain functions which reduce the interruption caused by cell re-selection.

These functions may be applied either to assist the MM of the MS, that is to keep track of the movements of the MS, or the functions may be applied to recover MLE connections between a MS and the SwMI during cell re-selection. The functions may also assist the recovery of communications (call restoration) during the cell re-selection, but the specific communication recovery procedures are outside the scope of the present document. The MLE connection recovery and the assistance of communication recovery may also be relevant after a temporary loss of coverage within the same cell.

This clause gives a description of the functions and the different levels of capability that the MLE protocol supports within TETRA. It gives also an overview of the different stimuli known to the MLE, including the MLE PDUs. The clause describes how these stimuli may be used by the MLE to support the MLE mobility functions.

H.3 MLE responsibilities

MS-MLE is responsible for the following:

- manage the scanning for suitable cells using the relevant LAs and the cell selection/re-selection procedures for the MLE;
- manage the monitoring of neighbour cells by instructing the lower layers. The function may help the scanning process in ranking the cells;
- manage the surveillance of the serving cell by instructing the lower layers to provide quality information, when attached to the cell;
- manage the undeclared cell re-selection;
- invite MM entity intervention if no service is found, whereby guidance is received containing information on new LAs;
- invite MM entity intervention if a suitable cell is outside RA, whereby MM is envisaged to perform the registering procedure.

SwMI-MLE and MS-MLE is responsible for the following:

- manage the announced cell re-selection;
- manage the unannounced cell re-selection;
- advise the higher layer 3 entities of the potential of errors arising from a break in the MLE connection while attaching to another cell. The advisory is only supported by the MLE if higher layers have asked for a MLE connection;
- advise the higher layer 3 entities when an existing MLE connection has been terminated due to a lower layer failure;

- advise the higher layer 3 entities by the time MLE service is required, that due to ongoing cell re-selection service is not available;
- exchange network information via network information broadcast, this information is used by the initial cell selection and cell re-selection procedures.

The MLE in the MS or SwMI may support a number of levels of TETRA system capability for the assistance of communications recovery or attachment recovery both with and without MLE connection. These are summarized in the following list:

- initial cell selection;
- announced cell re-selection type 1 by roaming;
- announced cell re-selection type 2 by roaming;
- announced cell re-selection type 3 by roaming;
- unannounced cell re-selection by roaming;
- undeclared cell re-selection by roaming;
- announced cell re-selection type 1 by migrating;
- announced cell re-selection type 2 by migrating;
- announced cell re-selection type 3 by migrating;
- unannounced cell re-selection by migration;
- undeclared cell re-selection by migration;
- no MLE recovery.

H.4 MS-MLE model

In the scenarios that follow, the LCMC SAP is taken as an example of an LXX SAP. The services offered to the LCMC SAP during the scenarios that follow may be the same as for the other LXX SAPs.

For each scenario examined, two perspectives are considered:

- LMM SAP perspective (see figure H.1);
- LCMC SAP perspective (see definitions and figure H.1).

NOTE: The layer to layer primitives shown on the SwMI side in the following scenarios are only informative and shown for the description of the model.

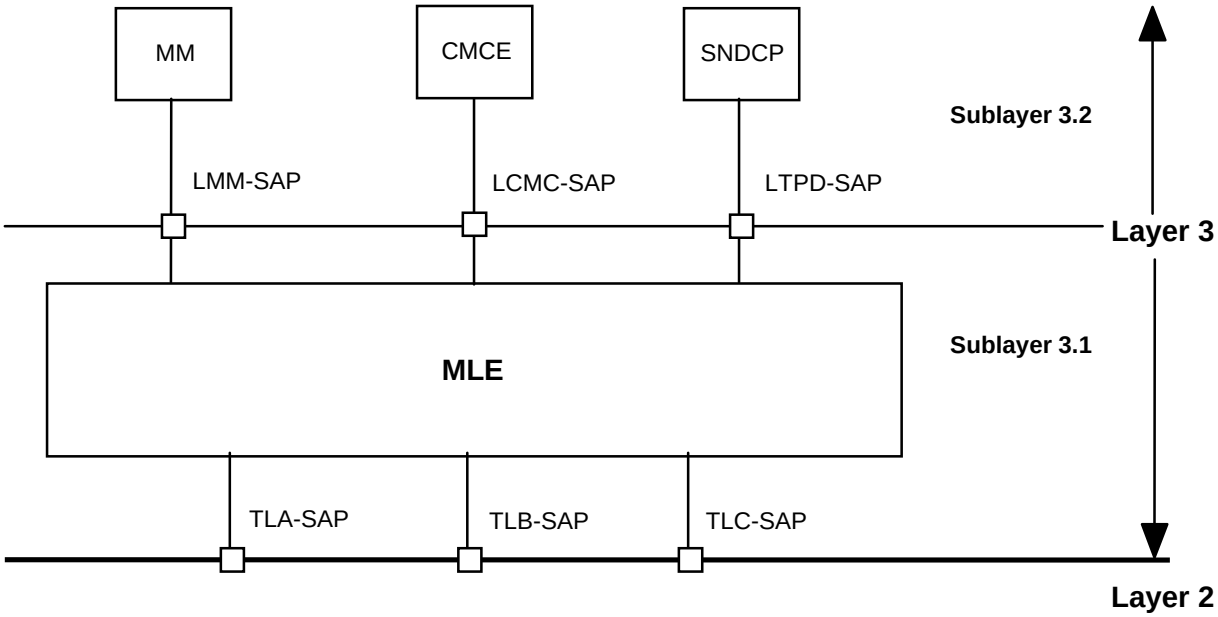


Figure H.1: SAPs offered to the MS MLE

H.5 MLE functionalities

The overall mobility functionalities as outlined in figure H.1 can be broken down into different sub-functions. Each of these sub-functions is described by an individual scenario. These are:

1) monitoring of neighbour cells (MS - side);
2) scanning of neighbour cells (MS - side);
3) MM Activation of MLE (MS - side);
4) open up MLE services (SwMI/MS - side);
5) closing MLE services (SwMI/MS - side);
6) changing to the serving cell (MS - side);
7) surveillance of the serving cell (MS - side);
8) inviting MM intervention when no service is found (MS - side);
9) inviting MM intervention when found LA is outside RA (MS - side);
10) set-up MAC broadcast (SwMI - side);
11) initiating MLE broadcast (SwMI - side);
12) MM registering (MS - side);
13) announce old cell and go-to-channel (MS/SwMI - side);
14) announce old cell (MS/SwMI - side);
15) announce new cell and successful restoration (MS/SwMI - side);
16) announce new cell and restoration failure (MS/SwMI - side);
17) path lost to the serving cell (MS - side).

H.5.1 Monitoring of neighbour cells (scenario 1)

Monitoring of the neighbour cells is started by issuing a TL-MONITOR-LIST request primitive from the MS-MLE to the lower layers at the TLC-SAP. Before starting the monitoring, the MS-MLE should have received a <D-NWRK BROADCAST> PDU containing information of neighbour cells. The parameters to the TL-MONITOR-LIST request primitive are a list of cell-ids and the corresponding broadcast information from the <D-NWRK BROADCAST> PDU. The lower layers are then instructed to perform power measurements and path loss calculations concurrently with other services. The measurement method and the monitor function are described in EN 300 392-2 [4], clause 23. When a measurement on one neighbour cell is finished, the result should be passed up to the MS-MLE in a TL-MONITOR indication primitive. The path loss result C_2 for the concerned cell should be passed as a parameter. Based upon the individual C_2 results from each of the neighbour cells, the MS-MLE should build a ranking list. The scenario is outlined in figure H.2.

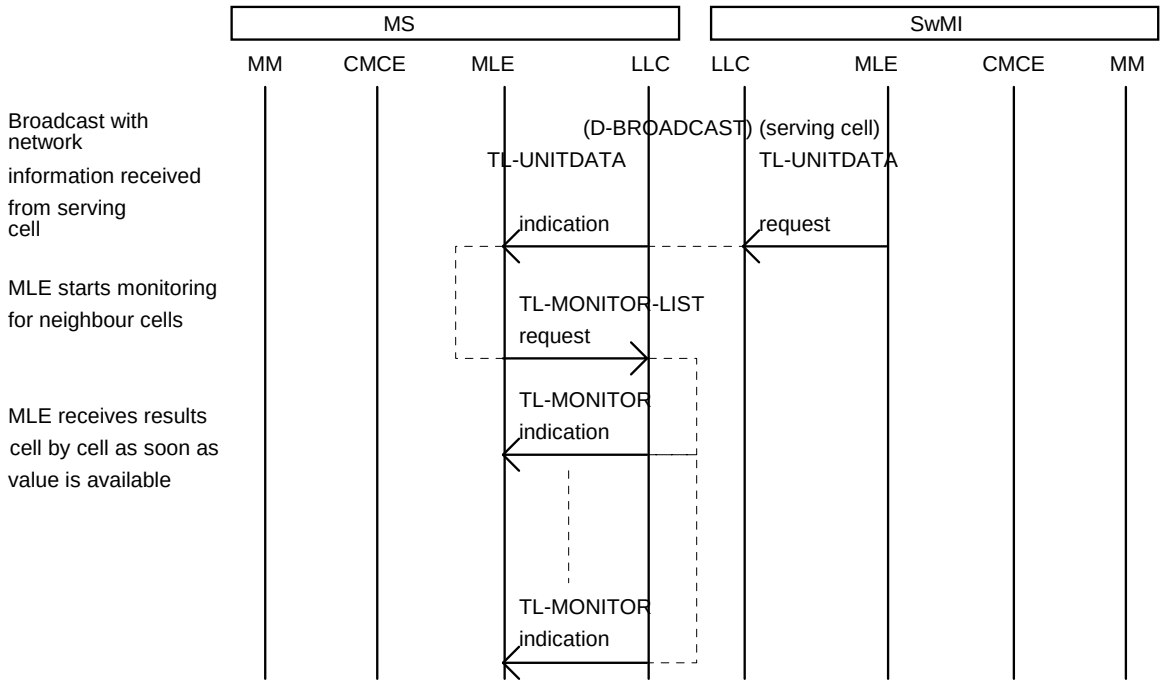


Figure H.2: Monitoring of neighbour cells (scenario 1)

H.5.2 Scanning of neighbour cells (scenario 2)

The scanning procedure seen from the MS-MLE may be a procedure in several steps employing a scanning list. This list can be built using various inputs such as:

- the result from the ranking of the neighbour cells performed by the monitoring sub function;
- a stored cell list;
- the result of the MLE-ACTIVATE request primitive;
- preference for certain cells.

The scanning is started by issuing a TL-SCAN request primitive from the MS-MLE to the lower layers at the TLC-SAP. Each scan is performed on only one neighbour cell. The parameters sent in the primitive are apart from a scanning list element, the measurement method to be utilized at the lower layers. The measurement methods applied to the scanning may be:

- foreground measurements; or
- background measurements; or
- interrupted measurements.

The measurement methods are described in EN 300 392-2 [4], clause 23. Based upon the TL-SCAN request primitive parameters, the lower layers should be instructed to perform power measurements and to synchronize and read the information from the SYNC broadcast and the SYSINFO broadcast. When the lower layers have finalized their task, a TL-SCAN confirm primitive should be issued to the MS-MLE. Information about the scanned cell should be returned as parameters including the calculated path loss C_1.

From now on, the path loss parameter C_1 is returned in a TL-SCAN-REPORT indication primitive every time the monitor process (scenario 1, figure H.2) has retrieved the power measurement. Refer to figure H.3.

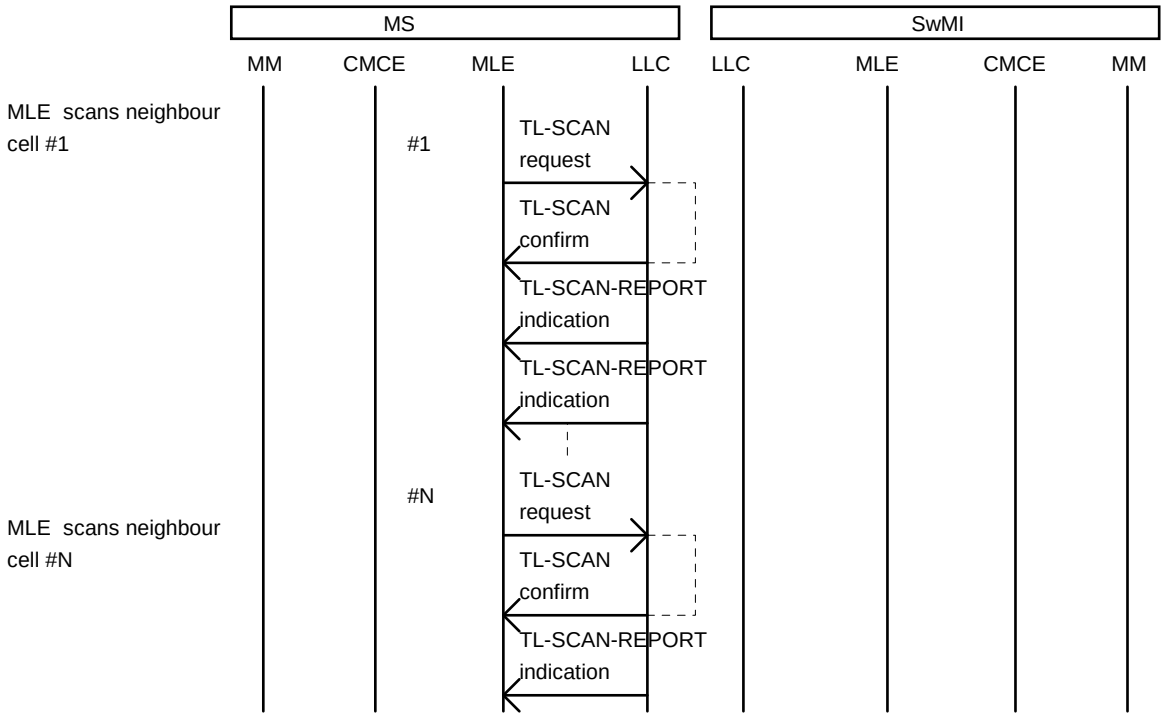


Figure H.3: Scanning of neighbour cells (scenario 2)

H.5.3 MM activation of the MS-MLE (scenario 3)

Activation of the MS-MLE should be performed by the MM entity. The activation process should be started by the MM issuing a MLE-ACTIVATE request primitive to the MS-MLE. The LAs containing the cell-ID in which the MM empowers the MS-MLE to search for service in should be passed as parameters to the primitive. The cell-ID may be the preferred cells for the LAs.

The MS-MLE then should start scanning procedure according to clause H.5.2 and when a suitable cell is found, the selection procedure according to clause H.6 should be applied. The measurement method, given as parameter to the lower layers in the TL-SCAN request primitive, should be foreground measurement. The method is described in EN 300 392-2 [4], clause 23.

NOTE: The activation of the MS-MLE may start with monitoring according to scenario 1 (see figure H.2). Since it is an initial monitoring, the broadcast parameters on neighbour cells may not be known to the MS-MLE and therefore default values should in this case be assigned.

When the activation process has finished, the MS-MLE should inform the MM about the result in a MLE-ACTIVATE confirm primitive. The result may either be that no suitable cells could be found or that the MS is now camped on the cell. In both cases, the MS-MLE should wait for intervention from the MM. Refer to figure H.4.

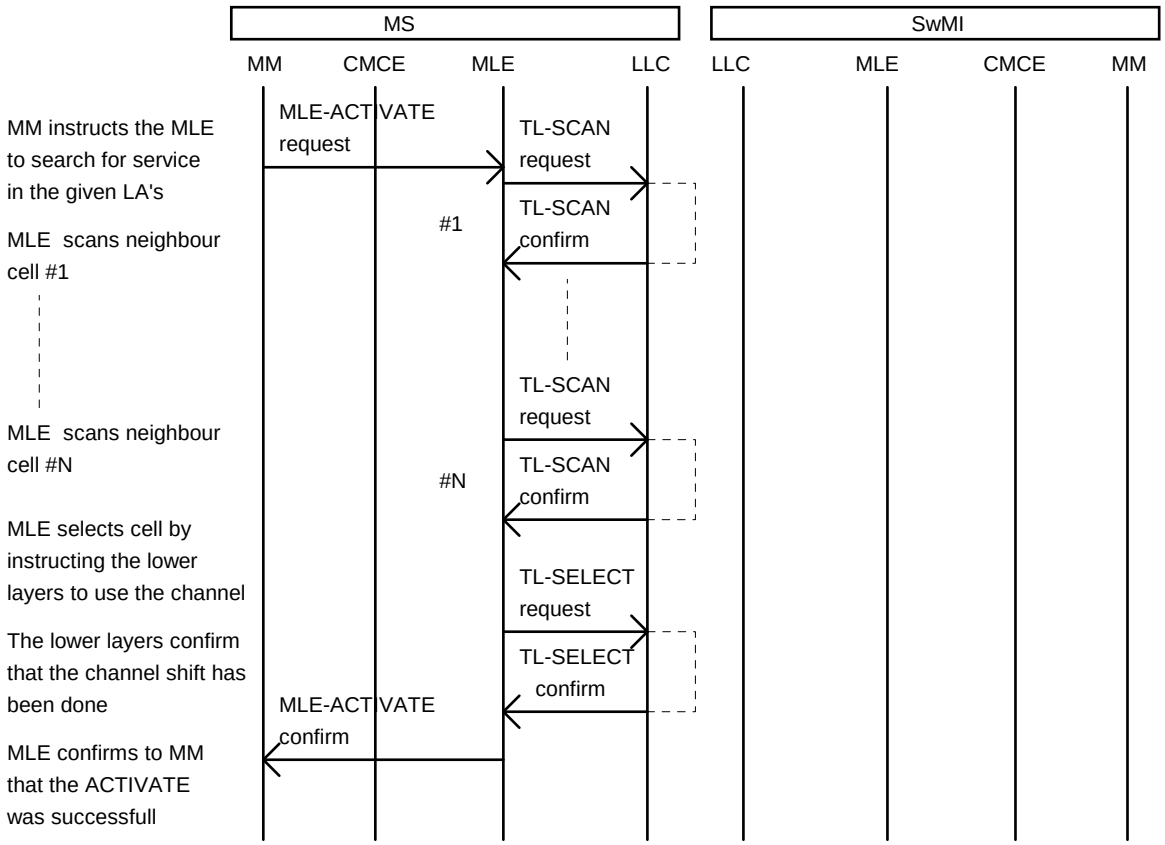


Figure H.4: MM activation of the MS-MLE (scenario 3)

H.5.4 Open up MLE service (scenario 4)

The MM should decide when to open up for MLE services. When the MM issues an MLE-OPEN request primitive to the MLE this opens up the MLE services both in the MS and in the SwMI. In order to synchronize the events, signalling between the MM entities in the MS and in the SwMI takes place before the employment of the "open-up-MLE-service" function. After reception of the MLE-OPEN request primitive, the MS-MLE and the SwMI-MLE should issue a MLE-OPEN indication primitive to their service users, e.g. CMCE and SNDCP. After this sub-function is performed, the MLE service users will have access to the communication resources. Refer to figure H.5.

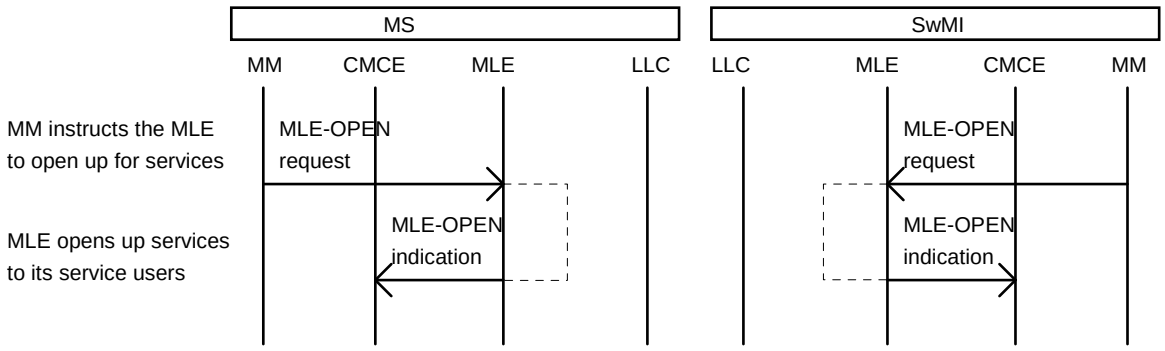


Figure H.5: Open up MLE services (scenario 4)

H.5.5 Close of MLE service (scenario 5)

The MM should decide when to close for MLE services. When the MM issues an MLE-CLOSE request primitive to the MLE this closes MLE services both in the MS and in the SwMI. In order to synchronize the events, signalling between the MM entities in the MS and in the SwMI can take place before the employment of the "close-of-MLE-service" function. After reception of the MLE-CLOSE request primitive, the MS-MLE and the SwMI-MLE should issue a MLE-CLOSE indication primitive to their service users, e.g. CMCE, CONP and S-CLNP. After this sub-function is performed, only the MM entity will have access to the communication resources. All other MLE SAPs are closed. Refer to figure H.6

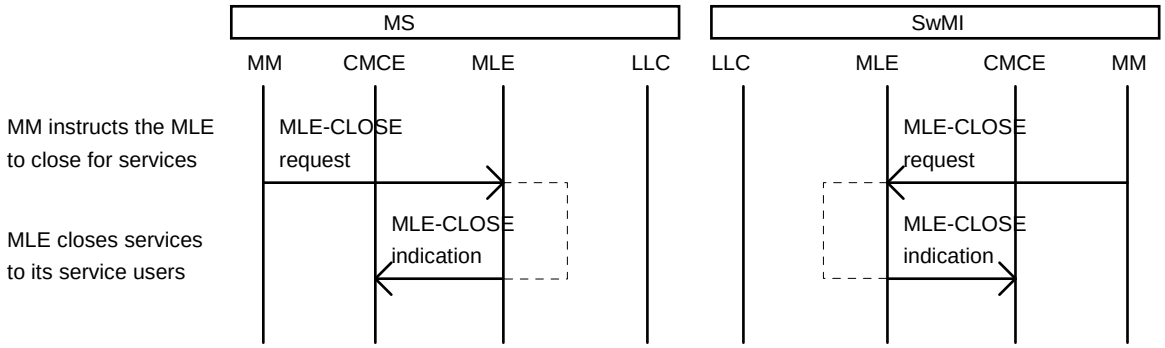


Figure H.6: Close of MLE services (scenario 5)

H.5.6 Changing to serving cell (scenario 6)

When MS-MLE decides to change to another cell, it should issue a TL-SELECT request primitive to the lower layers. The cell-ID (channel number) and some rules for surveillance of the serving cell should be provided as parameters. The lower layers should immediately change to the identified cell and start the survey. The TL-SELECT confirm primitive should be sent back to the MS-MLE indicating whether the selection has been successful or not. Refer to figure H.7.

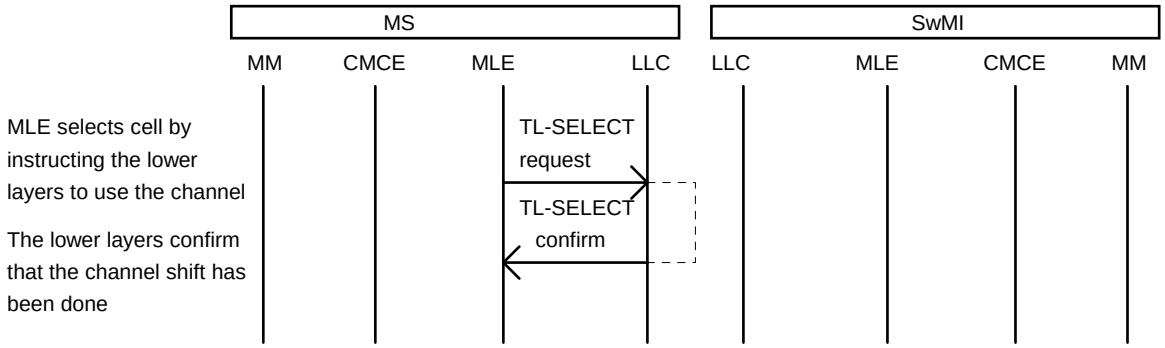


Figure H.7: Changing to serving cell (scenario 6)

H.5.7 Surveillance of the serving cell (scenario 7)

The MS-MLE should start surveillance of its serving cell when selection of the cell is performed by utilizing the TL-SELECT request/confirm primitives. From now on, the MS-MLE should receive TL-MEASUREMENT indication primitives containing quality information from the lower layers and network broadcasts from the SwMI-MLE. The quality parameters in the TL-MEASUREMENT indication primitives should also contain the calculated path loss C_1 (refer to EN 300 392-2 [4], clause 23) and may also contain message error rate, indication of random access failure and re-transmission failure on the LLC link. The <D-BROADCAST> PDU from the serving cell should contain information about neighbour cells and may also contain network information related to the serving cell. Refer to figure H.8.

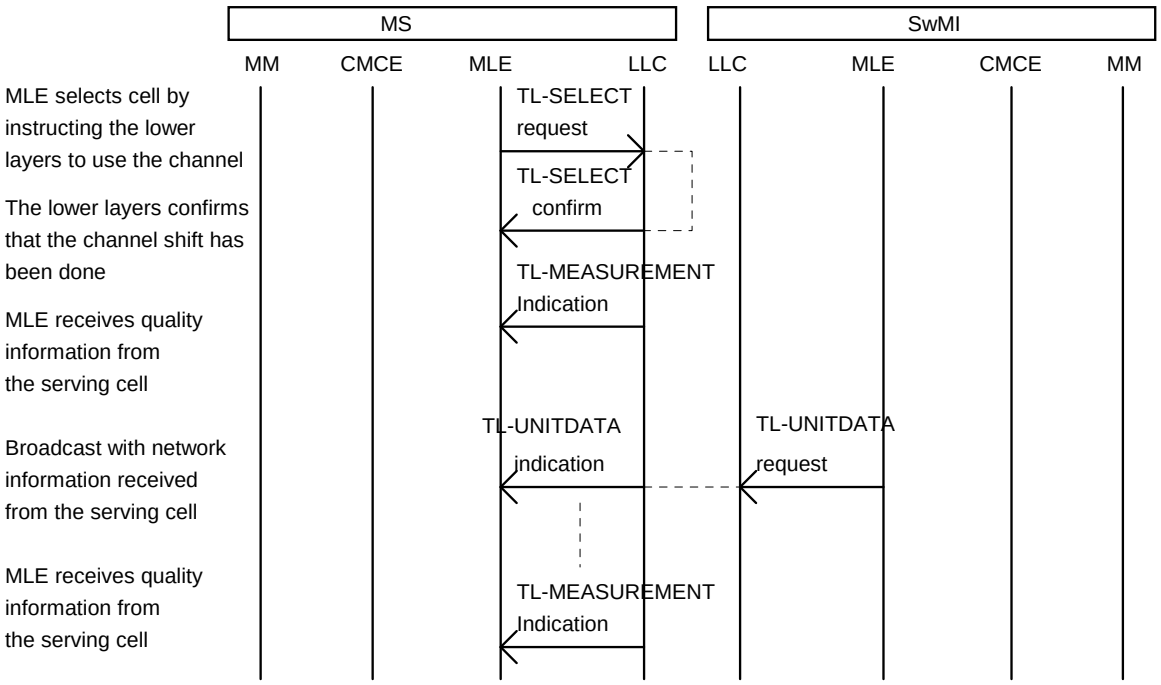


Figure H.8: Surveillance of the serving cell (scenario 7)

H.5.8 Inviting MM intervention

H.5.8.1 No service can be found (scenario 8)

After scanning or due to sudden loss of radio contact, the MS-MLE may invite MM entity intervention in order to receive instructions for new LAs. When the MS-MLE cannot obtain service using its current understanding of the network, it should send a MLE-ACTIVATE indication primitive to the MM entity with parameters containing information about the reason why to invite MM entity. The parameters may be the current LA, the current serving cell and some other network parameters which MS-MLE has obtained via the network broadcast. Refer to figure H.9.

After sending of the MLE-ACTIVATE indication primitive, the MM should proceed with a normal MLE activation as described in clause H.5.3.

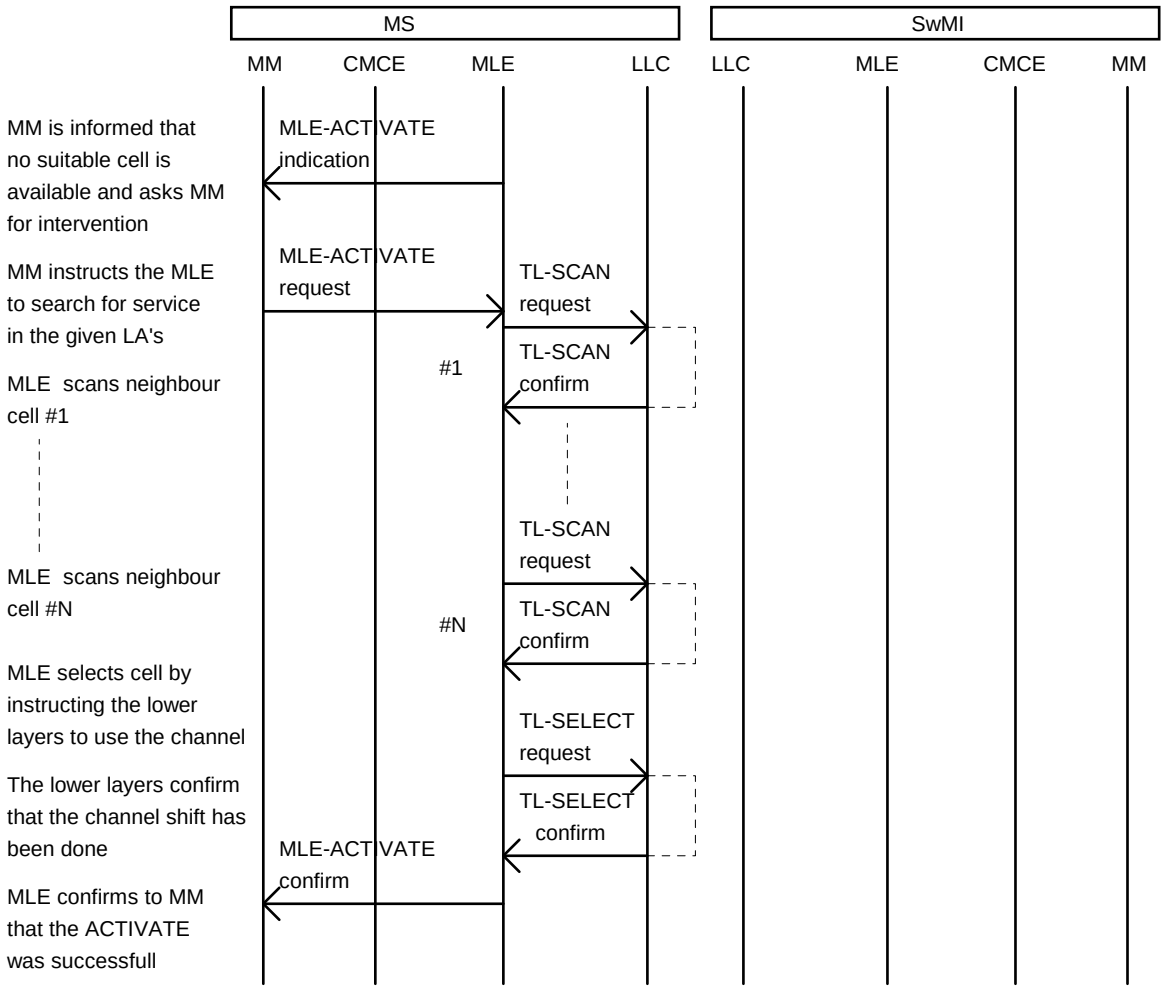


Figure H.9: Inviting MM intervention - no service can be found (scenario 8)

H.5.8.2 LA found outside RA (scenario 9)

When MS-MLE finds a cell in a LA which is outside the current RA, it should invite MM entity intervention. As soon as the MS-MLE has discovered that the obtained LA is outside the RA, it should send a MLE-LINK indication primitive to the MM entity. The new LA in which the MS-MLE wants the MM to register in should be provided as a parameter. Then the MM register procedure should take place as described in clause H.5.11 and according to clause 9. When the MM is satisfied with the new LA, it should send a MLE-UPDATE request primitive to the MS-MLE with the new RA in which the MS-MLE is empowered to search for service. Refer to figure H.10.

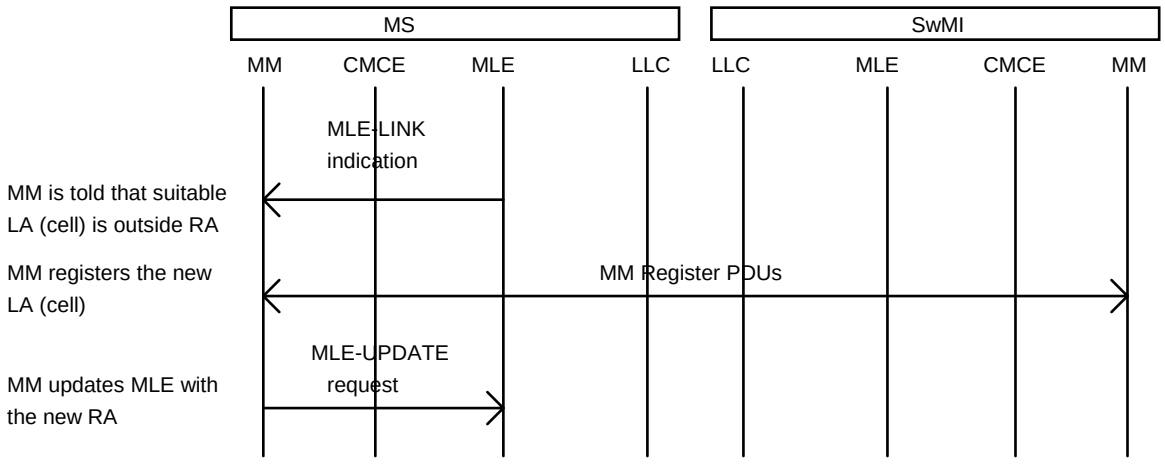


Figure H.10: Inviting MM intervention - LA outside RA (scenario 9)

H.5.9 Set-up of MAC broadcast (SYNC + SYSINFO) (scenario 10)

The MS-MLE can receive information about its serving cell via the SYSINFO broadcast and the SYNC broadcast. The decoding of the broadcasts is undertaken by the lower layers in the MS and is passed on to the MS-MLE via the survey sub-function (see clause H.5.7) and the scanning sub-function (see clause H.5.2). The SwMI-MLE provides network information to the lower layers for broadcasting by issuing a TL-SYNC request primitive and a TL-SYSINFO request primitive. Refer to figure H.11.

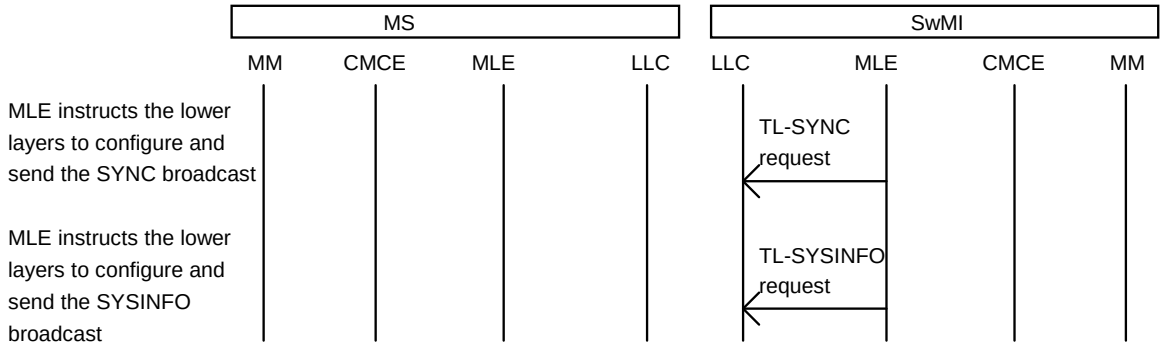


Figure H.11: Set-up of MAC broadcast (scenario 10)

H.5.10 Set-up of MLE broadcast (NETWORK) (scenario 11)

The MS-MLE can receive network information from the SwMI-MLE when attached to a cell. The broadcast may contains information about neighbour cells. The broadcast is sent in a <D-NWRK BROADCAST> PDU which is triggered by a TL-UNITDATA request primitive to the lower layers in the SwMI. The MS-MLE should receive the PDU in a TL-UNITDATA indication primitive. Refer to figure H.12.

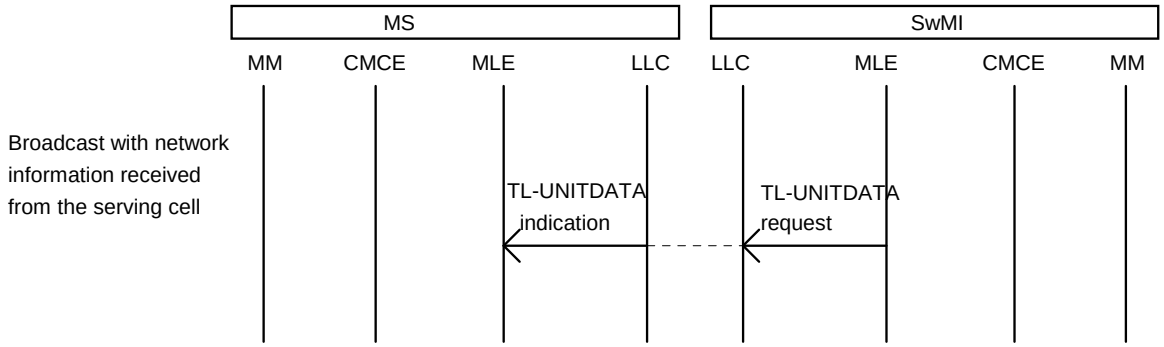


Figure H.12: Set-up of MLE broadcast (scenario 11)

H.5.11 MM registering (scenario 12)

The MM entity may register without being triggered from the MS-MLE. When these procedures are applied (see clause 9) and when the MM is satisfied with the registering, the MS-MLE should receive a MLE-UPDATE request primitive with the new RA. The MS-MLE is empowered to search for service in the new RA. Refer to figure H.13.

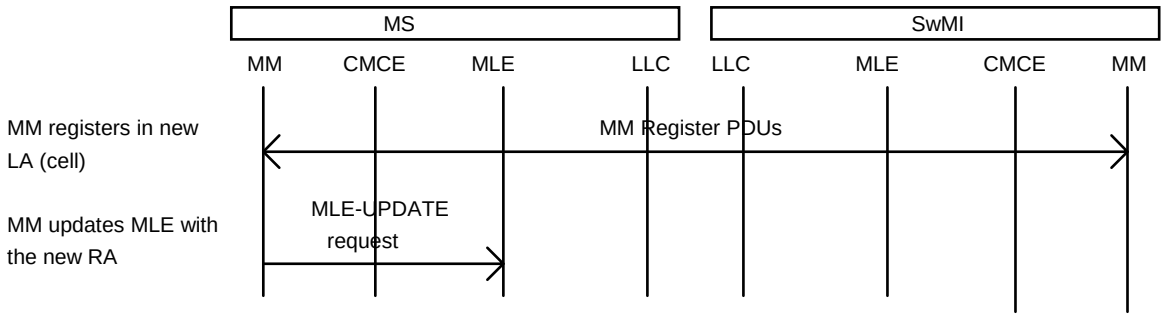


Figure H.13: MM registering (scenario 12)

H.5.12 Announce old cell and go-to-channel (scenario 13)

Before announcing the SwMI-MLE, the MS-MLE issues a MLE-BREAK indication to the CMCE entity.

The MS-MLE then issues a <U-PREPARE> PDU. This informs the SwMI-MLE that the MS intends to move to the new cell. The identity of the new cell is contained in the <U-PREPARE> PDU. On receipt of the <U-PREPARE> PDU, the SwMI-MLE issues a MLE-BREAK indication primitive to the CMCE entity.

If the SwMI is not able to support the MLE recovery procedure, the SwMI-MLE issues a <D-PREPARE FAIL> PDU.

The SwMI MLE then issues a <D-NEW CELL> PDU. This PDU is transmitted through the existing cell and is piggybacked with lower layer information identifying a traffic channel in the next cell, e.g. a go-to-channel. After the <D-NEW CELL> PDU, no further communications are expected in the cell being disused. In the new cell, the configuration of logical channels (e.g. a traffic channel and associated control channels) available to the MS enables the MS to preserve connections which were established prior to the initiation of a cell re-selection. Refer to figure H.14.

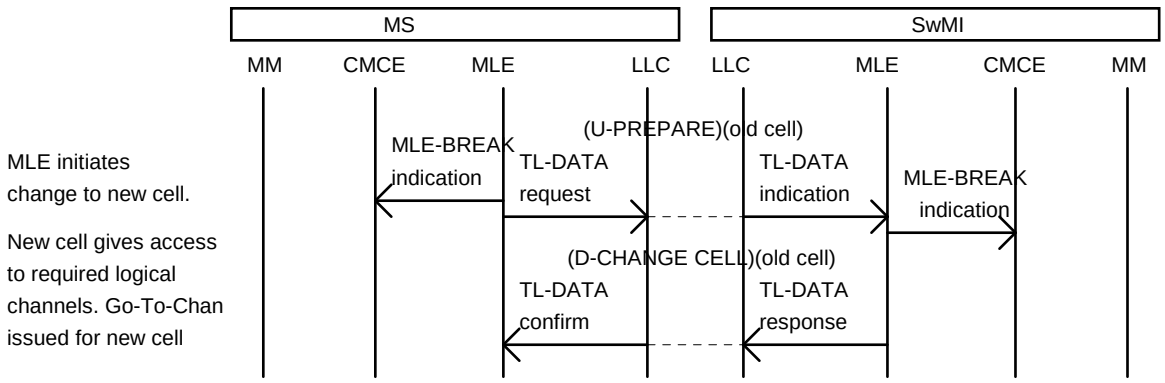


Figure H.14: Announce old cell and go-to-channel (scenario 13)

H.5.13 Announce old cell (scenario 14)

Before announcing the SwMI-MLE, the MS-MLE issues a MLE-BREAK indication to the CMCE entity.

The MS-MLE then issues a <U-PREPARE> PDU. This informs the SwMI-MLE that the MS intends to move to the new cell. The identity of the new cell may or may not be in the <U-PREPARE> PDU. On receipt of the <U-PREPARE> PDU, the SwMI-MLE issues a MLE-BREAK indication primitive to the CMCE entity.

If the SwMI is not able to support the MLE recovery procedure, the SwMI-MLE issues a <D-PREPAREFAIL> PDU.

The SwMI MLE then issues a <D-NEW CELL> PDU in response to the <U-PREPARE> PDU. This <D-NEW CELL> PDU indicates that the MS may change to the new cell, but does not have access to a configuration of logical channels which would enable the MS to continue any ongoing communications. Instead, the MS will begin communications in the new cell using the common control channels. Refer to figure H.15.

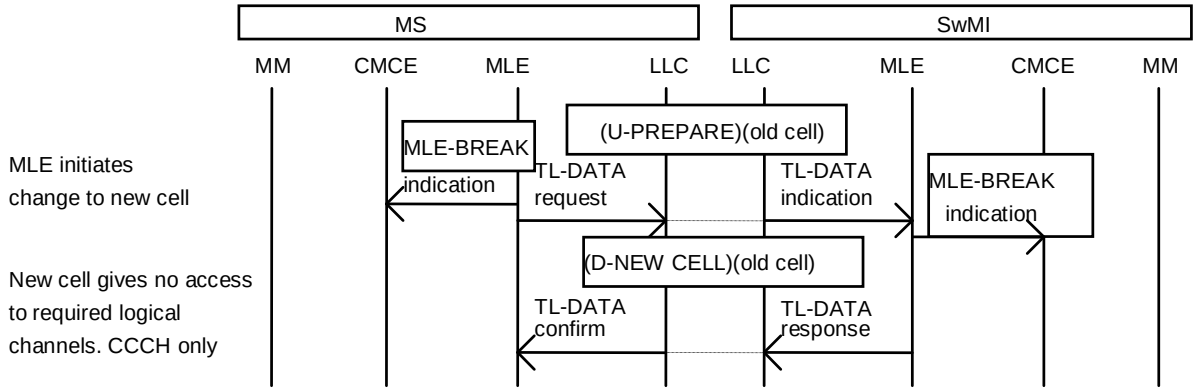


Figure H.15: Announce old cell (scenario 14)

H.5.14 Announce new cell and successful restoration (scenario 15)

The MS-MLE sends a <U-RESTORE> PDU to the SwMI using the new cell. This indicates to the SwMI-MLE that the old cell is no longer being used by the MS. All further communications will be passed through the new cell. The SwMI MLE issues a MLE-RESUME indication primitive to the CMCE, indicating that the MLE connection now has been restored and the continuous service is now available again.

The CMCE information may be different in the new cell from that of the previous cell. The CMCE in the SwMI may send an SDU to the SwMI-MLE for transmission. The SwMI-MLE should piggyback a <D-RESTORE ACK> PDU on to the CMCE-generated SDU. If no SDU is received from the CMCE, the SwMI-MLE still issues a <D-RESTORE ACK> PDU.

On receipt of the <D-RESTORE ACK> PDU, the MS-MLE issues a MLE-RESUME indication to the CMCE entity. Refer to figure H.16.

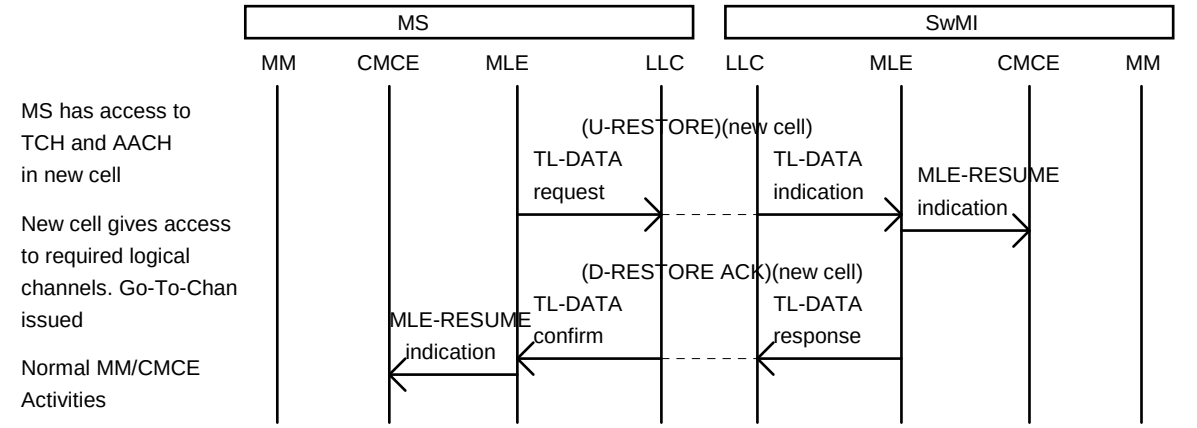


Figure H.16: Announce new cell and successful restoration (scenario 15)

H.5.15 Announce new cell and restoration failure (scenario 16)

The MS-MLE sends a <U-RESTORE> PDU to the SwMI using the new cell. This indicates to the SwMI-MLE that the old cell is no longer being used by the MS. All further communications will be passed through the new cell.

If the SwMI-MLE is unable to restore the connection to the MS in the new cell, the SwMI-MLE responds to the <U-RESTORE> PDU with a <D-RESTORE FAIL> PDU. After a <D-RESTORE FAIL> PDU has been issued, both the MS and SwMI MLEs issue a MLE-REOPEN indication primitive to the CMCE entity. Refer to figure H.17.

NOTE: It is now up to the CMCE entity to cater for the restoration of the MLE connection by setting up a new one. It is also the responsibility of the CMCE to restore its own services. Refer to EN 300 392-2 [4], clauses 14 and 18 for details.

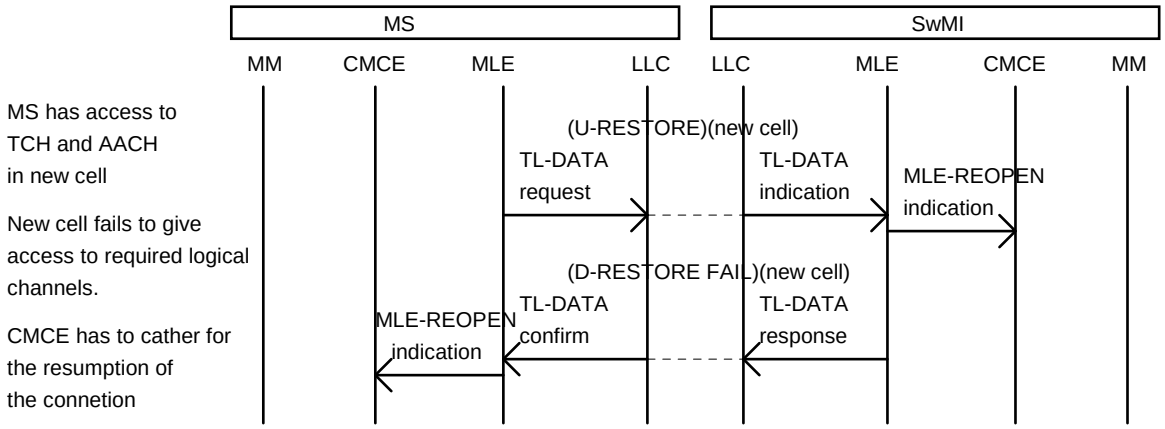


Figure H.17: Announce new cell and restoration failure (scenario 16)

H.5.16 Path lost to the serving cell (scenario 17)

When the path is lost to the serving cell (e.g. the MAC layer has failed to obtain the SYNC and the SYSINFO broadcast for a certain time), the MS-MLE should be informed by a TL-REPORT indication primitive. The parameters to the primitive should contain the cause of the path loss.

If MLE-connection services have been invoked in the MLE by service users, these are informed by a MLE-BREAK indication. Refer to figure H.18.

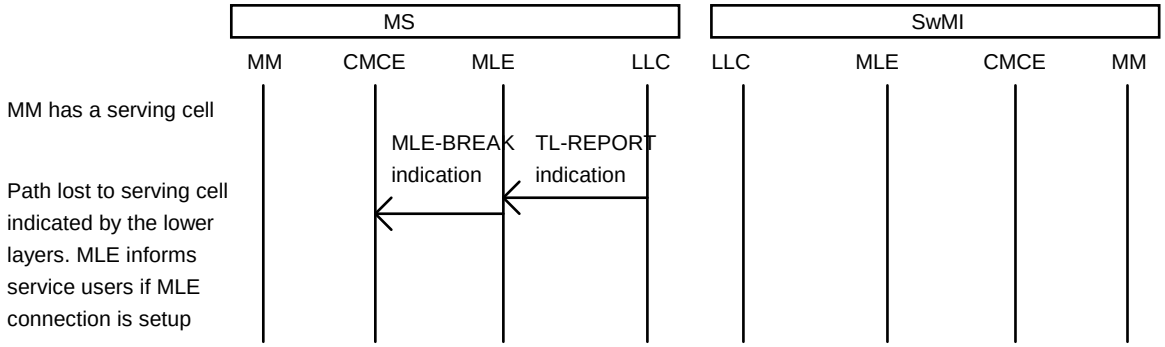


Figure H.18: Path lost to the serving cell (scenario 17)

H.6 Initial cell selection

While moving from cell to cell, the MS can use cell re-selection. However, the very first time a MS wants to be attached to a cell, i.e. the first time where registration is performed after for instance power up, it employs the initial cell selection procedures.

Initial cell selection in the MS-MLE comprises special procedures due to the fact, that both leaving cell and LA are unknown. The initial LAs and preferred cells are given to the MS-MLE by the MM before starting scanning after a suitable cell. The measurement procedures themselves are outside the scope of MS-MLE and are performed by the MAC. Thus the procedures used for initial cell selection may be different to the procedures used at cell re-selection.

When a MS attaches to the SwMI by using initial cell selection, any recovery of MLE connections is not applicable. Therefore an initial cell selection is only valid for the LMM SAP and other upper layer 3 SAPs are in principle closed for communication.

H.6.1 MLE functions as viewed at the LMM SAP

Until MM starts the scanning process, the MS-MLE should be in a NULL state and not able to communicate with anyone. MM should start the selection process by activating the MS-MLE as outlined in scenario 3 (see figure H.4).

The MM intervention performed after the activation may be registration and authentication in the new cell. If these procedures are successful, the MS is attached to the cell. The MM informs the MS-MLE about the new RA by a MLE-UPDATE request primitive. Finally the MM opens up the services as described in scenario 4 (see figure H.5).

NOTE: The MM intervention may also be another activation of the MS-MLE via a new MLE-ACTIVATE request primitive. The parameters may then contain a different set of LAs. The initial cell selection procedure will now start all over again.

H.6.2 MLE functions

The MS-MLE uses scanning when initial cell selection is performed, refer to figure H.19. The procedure in scenario 2 (see figure H.3) may then apply. If a suitable cell can be obtained amongst the scanned cells, the MS-MLE will select this cell (see scenario 3, figure H.4).

If no suitable cell is found, the MM entity may be invited for intervention. However, if the cell is found to be suitable for communication, the MM entity registers the MS.

The initial cell selection is completed by opening up the service SAPs towards the MLE service users (see scenario 4, figure H.5).

Now the MS-MLE may prepare the monitoring of neighbour cells (see scenario 7, figure H.8).

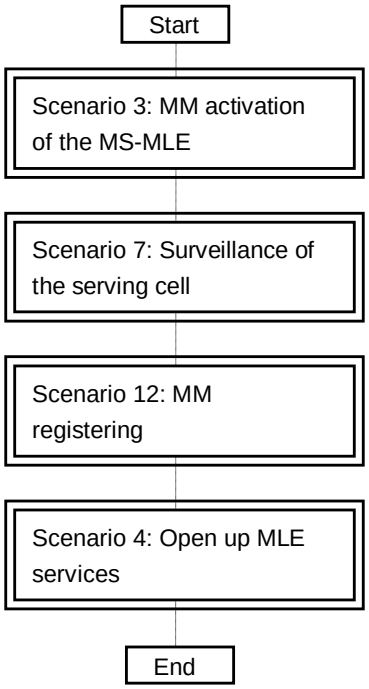


Figure H.19: Initial cell selection

H.7 Cell re-selection by roaming

After the initial cell selection, further change of cells should be made using cell re-selection procedures. While moving within the same network, cell re-selection procedures for roaming are applied. The network procedures are defined in the MLE.

When the MS is migrating instead of roaming it simply means that the cell re-selection is performed choosing a cell in another TETRA infrastructure (SwMI).

In principle, the procedures described for roaming are also applicable for migration with a few exceptions:

- MM opens up a communication path to a new functional entity if MM intervention is required;
- MS informs the SwMI about the cell re-selection. It is assumed that migration will lead to a change in LA.

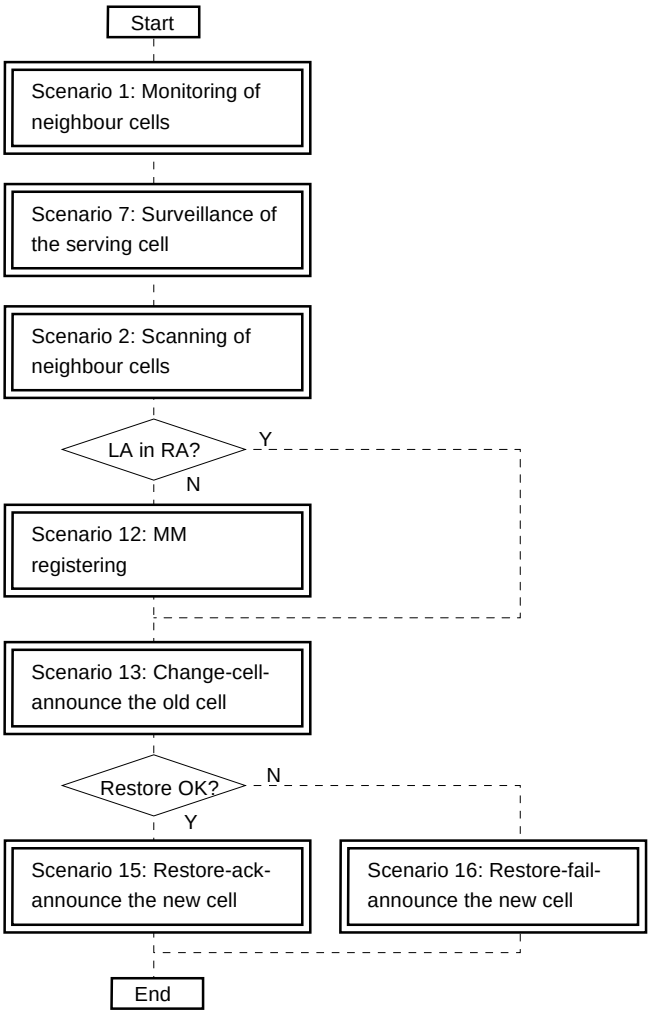
H.7.1 Announced cell re-selection

When a MLE connection has been established, it means that MLE has some responsibilities during cell re-selection. These responsibilities are depending on the choice of the type of re-selection procedure. There may be three different types of announced cell sub-functions for assistance of this overall procedure:

- type-1;
- type-2;
- type-3.

NOTE: A special case exists when the MS does not announce its decision to change cell to the old (leaving) cell. It may be due to external events such as loss of signal to the serving cell or it may be a controlled way of making cell re-selection. This case is known as the unannounced cell re-selection and is described in clause H.7.2.

H.7.1.1 Announced cell re-selection (type-1)



NOTE: The flowchart details may not reflect the actual protocol as defined in EN 300 392-2 [4].

Figure H.20: Announced type-1 cell re-selection

For the announced type-1 cell re-selection, the MS-MLE knows the new Traffic Channel (TCH) in advance, e.g. before making the decision of changing to the new cell. The cell re-selection may then be performed "seamless", where the point of reference for the description "seamless" is the layer 3 service boundary. Refer to figure H.20.

The layer 3 service boundary is the sum of all the services offered by MM, CMCE and SNDCP. This means that at this service boundary, the cell re-selection should not cause any significant interruption of services offered by existing MLE connections.

In order to achieve an announced type-1 cell re-selection, a "go-to-channel" message is issued in the present serving cell and direct the MS to one or more traffic channels in the new cell. This means that the announced type-1 cell re-selection can only be valid for a service user employing the MLE connection service.

H.7.1.1.1 MLE functions as viewed at the LMM SAP

When MM makes the activation of the MS-MLE, the parameters given by the activation are the LAs and preferred cells wherein the MS-MLE is empowered to search for service. By the activation, the MM has also informed the MS-MLE of any rules for making the decision to change cell within the RA. The MS-MLE is empowered to initiate and perform changes from cell to cell within the RA, which is always maintained by the MM.

If the new cell is found suitable and it is a part of the current RA understood by the MS-MLE, the MM is not be involved at all in the cell re-selection procedure.

NOTE 1: If MS-MLE does not find a suitable cell, this is reported to the MM, which then instructs the MS-MLE to search for services in other LAs. The instruction will be initiated by a new activation of the MS-MLE (see clause H.5.8.1).

NOTE 2: If MS-MLE finds a suitable cell but it is outside the current RA, the MM is informed. After the MM registering process is finished, the MS-MLE is empowered to continue the cell change (see clause H.5.8.2).

H.7.1.1.2 MLE functions as viewed at the LCMC SAP

For announced type-1 cell re-selection to be meaningful to the CMCE service boundary, it is assumed that a MLE connection is set-up, i.e. to assist a circuit switched call re-establishment in the U-plane.

When the MS-MLE identifies a second cell in the same RA, which is preferred due to fulfilment of certain network parameters, the MS-MLE will employ the change-cell-announce procedure described in scenario 13 (see figure H.14) towards the current serving cell (old cell) and to all service users that have established a MLE connection. Once the cell change has been completed and the MLE connections have been re-established, the MS-MLE makes a restore-cell-announce to the new cell according to scenario 15 (see figure H.16).

NOTE: Service users that have not set-up a MLE connection in advance are not informed about the cell re-selection. However, if a MLE service is invoked during a cell re-selection, the service user is informed about the current condition of the MLE - see clause H.9.

If the new cell is found suitable, but the MLE is unable to recover the MLE connection to the new cell, the MLE re-opens the service user SAPs as described in scenario 16 (see figure H.17).

When the LCMC SAP has been re-opened, it is the CMCE responsibility to recover the ongoing call in the U-plane using CMCE protocol.

H.7.1.1.3 MLE functions

Before reaching the point where to decide to start the cell re-selection procedure, the survey scenario 7 (see figure H.8) should have been employed beforehand by the MS-MLE. As output from the surveillance process, the MS-MLE should receive path loss measurements and network broadcasts.

Also the monitoring process shown in scenario 1 (see figure H.2) is employed by the MS-MLE beforehand.
A concurrent ranking of neighbour cells takes place based upon the output from the monitoring process.

When the quality of the serving cell is then deteriorating below a certain threshold, the MS-MLE may start the scanning for a new cell employing the scanning scenario 2 (see figure H.3) or the MS-MLE may base the choice of cell on the current ranking performed by the monitoring process (scenario 1, see figure H.2).

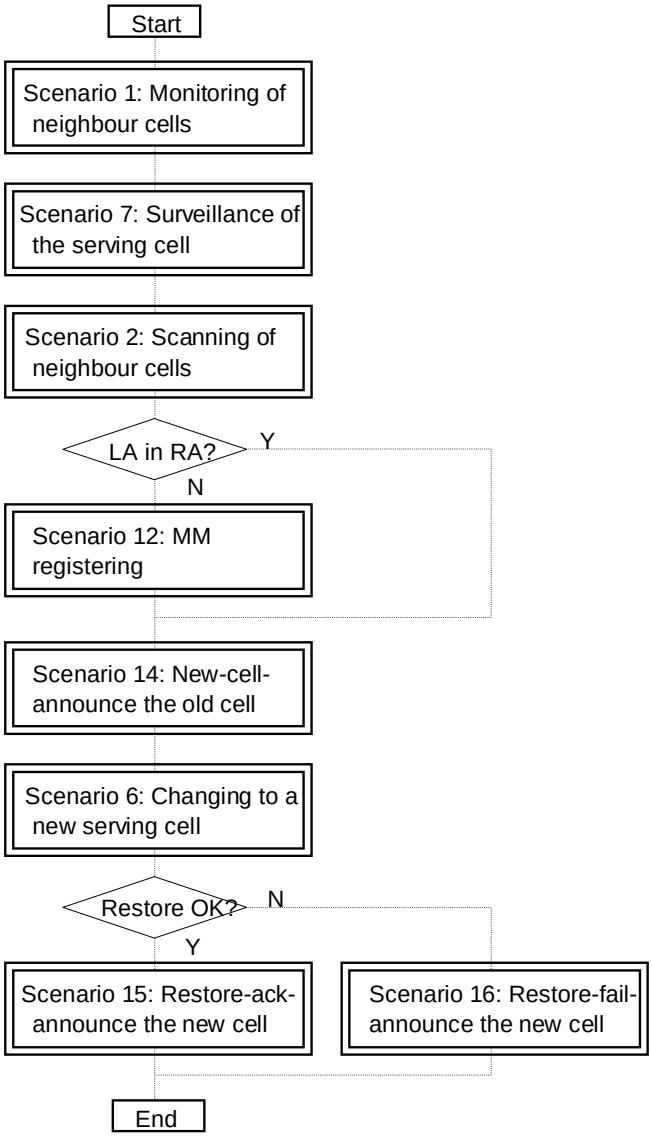
The cell ranking from the monitoring process and the rules which may have been given to the MS-MLE by the MM during a former activation is used as parameters to the scanning scenario.

The path loss for the scanned cell and the network parameters obtained from the SYSINFO broadcast and the SYNC broadcast (EN 300 392-2 [4], clause 23) are used as output from the scanning process.

If the new cell is found to be in the same RA and the MS-MLE has approved the quality information available for the new cell, the MS-MLE will decide to change to that cell and employs the change-cell-announce procedure for the old serving cell as described in scenario 13 (see figure H.14). If MS-MLE is satisfied with the received information regarding the new cell, the MS-MLE employs the restore-announce in the new cell as outlined in scenario 15 (see figure H.16). The result of the restore-announcement in the new cell may either be successful or it may fail.

When the announced cell re-selection type-1 has finished, the MS-MLE starts the monitor sub-function in the new cell, as described in scenario 1 (see figure H.2).

H.7.1.2 Announced cell re-selection (type-2)



NOTE: The flowchart details may not reflect the actual protocol as defined in EN 300 392-2 [4].

Figure H.21: Announced type-2 cell re-selection

The announced type-2 cell re-selection requires only that the MS-MLE knows the new cell in advance. The MS does not receive any knowledge of the channel organization on the new cell before making the decision to change cell. Refer to figure H.21.

NOTE: The reason to utilize this type-2 announcement may be because the SwMI is not able to issue a go-to-channel in the present serving cell, or the network information cannot be provided via the present serving cell.

When employing the announced type-2 cell re-selection procedures, the MLE performs the same procedures as described in clause H.7.1.1.1 except for fact that when the MS-MLE decides to change to the new cell, it will employ the new-cell-announce procedure for the old serving cell (described in scenario 14, see figure H.15) instead of the change-cell-announce procedure. The restore-cell-announcement in the new cell is the same as described in clause H.7.1.1.

Figure H.21 shows the scenarios sequence for the announced type-2 cell re-selection. The shaded scenarios are those which are in addition or in another order compared with figure H.20 and which characterize this type of cell re-selection.

H.7.1.3 Announced cell re-selection (type-3)

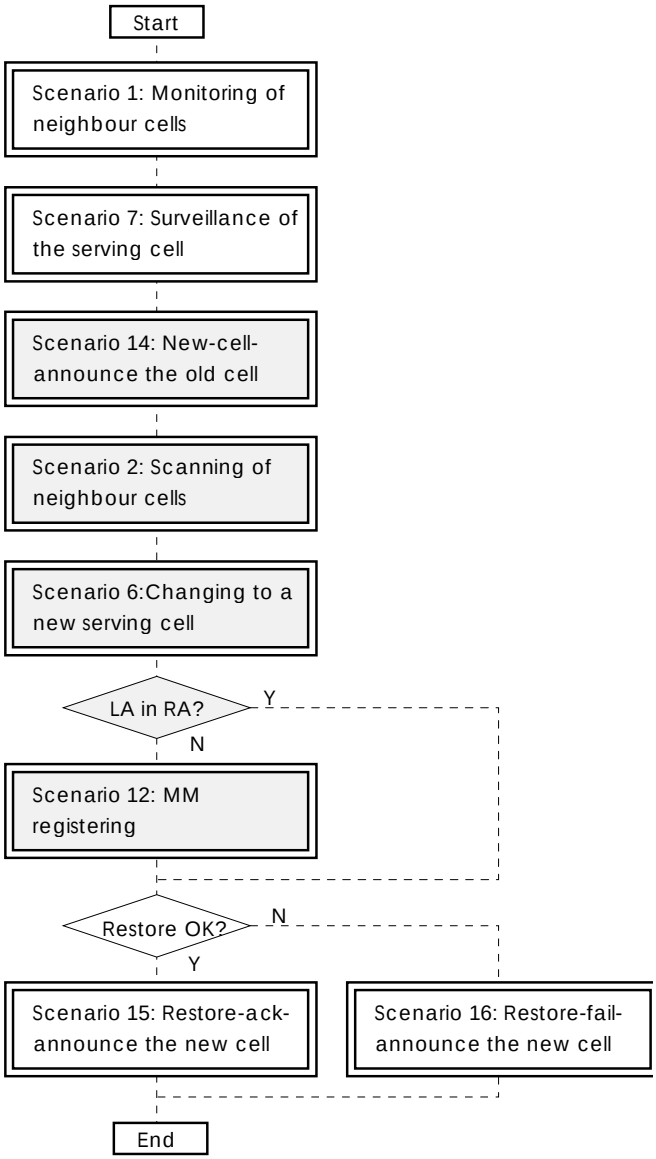


Figure H.22: Announced type-3 cell re-selection

The announced type-3 cell re-selection implies that the MS-MLE has not synchronized to the new cell in beforehand, i.e. before MS makes the decision to change cell. The announcement of the old cell is then only an information stating that the MS leaves the cell and services may be interrupted for a while. Refer to figure H.22.

H.7.1.3.1 MLE functions as viewed at the LCMC SAP

When MS-MLE decides to attempt to change cell based upon the quality information from the serving cell and the monitor information from the neighbour cells, new-cell announcement is performed in the old cell. Once the MS-MLE is satisfied with a new cell, restore-cell announcement is performed in the new cell.

H.7.1.3.2 MLE functions

The MS-MLE checks the quality information available for the serving cell and the neighbour cells. This quality information should be provided by the lower layers according to scenario 1 and scenario 7 (see figures H.2 and H.8). When the MS-MLE decides to change to the new cell, it performs the new-cell announcement before the scanning scenario 2 (see figure H.3) is started. When a suitable cell is found, the MS-MLE will change to the new serving cell according to scenario 6 (see figure H.7).

Invitation of MM by MS-MLE depends on whether the new cell (LA) is within the current RA. If MM intervention is needed, MM registering scenario 12 (see figure H.13) is applied.

Figure H.22 shows the scenario sequence for the announced type-3 cell re-selection. The shaded scenarios are those which are in addition or in another order compared with figure H.20, and which characterize this type of cell re-selection.

H.7.2 Unannounced cell re-selection

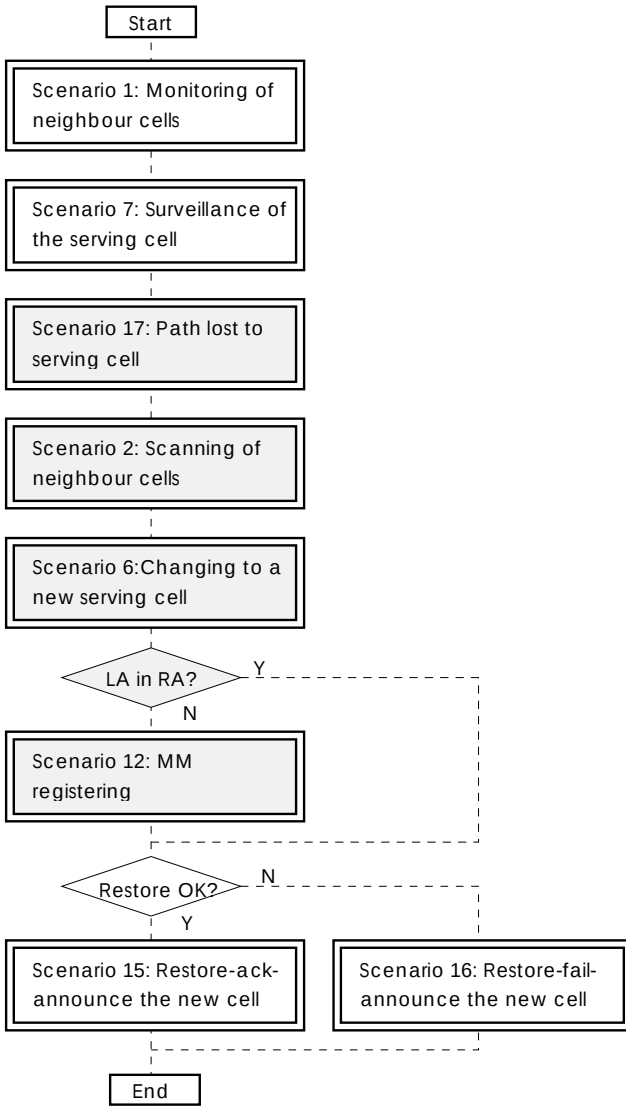


Figure H.23: Unannounced cell re-selection

In these scenarios, the MS-MLE does not inform the present serving cell of the intention to change cell. The reason may be that the MS has lost the path or there may be no time to inform the serving cell in beforehand. Refer to figure H.23.

NOTE: It may also be part of normal operation that the MS does not inform its serving cell when it decides to change cell.

The scenario sequence shown in figure H.23 is for the unannounced 3 cell re-selection. The shaded scenarios are those which are in addition or in another order compared with figure H.20, and which characterize this cell re-selection function.

H.7.3 Undeclared cell re-selection

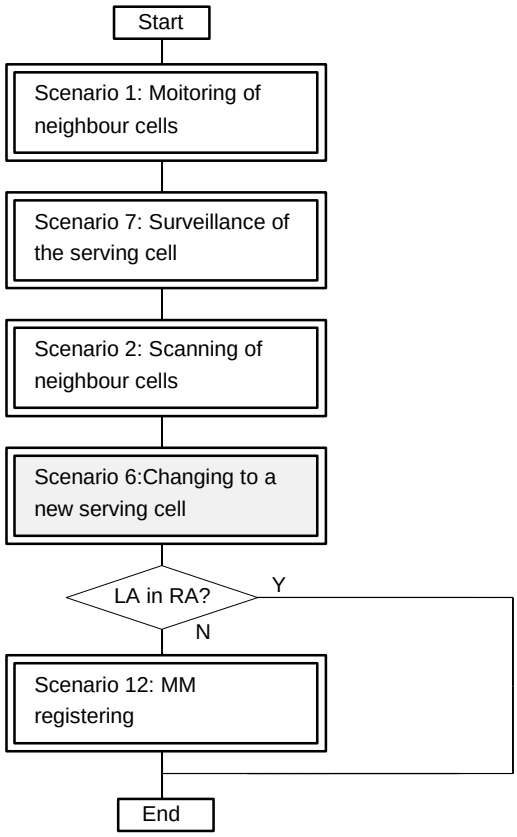


Figure H.24: Undeclared cell re-selection

When no MLE connection is present, the MS-MLE does not have any obligation towards its service users and it will not declare the cell change to neither the serving cell or to the new cell. The MS-MLE is empowered to move freely within the RA without contacting the SwMI. Refer to figure H.24.

H.7.3.1 MLE functions as viewed at the LMM SAP

The MM is invited to make intervention if the MS-MLE finds that a new cell during the scanning scenario 2 (see figure H.3) is outside the current RA. The scenario 12 (see figure H.13) may then apply according to the scenario sequence in figure H.24. The shaded scenarios are those which are in addition or in another order compared with figure H.20, and which characterize this type of cell re-selection.

H.8 MLE service requests during cell re-selection

If the MLE service users request service while the MLE is performing cell re-selection, they are informed about the current situation by the MLE. If service is not available, the scenario in figure H.25 may apply.

H.8.1 Undeclared cell re-selection

The information provided by the MLE informs the service users that service is temporarily not available. The information is provided in a MLE-REPORT indication primitive with the cause = "service not available". Refer to figure H.25.

NOTE: The normal case when this information is provided is during undeclared cell re-selection; however, the procedure may also be applicable towards service users that do not employ MLE connections.

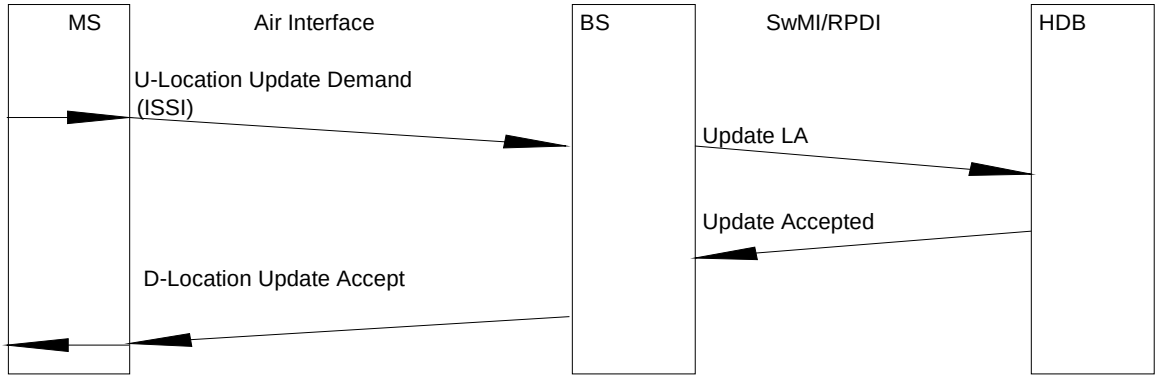


Figure H.25: Service requests during undeclared cell re-selection

H.9 No MLE recovery

It is not a mandatory requirement for the MLE to perform any recovery functions on cell re-selection.

At the LCMC SAP, the MLE issues a MLE-BREAK indication primitive prior to the cell re-selection. After the cell re-selection is complete, the MLE will apply the restore-fail announcement scenario issue a MLE-REOPEN indication primitive.

At the LMM SAP, the MS-MLE issues a MLE-LINK indication primitive or a MLE-ACTIVATE indication if MM intervention is required.

H.10 Use of LLC

The SwMI-MLE can use multiple LLCs simultaneously to provide links to different endpoints.

The MS-MLE can use multiple LLCs to support concurrent and different kinds of services.

Each LLC may offer two different types of logical links (basic link and advanced link) between one MS and one cell. A basic link and an advanced link provides different services to the MLE, which then may choose to use either of them based upon the type and the size of the MLE SDU and the quality parameters associated.

H.10.1 MS-MLE using the LLC basic link

Whenever a MS has registered and all mobility management activity is finished, the MS is attached to the SwMI.

The SAPs towards the MLE service users are opened, indicating that the communication path to the SwMI is available.

When a MS is attached to a SwMI the MLE have a basic link available from the LLC. This link has certain characteristics that the MLE recognizes and use whenever the MS-MLE service users want to communicate with the SwMI. This basic link is chosen using a set of decision parameters, which may be:

- the type of SDUs received on the MLE SAPs;
- the size of the SDUs delivered on the MLE-SAPs;
- other parameters available.

H.10.1.1 Basic link and connectionless MLE service

Figure H.26 shows a MS attached to the SwMI and a MLE-UNITDATA is sent to the SwMI using the basic link of the LLC.

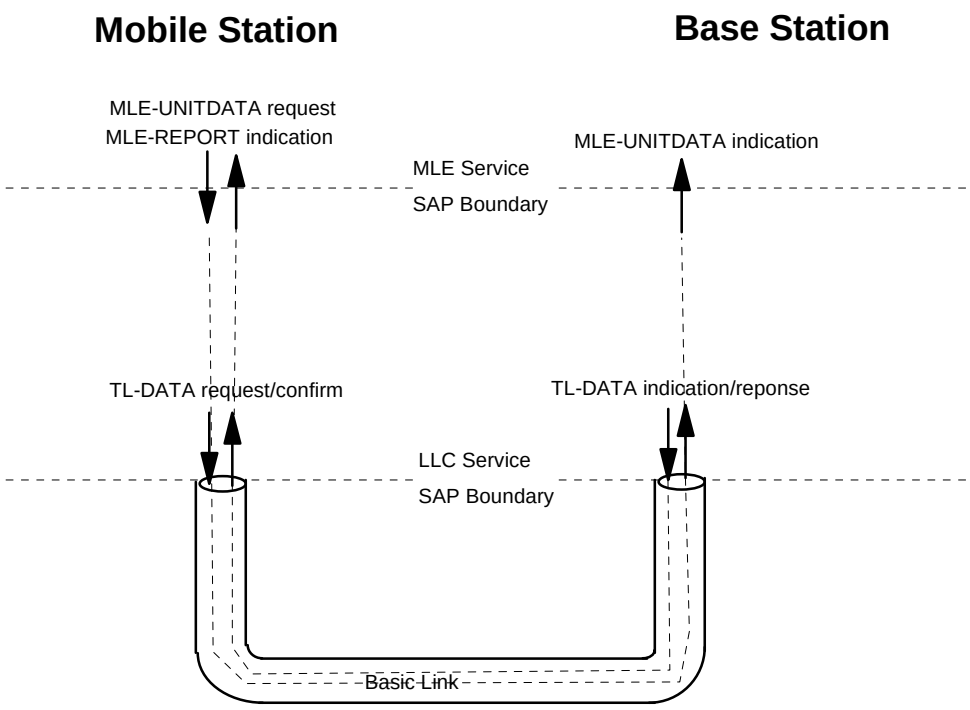


Figure H.26: MLE utilizing the LLC basic link

H.10.1.2 Basic link and MLE connections

If a better service is desired from the MLE Service Users point of view, a MLE connection may be established. The connection is not a real connection, but simply an association both on the MS side and on the SwMI side. Establishing a MLE connection forces the MLE to synchronize the transportation of data with MLE controlled functions, such as cell re-selection.

The connection may be established at any time and removed when no use is required by using MLE-CONNECT and MLE-DISCONNECT primitives. The owner of the connection is the MLE service user who has established the connection. When establishing a connection, a connection identifier should be allocated and associated locally to the MLE. This connection identifier, which is provided to the MLE service users, should then be used hereafter whenever data is sent or received on this particularly MLE connection.

Figure H.27 shows a MS attached to the SwMI and three MLE connections have been established. These connections may have been created by the CMCE. In order to create a MLE connection, MLE-CONNECT request is sent to the MLE. The connection identifier is returned in the MLE-CONNECT confirm. Hereafter only MLE-UNITDATA is necessary to send until MLE-DISCONNECT request is requested in order to break the MLE connection.

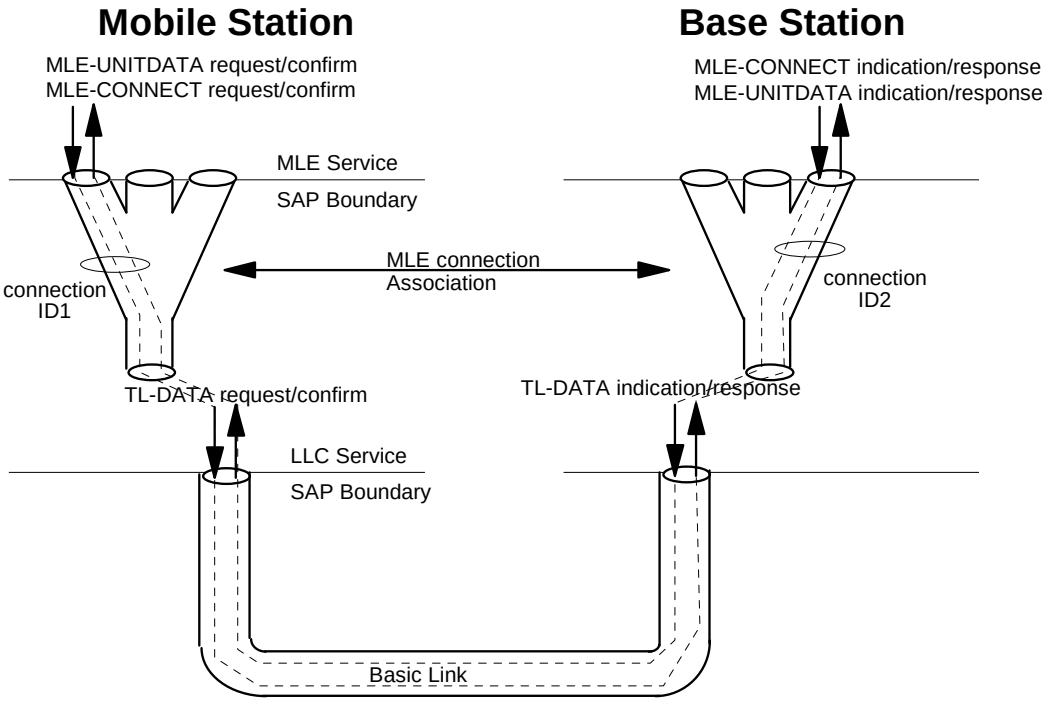


Figure H.27: MLE attached and connections established

H.10.2 MS-MLE using the LLC advanced link

If the MLE receives a SDU from the service users that is considered not to be suitable for the LLC basic link, the MLE should create an advanced link on the LLC to the SwMI. The decision to deny access to the LLC basic link should be taken using the previously defined decision parameters.

Basically there are 2 reasons to create the advanced link:

1) the grade of service offered from the basic link results in very long transmission time, if packet size is too big. The advanced link will provide better grade of service, which will decrease transmission time and increase efficiency (throughput);

2) the load of the air interface, which is a precious resource, is increasing due to the acknowledgement scheme associated to the basic link. On the advanced link windowing will utilize the air interface in a more efficient way.

H.10.2.1 Advanced link and connectionless MLE service

Figure H.28 shows a MS attached to the SwMI and a MLE-UNITDATA is sent to the SwMI using the advanced link of the LLC. The MLE-UNITDATA may originate from the SNDCP entity.

Before using the advanced link on the LLC, the MLE creates it since it is not present by default when attachment to the SwMI is performed. This creation is performed by using TL-CONNECT request/confirm primitives. For the very first creation, this primitive can be used for transporting the MLE-UNITDATA PDU to the peer entity.

As long as the MS is attached to the SwMI using the same cell, the advanced link is available permanently after creation unless a TL-DISCONNECT is used to remove it. A MLE-DISCONNECT issued from the MLE service user or an automatically time out mechanism may be applied in order disconnect the advanced link.

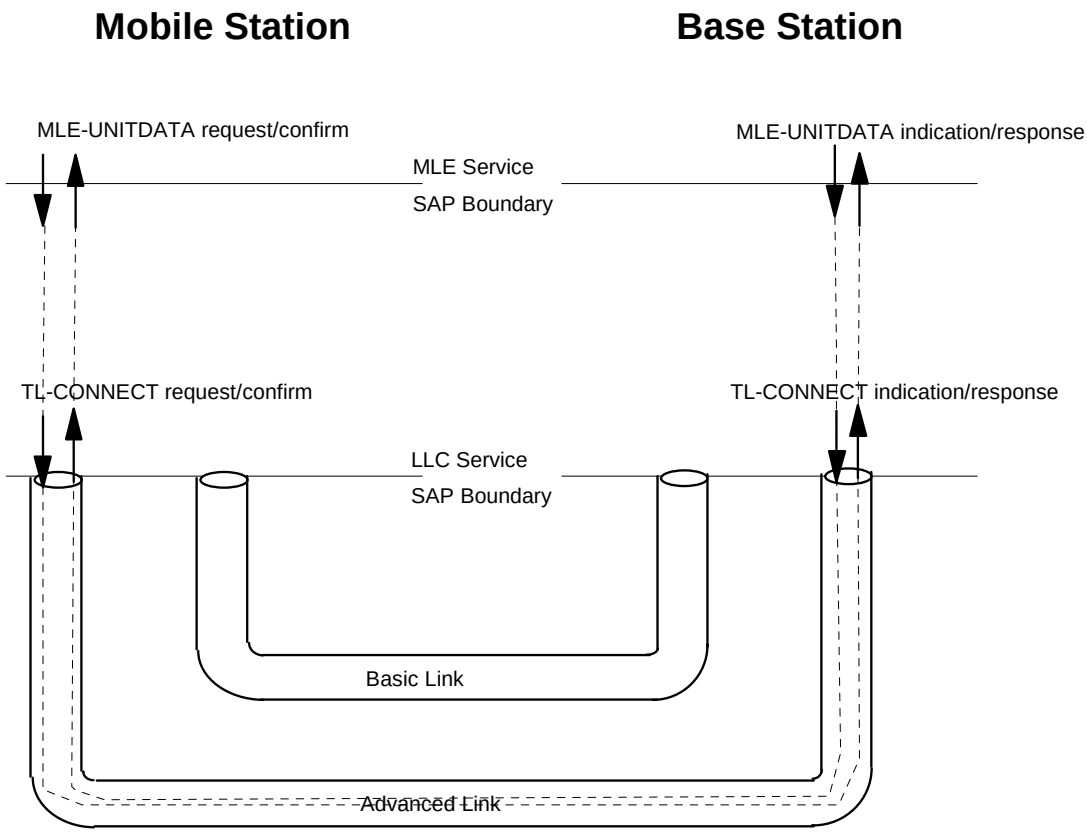


Figure H.28: MLE utilizing the LLC advanced link

H.10.2.2 Advanced link and MLE connection

The MLE has also a choice of using the advanced link offered by the LLC based on the decision parameters defined previously.

NOTE: The QoS parameters negotiated at higher layers may also be the reason to choose the advanced link if the basic link is not capable of providing the necessary assistance.

Annex I (informative): Void

Annex J (informative): Technical realization of SDS and SDS-TL

J.1 Introduction

This clause specifies the technical realization of the SDS on the network layer of the air interface, i.e. specifying:

- an overview of the architectural organization of the network layer, focusing on the short data entity;
- the services provided for the user of the SDS defined as primitives and parameters at the network layer SAP;
- the protocol function of the Short Data Protocol (SDP) defined as the encoding of the Protocol Data Units (PDU) and the descriptions of the related state machines.

J.2 General

The SDS is a message service which is optimized to be a quick service enabling the user to exchange a short user defined message or a short pre-defined message - e.g. emergency message. The message can be sent or received in parallel with an ongoing speech call.

In order to obtain a fast service, the SDS-message should be carried or embedded in a single up link transmission, e.g. one transfer unit. Usually the SDS applies random access procedure which implies that the transfer unit should be equal to half a TDMA slot. However, if the message size does not fit into a half slot the continuation of the message uses reserved access.

The SDS service comprises point-to-point and point-to-multipoint capabilities and may use Short Number Addressing (SNA), full TETRA Subscriber Identity (ITSI/GTSI) and Short Subscriber Identity (SSI) addressing or even external subscriber number. The relation of address method and SDS data length is an optimization issue only.

The basic service does not provide end to end acknowledgement, but uses acknowledged services from the lower layers in order to obtain a more reliable transmission on a per hop basis.

SDS-TL is build on top of the basic SDS and it provides "received" and "consumed" end to end acknowledgement. Refer to EN 300 392-2 [4], clause 29. SDS-TL may provide message storage, if the destination MS is not reachable.

Supplementary services defined in the CMCE associated with the SDS may be applied. Some supplementary services, i.e. SNA, priority and Area Selection (AS) may be invoked by the short data message itself.

Within the SwMI, storage capability may also be available. However, the management of the storage is beyond the scope of the present document.

J.3 Internal organization of the network layer

The short data protocol entity resides on the layer 3 and is a sub-entity in the circuit mode control entity. The service modelling and the network modelling are carried out with respect to this relationship throughout the present document.

J.3.1 Service model

The service model describes the SDS from the perspective of the SDS-SAP as illustrated on figure J.1. In order to send a short data message, the user sends a request to the layer 3 SDS. When the request has been sent on the first link, a report indication will be returned to the user with an indication of send-success or send-failure. At the receiver side, the short data message is seen as an indication.

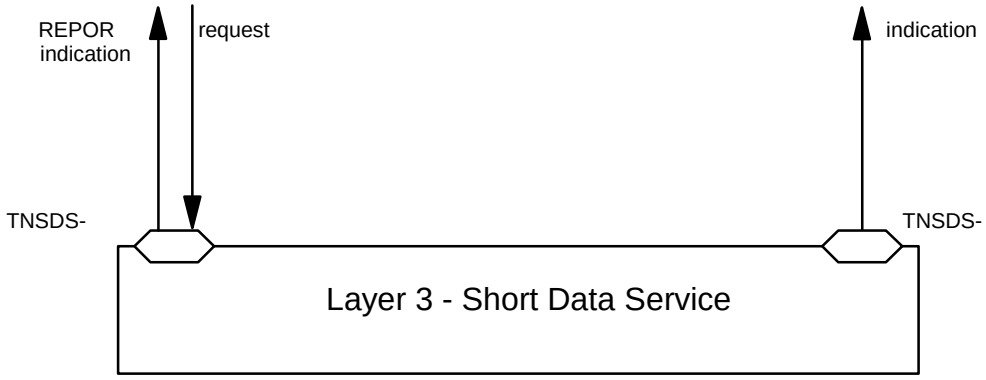
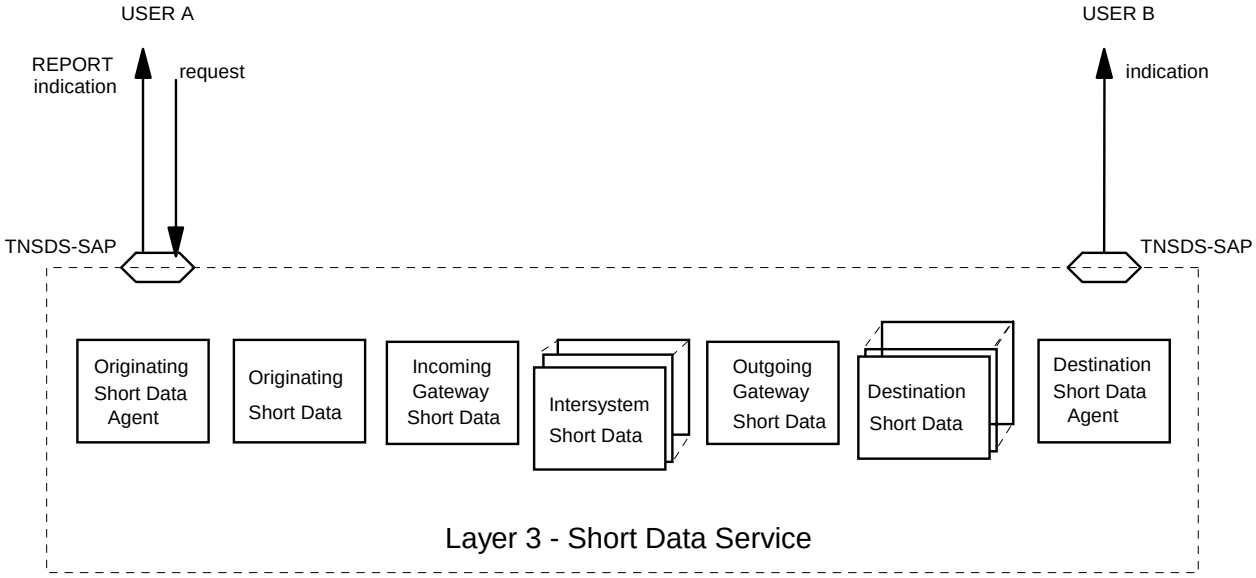


Figure J.1: Service model for SDS

J.3.2 Network model

The layer 3 SDS entity may be broken down into a number of functional entities, each of them having special functional capabilities, in order to transport the message and provide the service for the user. In figure J.2, the different functional entities are shown. Not all of them can be allocated within a message transfer. The ones which are not involved will be idle.



NOTE: The functional entities shown are described in clause J.3.2.1. The use of the functional entities is described in clause J.3.3.

Figure J.2: Network model for SDS

J.3.2.1 Description of the functional entities

Each functional entity comprises a set of entity specific functions:

NOTE: Priority is not valid in general for SDS but access priority may be applied.

- Originating Short Data Agent (OSDA) functional entity:
  - the OSDA is located in the CMCE-MS;
  - it is capable to receive primitives and parameters from the user and send the information to the adjacent Originating Short Data (OSD) functional entity in the SwMI;

- the following functional capabilities exist within the OSDA:
  - ability to send a user defined message limited in length;
  - ability to send a pre-defined message, e.g. emergency message;
  - ability to address a single point by using ISSI or ITSI address of the message receiver;
  - ability to address a multipoint by using GSSI or GTSI of the message receivers;
  - ability to address point-to-point or point-to-multipoint by using SNA;
  - ability to apply access priority to the message;
  - ability to apply 1 of 16 paging areas for the message receiver(s).

- Destination Short Data Agent (DSDA) functional entity:
  - the DSDA is located in the CMCE-MS:
    - it is capable to receive information from the adjacent Destination Short Data (DSD) functional entity in the SwMI and forward primitives and parameters to the user;
  - the following functional capabilities exist within the DSDA:
    - ability to receive a user defined message and relay it to the user;
    - ability to receive a pre-defined message and relay it to the user, e.g. emergency message;
    - ability to receive the ISSI or ITSI address of the message sender and relay it to the user;
    - ability to receive the priority applied to the message, and relay it to the user.

- Originating Short Data (OSD) functional entity:
  - the OSD is located in the CMCE-SwMI, e.g. in the BS at the message sender side in the SwMI;
  - it is able to receive information from the preceding OSDA functional entity in the MS or the LS and forward requests to the subsequent Inter-system Short Data (ISD) functional entity or the subsequent Destination Short Data (DSD) functional entity;
  - the following specific functional capabilities exist within the OSD:
    - ability to multiply a received message to different DSDs or ISDs depending on the location of the MSs, having the same GSSI or GTSI;
    - ability to implement the priority set for the message either by selecting special routes, queues or by pre-emption of other messages within the SwMI;
    - ability to react on different supplementary services set for the service in advance, such as:
      - SNA;
      - AS; and
      - Access Priority (AP);
    - ability to multiply a received message to different DSDs or ISDs depending on the selected paging area.

NOTE 1: The OSD is located entirely within the SwMI and further specification and definition is beyond the scope of the present document.

- DSD functional entity:
  - the DSD is located in the CMCE-SwMI;
    - it is able to receive information from the preceding OSD functional entity in the SwMI or the preceding ISD functional entity in the SwMI and forward requests to the subsequent DSDA functional entity in the MS or in the LS;
  - the following specific functional capabilities exist within the DSD:
    - ability to validate the address of the message receiver, e.g. the SSI or the TSI;
    - ability to react on different supplementary services set for the service in advance, such as:

      Call Forwarding Unconditional (CFU).

NOTE 2: The DSD is located entirely within the SwMI and further specification and definition is beyond the scope of the present document.

- ISD functional entity:
  - the ISD functional entity is located in CMCE-ISI, e.g. in the equipment of the ISI in the SwMI;
  - the functional entity exists both at the sending side and at the receiving side;
  - it is able to receive information from the preceding OSD functional entity in the same SwMI or the preceding ISD functional entity in another SwMI;
  - received information is forwarded as requests to the subsequent DSD functional entity in the same SwMI or the subsequent ISD functional entity in another SwMI;
  - the following specific functional capabilities exist within the ISD:
    - ability to multiply a received message from a preceding ISD to different DSDs or ISDs depending on the location of the MSs, having the same GSSI or GTSI;
    - ability to map received messages from a preceding OSD or ISD onto Remote Operations Service Element (ROSE) (as defined in ITU-T Recommendation X.219 [i.4] and ECMA 165 [i.6]) via the co-ordination function ECMA 165 [i.6] at the ISI. This mapping is done by using the service provided by ROSE;
- Incoming Gateway Short Data (IGSD) functional entity:
  - the IGSD functional entity is located in CMCE-IGW, e.g. in the equipment of the gateway in the SwMI;
  - is able to receive information from other non-TETRA networks;
  - received information is forwarded as requests to the subsequent DSD functional entity in the same SwMI or the subsequent ISD functional entity in the same SwMI;
  - the following specific functional capabilities exist within the IGSD:
    - ability to map the address domain of the gateway network to the TETRA address domain.
- Outgoing Gateway Short Data (OGSD) functional entity:
  - the OGSD functional entity is located in CMCE-OGW, e.g. in the equipment of the gateway in the SwMI;
  - is able to receive information from the preceding OSD functional entity or the ISD functional entity in the same SwMI;
  - received information is sent to other non-TETRA networks forwarded as requests;
  - the following specific functional capability exists within the OGSD:
    - ability to map the TETRA address domain to the address domain of the gateway network.

J.3.2.2 Description of the relationships between functional entities

Between each functional entity, a functional relationship specifies the information flow between them. The relationships are called r_1 r_2 and r_2*.

The r_1 relationship specifies the access relation between the OSD agent functional entity and the AOSD functional entity within the SwMI. It also specifies the relation between the DSD functional entity within the SwMI and the adjacent DSDA. The r_1 relationship specifies the TETRA air interface protocol at the Um reference point (as defined in annex A).

The r_2 relationship specifies the distributive relation between ASD functional entities within one or several SwMIs. These are the ISD functional entity, the IGSD functional entity and the OGSD functional entity.

NOTE: Except for the relationship to the ISD functional entity, the r_2 relationships are beyond the scope of the present document. Thus, these r_2 relationships should then only be considered as informative.

The r_2 relationship between two ISD functional entities specifies part of the TETRA Network Protocol 3 (TNP3 protocol), which is visible at the Q reference point.

The r_2* relationship specifies the general relation between a gateway SDS functional entity (incoming or outgoing) and a non TETRA system, e.g. a PTN, a PSTN or an ISDN.

J.3.3 Allocation of functional entities

The functional entities described in clause J.3.2.1 may be allocated to different physical locations. Figures J.3 to J.10 show different allocations.

J.3.3.1 Point-to-point message transfer within one SwMI

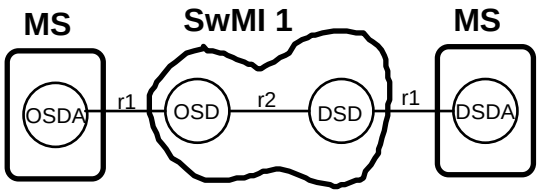


Figure J.3: Point-to-point message transfer within one SwMI

J.3.3.2 Point-to-multipoint message transfer within one SwMI

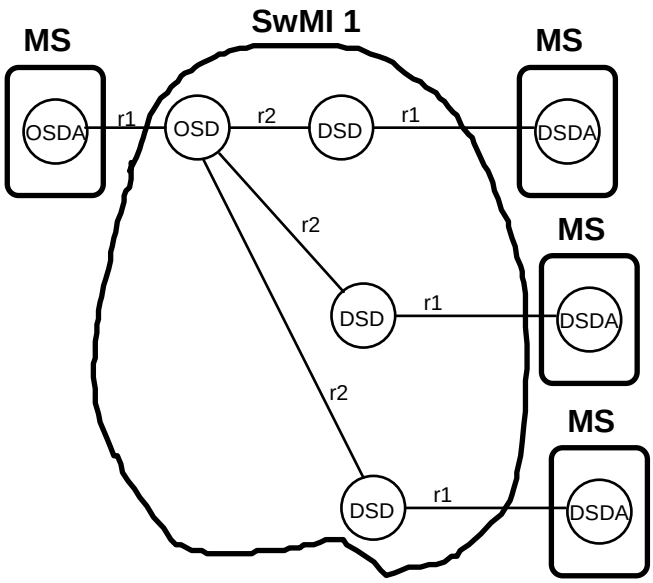


Figure J.4: Point-to-multipoint message transfer within one SwMI

J.3.3.3 Point-to-point message transfer within two SwMI

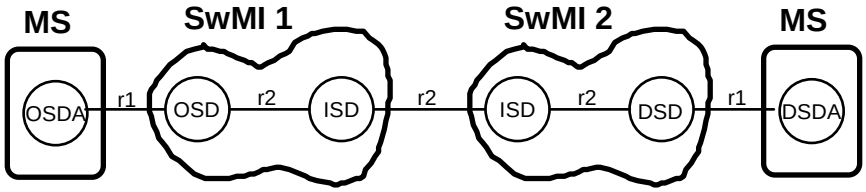


Figure J.5: Point-to-point message transfer within two SwMI

J.3.3.4 Point-to-multipoint message transfer within two SwMI

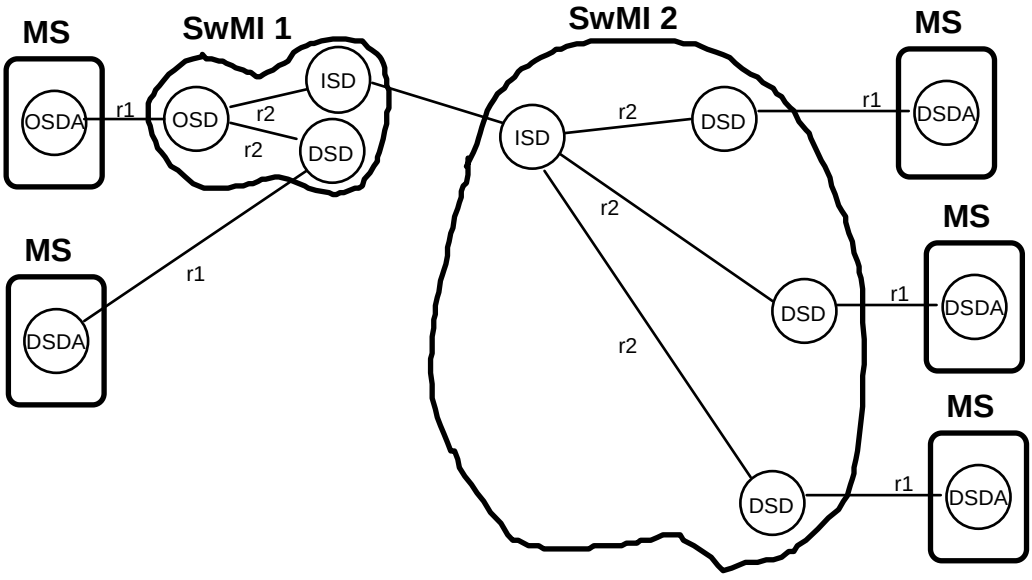


Figure J.6: Point-to-multipoint message transfer within two SwMI

J.3.3.5 Point-to-point message transfer via an outgoing gateway

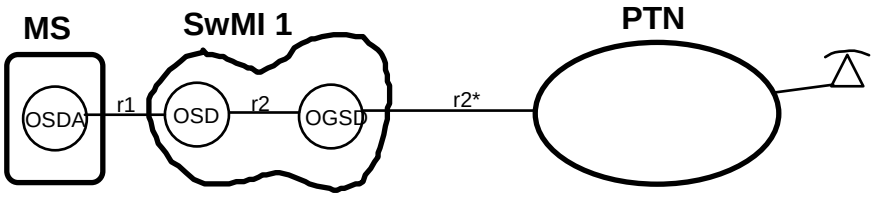


Figure J.7: Point-to-point message transfer from a SwMI to a PTN, using OGSD

J.3.3.6 Point-to-point message transfer via an incoming gateway

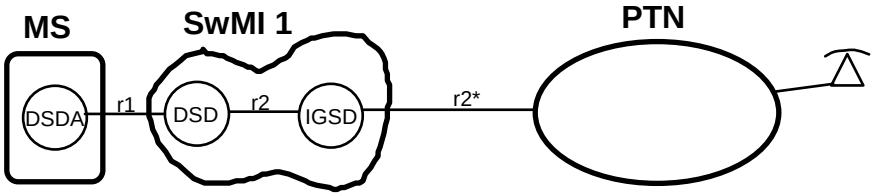


Figure J.8: Point-to-point message transfer from a PTN to a SwMI, using IGSD

J.3.3.7 Point-to-multipoint message transfer via an outgoing gateway

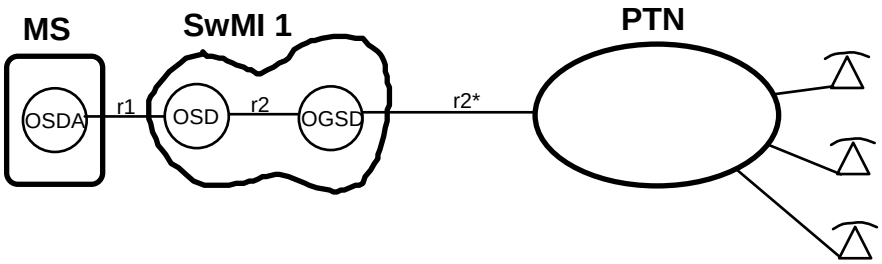


Figure J.9: Point-to-multipoint message transfer from a SwMI to a PTN, using OGSD

J.3.3.8 Point-to-multipoint message transfer via an incoming gateway

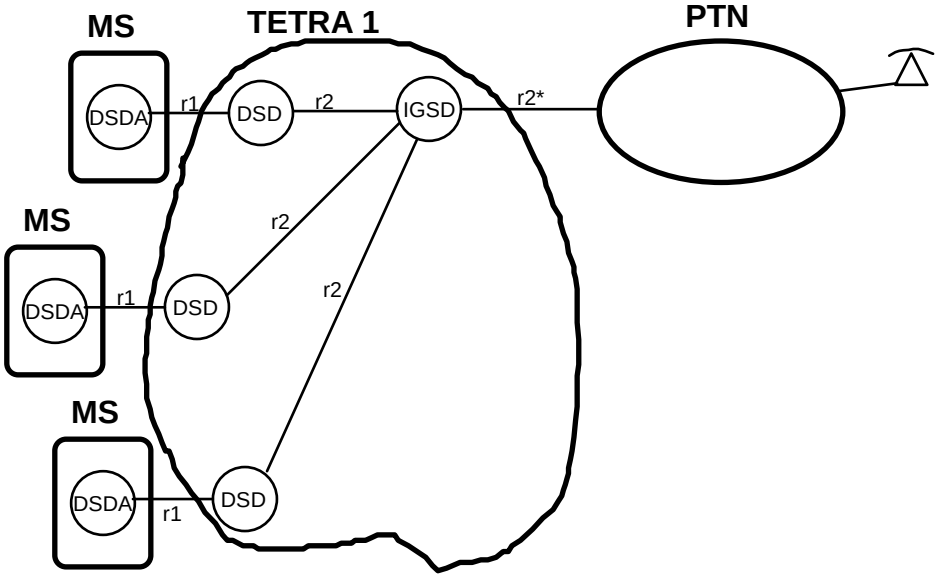


Figure J.10: Point-to-multipoint message transfer from a PTN to a SwMI, using IGSD

J.4 Protocol architecture

The layer 3 SDS entity should be a sub-entity in the CMCE. The C-plane protocol stacks for the MS and the BS are shown on figures J.11 and J.12.

J.4.1 MS protocol stack

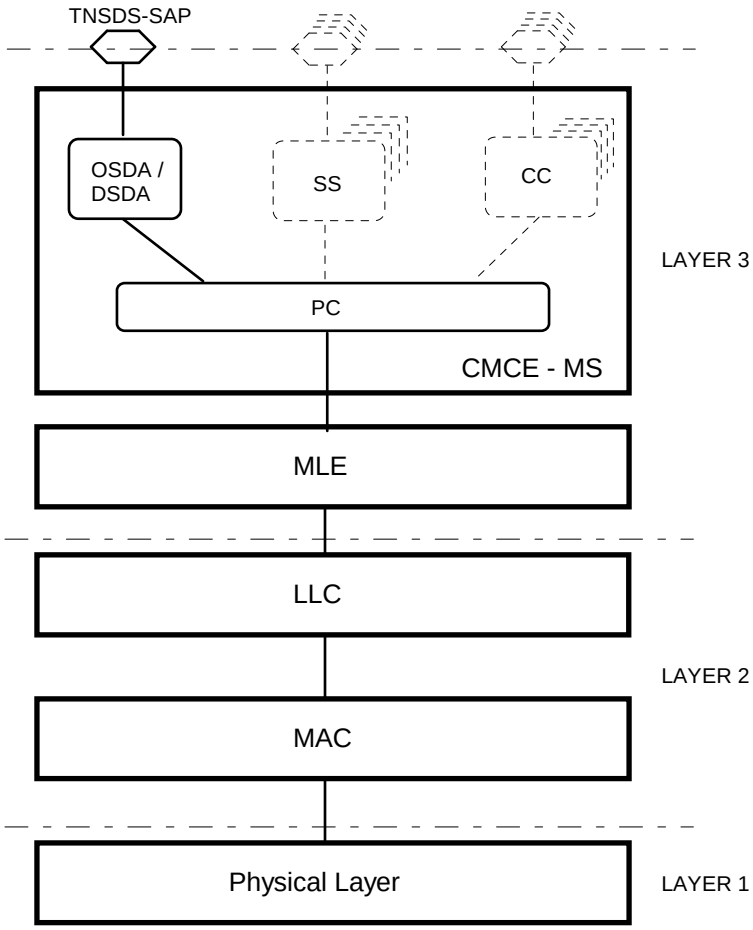


Figure J.11: MS protocol stack

OSDA functional entity and DSDA functional entity are both located at the top of the Protocol Control (PC) within the CMCE-MS. The SDS is provided to the user via the TNSDS-SAP at the top of the CMCE-MS. The functions of the entities are described in clause J.3.2.1.

PC contains the state/event machine for the air interface protocol, e.g. it handles short data PDU (as defined in EN 300 392-2 [4], clause 14), and has a peer to peer relationship with the PC within the CMCE-SwMI. The PC uses the normal MLE-primitives to achieve this peer-to-peer relationship.

MLE, LLC and MAC are entities which are described in clause 6.

J.4.2 BS protocol stack

This clause contains information residing in the SwMI and as such is considered to be outside the scope of the present document and is therefore informative only. The BS architecture is different from the MS regarding the SAP to the short data sub-entity. The SAP is a sub-network SAP since it provides service to another layer 3 sub layer within the SwMI, e.g. a routing and relaying capability.

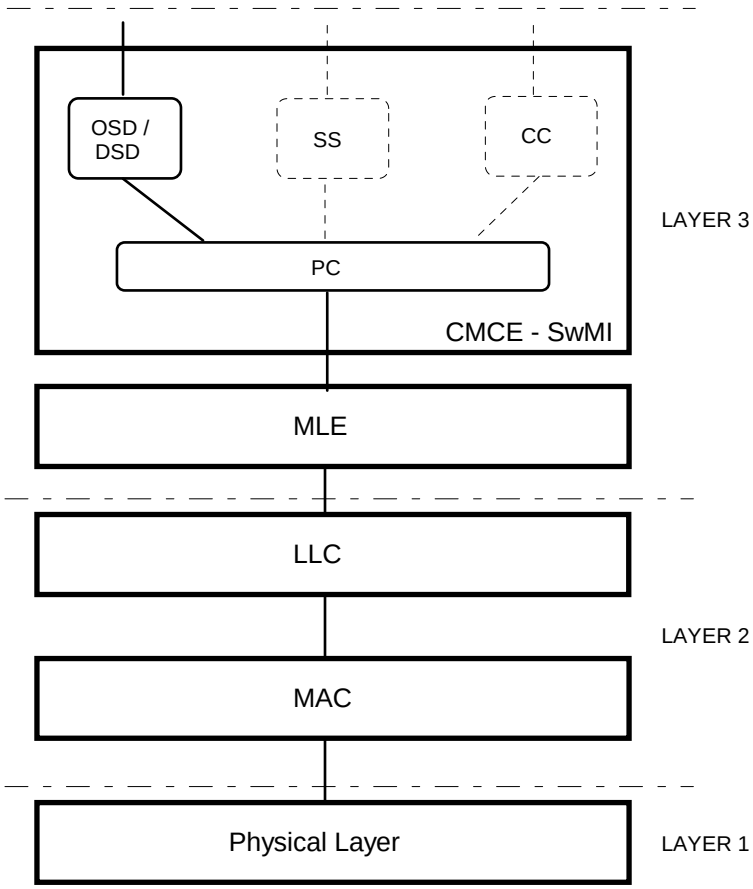


Figure J.12: SwMI protocol stack

The OSD functional entity and the DSD functional entity are both located at the top of the PC within the CMCE-SwMI. The short data sub-entity has relationships to other short data functional entities within the SwMI as described in clause J.3.2.1.

PC has the same structure as the PC within the MS and LS.

MLE, LLC and MAC are entities which are described in clause 6.

J.5 Addressing

J.5.1 Uplink addressing on the air interface

The addressing to be used in connection with the SDS on the up link is either:

- SSI, when employed, it is used both as a destination address and as a source address; or
- TSI, when employed, it is only be used as a destination address. The source address, i.e. MAC address, is still the SSI; or
- SNA, when employed, it is only be used as a destination address. The full address, either the SSI or the TSI, will be expanded within the SwMI. The source address, i.e. MAC address, is still the SSI.

J.5.2 Downlink addressing on the air interface

The addressing to be used as a destination address in connection with the SDS on the downlink is a SSI.

The addressing to be used as a source address in connection with the SDS on the down link is either:

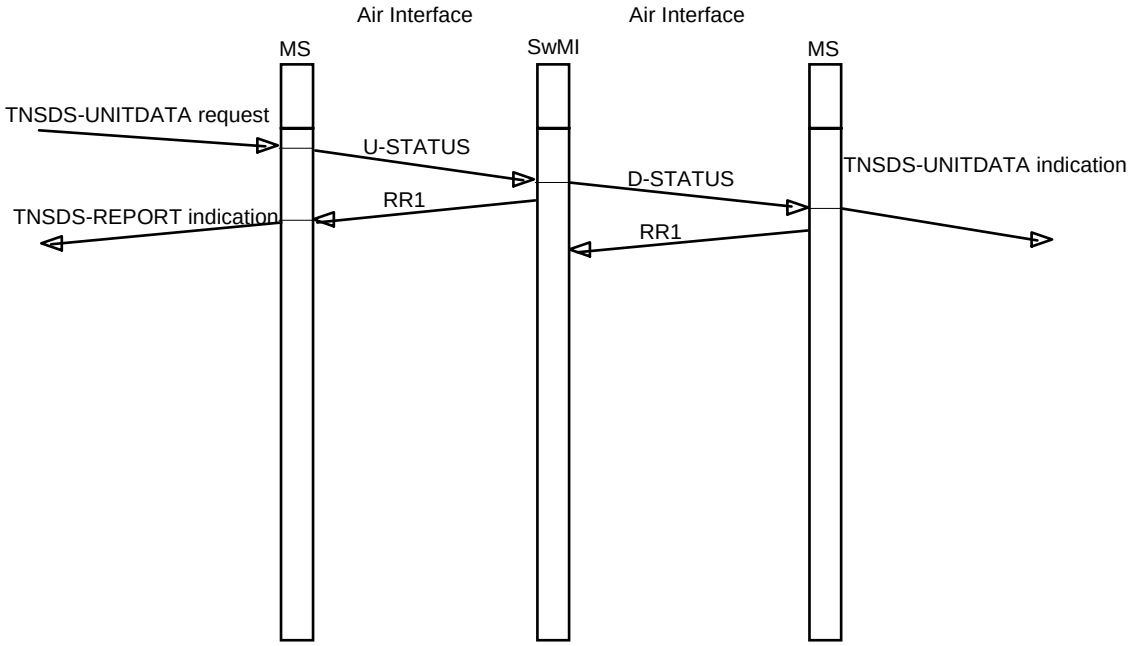
- a SSI; or
- a TSI.

J.6 Services provided by the air interface protocol

The service offered by the short data sub-entity in the CMCE is:

- sending and receiving short messages without establishment of a connection over the air interface;
- sending and receiving user defined or pre-defined messages;
- sending messages point-to-point as shown in figure J.13 or point-to-multipoint as shown in figure J.14.

NOTE: In the figures the U-STATUS may be also U-SDS DATA and D-STATUS may be D-SDS DATA.



RR1 : Layer 2 acknowledgement PDU
U-STATUS, D-STATUS : Layer 3 PDU

Figure J.13: Intra-TETRA (point-to-point)

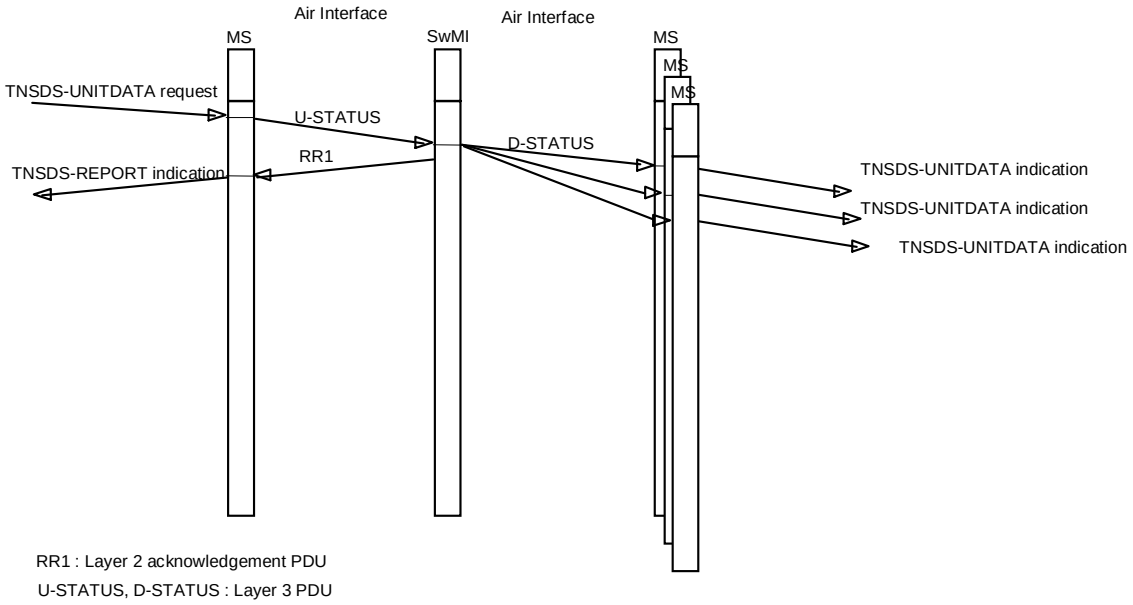


Figure J.14: Intra-TETRA (point-to-multipoint)

J.7 Lower layer services used

The short data functional sub-entities use the services of other sub-entities within the CMCE. Depending on the location of the CMCE, different lower layers are applied.

J.7.1 MLE primitives used in the MS and the LS

The CMCE in the MS and the LS should use the following primitives at the LCMC-SAP in order to provide the necessary service to the short data functional sub-entities:

- MLE-UNITDATA request/indication - for providing unconfirmed service in order to transfer the short data message;
- MLE-REPORT indication - for providing a report on the transfer of the short data message over the air interface.

Annex K (informative): General on supplementary services

K.1 Introduction

This annex defines a set of supplementary services to the teleservices and bearer services which may be supported by a TETRA network.

K.2 General

K.2.1 Framework for the description of supplementary services

ETR 086 [i.7] describes the principles of the telecommunication services provided in a TETRA network. It defines the concepts of telecommunication services and describes their characterization by appropriate attributes. Bearer services and teleservices, which are offered by a TETRA network in connection with other networks, are also defined in ETR 086 [i.7].

A supplementary service modifies or enhances a basic bearer service or teleservice or other supplementary service. The same supplementary service may be offered with a number of different telecommunication services.

Table K.1 illustrates the description of telecommunication services.

Table K.1: Categorization of telecommunication services

Telecommunication service			
Bearer service		**Teleservice**	
Basic Bearer Service	Basic bearer Service + Supplementary service	Basic Teleservice	Basic Teleservice + Supplementary service

In accordance with ITU-T Recommendation I.130 [i.1], the following three level structure is used to describe the supplementary telecommunications services as provided by European TETRA Operators:

- **Stage 1:** is an overall service description, from the user's stand-point;
- **Stage 2:** identifies the functional capabilities and information flows needed to support the service described in stage 1;
- **Stage 3:** defines the signalling system protocols and switching functions needed to implement the service described in stage 1.

K.2.2 Alignment with the European Computer Manufacturers Association (ECMA)

Stage 1, stage 2 and stage 3 descriptions of the TETRA supplementary services align with the appropriate corresponding ECMA standard as much as possible.

Where no ECMA standards exist, then new descriptions are devised, following the principles laid out in the ECMA documentation.

K.2.3 Methodology

The purpose of stage 1 and 2 specifications is to guide and constrain the work on signalling protocols at stage 3.

Stage 1 is a general description of the overall functioning of the service.

Stage 2 consists of the following steps:

- **Step 1:** functional model identification of functional entities and their relationship;
- **Step 2:** information flow diagrams;
- **Step 3:** SDL diagrams for each functional entity;
- **Step 4:** functional entity actions;
- **Step 5:** allocation of functional entities to physical locations.

The decision to follow ECMA's stage 2 is an important one and is based on considerations of signalling across the ISI. In the case of interworking, unless it is clearly understood where functional entities reside, then there is no means of understanding the signalling protocols across the ISI.

Steps 1, 4 and 5 of stage 2 identify functional entities within the infrastructure, allocate them to physical locations within it, and examine their behaviour. It is appreciated that, depending on the equipment manufacturer and service application, there may be many different combinations possible to locate functional entities.

The specific combination of functional entities may determine the type and content of messages across the ISI.

The protocol design at stage 3 can now be understood. Different allocations of functional entities to physical locations may produce different protocols and procedures across the ISI.

The stage one descriptions of the different supplementary services are contained in EN 300 392-10 [i.9].

K.3 Supplementary service concepts

A supplementary service modifies or supplements a basic bearer service or teleservice or other supplementary services.

K.3.1 Concepts associated with supplementary services

The terms used in the stage 1 descriptions are defined in the following clauses.

K.3.1.1 Provision

An action to make a service available to a user. The provision may be:

- **general:** where the service is made available to all users (subject to compatibility restrictions enforced) without prior arrangements being made with the service provider;
- **pre-arranged:** where the service is made available to an individual user only after the necessary arrangements have been made with the service provider.

K.3.1.2 Withdrawal

An action taken by the service provider to remove an available service from a user's access. The withdrawal may be:

- **general:** where the service is removed from all users provided with the service;
- **specific:** where the service is removed on an individual basis from users provided with the service;
- **temporary:** where the service is removed for a period of time and may be provided later without further arrangements.

K.3.1.3 Activation

An action taken by either the service provider or the served/authorized user to enable a process to run, as and when required, by the service concerned. The time during which the process is activated is defined as the active phase. During activation the service is either "operative" or "not operative" according to whether or not the system is actually using the service, e.g. to forward a call or to apply call waiting indication.

K.3.1.4 Deactivation

An action taken by either the service provider or the served/authorized user to terminate the process started at the activation. A supplementary service can be automatically deactivated at the end of a call if the supplementary service was specifically activated for that call. Additionally, a supplementary service may be automatically deactivated by the network as a consequence of activation of another supplementary service if it conflicts with the other activated supplementary service.

K.3.1.5 Definition

An action taken by either the service provider or the served/authorized user in order to define or redefine parameters relating to a particular supplementary service, (e.g. redefine short numbers within SS-SNA, or defining personalized areas in a network within SS-AS).

K.3.1.6 Registration

The programming by the service provider to identify certain authorized users, who may be allowed to activate/deactivate/invoke/define/cancel/interrogate a certain supplementary service.

K.3.1.7 Interrogation

An action taken by the served/authorized user in order that useful information regarding a particular supplementary service may be obtained, e.g. to ascertain the activity state and parameters of a given supplementary service.

A general interrogation of all supplementary services may be provided.

EXAMPLE: possible interrogation and testing processes.

The following interrogation and testing processes are identified here for possible use:

- **status check:** the following values can be returned by the infrastructure:
  - not supported;
  - not subscribed to;
  - activated;
  - deactivated.

Not all values are applicable to supplementary services:

- **data check:** this interrogation function compares the data input by the user during an interrogation procedure with the information stored in the infrastructure. The infrastructure signals an appropriate indication e.g. "check is positive" or "check is negative";
- **data request:** this interrogation function enables the user to obtain confirmation of his input data. The infrastructure signals an appropriate indication;
- **testing:** this test procedure allows the user to check whether or not the service is operating as the user desires. In some cases the use of the service is sufficient, for others a method of testing is included in the control procedure.

K.3.1.8 Cancellation

An action taken by the served/authorized user in order to stop an invoked supplementary service from continuing with its procedures.

NOTE: In TETRA cancellation is not normally used.

K.3.1.9 Invocation

An action to invoke the service required, taken by the user (e.g. pressing a specific button) or automatically by the network or terminal as a result of a particular condition (e.g. calling number identification for each incoming call).

K.3.1.10 Operation

Description of the normal operation of the service, the user's actions and the system response. Decision points, timing and call progress signals should be some of the aspects described for the service if they can be perceived by the users.

K.3.1.11 Exceptional procedures

Abnormal situations which are not described in clauses K.3.1.1 to K.3.1.10 are identified, the causes given and the responses expected. Procedures on time-out, unexpected signalling response and other such events should be defined.

K.3.1.12 Interworking considerations

Identification of user perceptions when a call exits from a TETRA network to another TETRA.

K.3.2 Supplementary service invocation order

Before offering an incoming call to the called user, or before allowing an outgoing call from a calling user to be completed, the infrastructure should search through the user supplementary service database for the activation of supplementary services and proceed with their invocation in the following order:

	Incoming Calls
1	CAD
2	BIC
3	CFU
4	CW
5	CFB
6	CFNRc

	Outgoing Calls
1	CAD
2	SNA
3	BOC
4	AS

K.3.3 Use of a password option in relation to supplementary services

Some supplementary services (e.g. call barring) may be offered to a user with the subscription option of using a password to control the service. When this option is selected every action (related to that supplementary service), such as registration, activation or deactivation should be performed by the mobile user with the concurrent entry of the password.

K.3.3.1 Description

When the subscription option "control of a supplementary service by the user using a password" is provided, password handling is supported by the network.

K.3.3.2 Management - normal procedures

K.3.3.2.1 Provision of password option

Each supplementary service for which the control by the usage of a password is relevant may be offered with the subscription option "control of the supplementary service". The values of this option may be:

- by the user using a password;
- by the service provider.

A service provider need not offer this option to its users.

K.3.3.2.2 Withdrawal of the password option

The password option may be withdrawn for administrative reasons or due to subscription modification.

K.3.3.2.3 Registration of password

If a mobile user selects at provision time the option of using a password for any given supplementary service, the password will be registered at the same time.

Furthermore, the user should be able to change the password by an appropriate control procedure at any time.

K.3.3.2.4 Erasure of password

A password may be erased in two ways:

1) registration of a new password erases the previous one; or
2) withdrawal of the password option.

K.3.3.2.5 Password checking

If the mobile user, in an attempt to control a supplementary service requiring a password, enters a correct password, the corresponding request will then be performed by the network.

K.3.3.3 Management - exceptional procedures

If the mobile user, in an attempt to control a supplementary service requiring a password or in an attempt to register a new password, enters an incorrect password, the corresponding request should be rejected by the network and the user should be notified.

If the mobile user enters incorrect password more than possibly three consecutive times, all control procedures related to the use of the password should be made impossible until the service provider instructs the network to again accept password-related requests from the user.

K.4 Supported supplementary services

Table K.2 gives a list of the supplementary services standardized in TETRA, the service definitions of which are given in EN 300 392-10 [i.9].

NOTE 1: All supplementary services identified within table K.2 are defined for calls within a TETRA system or between two TETRA systems which support the supplementary service.

Table K.2 lists the categories for all supported supplementary services. The following list shows the abbreviations used.

NOTE 2: Table 5 only gives general overview of the supplementary services and details in the actual supplementary service standards may be different.

Provision:

g = generally available;

p = pre-arrangement (subscription basis).

Withdrawal:

u = user's request or for administrative reasons.

Activation:

p = as a result of provision;

r = as a result of registration;

d = as a result of definition;

u = user controlled procedure;

c = when the conditions in the subscription options are met;

- = not applicable.

Deactivation:

w = as a result of withdrawal;

u = user controlled procedure;

n = when the conditions in the subscription. options are not met;

- = not applicable.

Definition:

u = user controlled procedure;

a = service provider controlled procedure;

- = not applicable.

Registration:

p = as a result of provision;

a = service provider controlled procedure;

u = user controlled procedure;

- = not applicable.

Interrogation:

u = user controlled procedure;

- = not applicable.

Cancellation:

u = user controlled procedure;

- = not applicable.

Invocation:

n = automatic invocation by the network as a result of a particular condition;

u = user invocation, by means of a control procedure;

- = not applicable.

Table K.2: Supported supplementary services

	Pro	Wit	Act	Deac	Def	Reg	Int	Can	Inv
Number ident SS									
1) CLIP	g/p	u	p/u	w/u	-	-	u	-	n
2) CLIR	p	u	p	w	-	-	u	-	n
3) COLP	g/p	u	p/u	w/u	-	-	u	-	n
4) CR	g/p	u	p	w/u	u	-	u	u	u
5) TPI	p	u	p	w/u	-	-	u	-	u/n
Call forwarding SS									
1) CFU	g/p	u	u	w/u	u	p	u	-	n
2) CFB	g/p	u	u	w/u	u	p	u	-	n
3) CFNRy	g/p	u	u	w/u	u	p	u	-	n
4) CFNRc	g/p	u	u	w/u	u	p	u	-	n
Call offering SS									
1) LSC	p	u	d	w/u	u	p	u	u	n
2) CAD	p	u	p	w	a	p	u	-	n
3) SNA	p	u	p	w/u	u	p	u	-	u/n
4) AS	p	u	u	w/u	u/a	p	u	u	u/n
5) AP	g/p	u	p	w	-	-	u	-	u/n
Call completion SS									
1) CW	g/p	u	p	w/u	-	-	u	-	n
2) HOLD	g/p	u	p	w	-	-	u	-	u
3) CCBS	g/p	u	p	w	-	-	u	u	u
4) LE	p	u	p	w	-	p	u	u	u
5) PC	g/p	u	p	w	-	-	u	-	u/n
6) PPC	g/p	u	p	w	-	p	u	-	u/n
7) CCNR	g/p	u	p	w	-	-	u	u	u
Multi party SS									
1) IC	g/p	u	p	w	-	-	u	u	u
2) DGNA	p	u	p	w	u	-	u	u	u
Call restriction SS									
1) BOC	p	u	p	w/u	u/a	p	u	-	n
2) BIC	p	u	p	w/u	u/a	p	u	-	n
Call intrusion SS									
1) DL	p	u	p	w	-	p	u	-	u
2) AL	p	u	p	w	-	p	u	-	u
Call retention SS									
1) CRT	p	u	p	w	-	-	u	-	u
NOTE: The individual abbreviations for the supplementary services are not repeated here but given in clause 3.									

K.4.1 Format of description

The supplementary services are described according to the following format:

Supplementary services stage 1:

a) service within TETRA:
   - definition;
   - description;
   - general description;
   - qualifications on applicability to telecommunication services;
   - procedures;
   - provision/withdrawal;
   - normal procedures;
   - exceptional procedures;
   - interaction with other supplementary services;

b) interworking considerations;

c) overall SDL;

Supplementary service stage 2:

d) functional model:
   - functional model description;
   - description of functional entities;

e) information flows;

f) functional entity actions;

g) functional entity behaviour;

h) relationship to basic call and mapping onto physical equipment;

i) interworking considerations;

Supplementary service stage 3:

j) service primitives;

k) coding requirements;

l) signalling protocol.

Annex L (informative): Packet mode reference points

L.1 Introduction

This annex gives the reference points for the TETRA data services, the MSs.

A set of examples of overall TETRA network configurations are described, together with all possible arrangements of the MS.

L.2 Physical interfaces

L.3 Configurations

L.3.1 Basic configurations

Case 1: a MS may be connected to another MS through a TETRA network;

Case 3: a MS may be connected through a TETRA network to internet;

L.3.2 Void

L.3.3 Interworking

Refer to TS 101 747 [i.13] for packet data services between TETRA systems.

L.4 Reference points

L.4.1 MS reference points

Figure L.1 shows the alternative configurations for a MS. The reference points are shown for each configuration.

These configurations show a family of different MTUs (MTU0, MTU2 etc.). Each MTU is a physical entity that contains all of the air interface stack. The TE supports the application, the MMI to the user and the interface with the MTU. The MTU supports the functions specific to the TETRA air interface and the interface to the TE.

R0 is a reference point within the MTU. It corresponds to the top of the MRS not including the routing. R0 is the network service boundary. This reference point exists in all MTUs.

R1 is a reference point between packet mode TE (TE2) and the MTU (MTU2). There may be several alternative interface protocols at R1.

R2 is the reference point at the TETRA air interface.

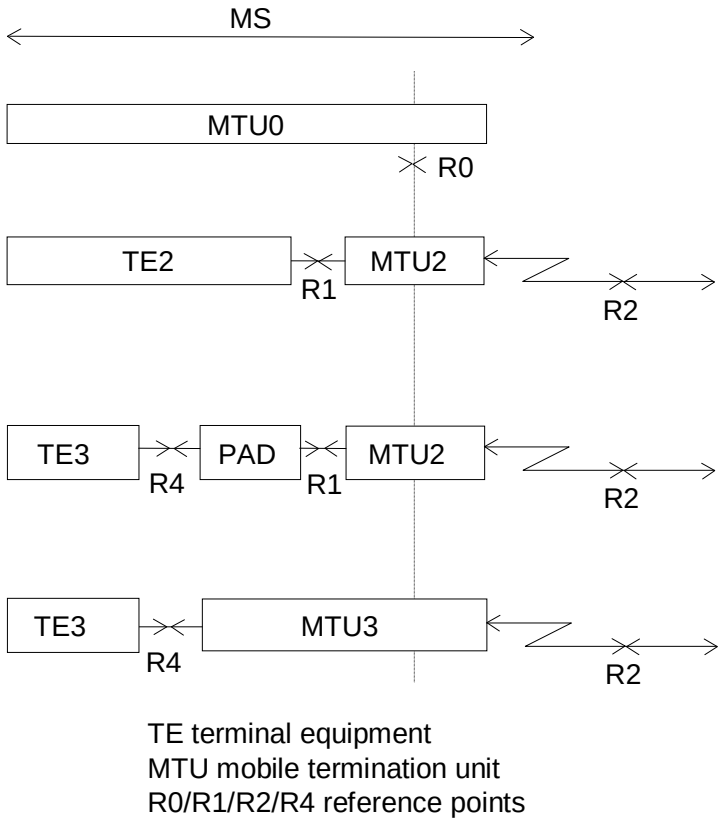


Figure L.1: MS reference points

L.4.2 Void

L.4.3 Void

L.4.4 TETRA to TETRA reference point

Figure L.2 shows R6 which is the reference point between one TETRA network and another TETRA network.

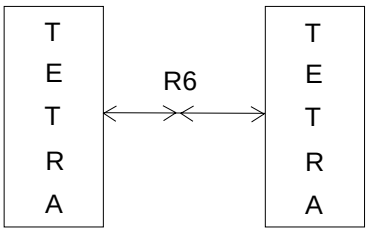


Figure L.2: TETRA to TETRA reference point

Figure L.3 shows the more general case of reference point R6, where the two TETRA networks are connected via a transparent transit network. R6 is the reference point between one TETRA network and the transparent transit network.

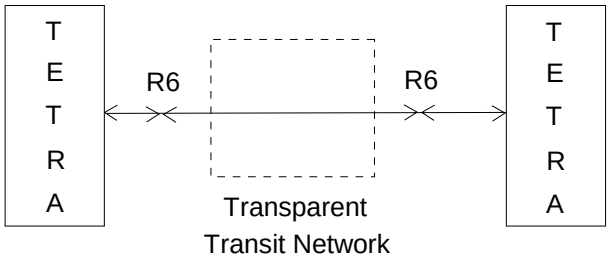


Figure L.3: TETRA to TETRA reference point

Refer also to TS 101 747 [i.13].

L.4.5 TETRA to non-TETRA reference point

Figure L.4 shows R7 which is the reference point between one TETRA network and a non-TETRA packet data network.

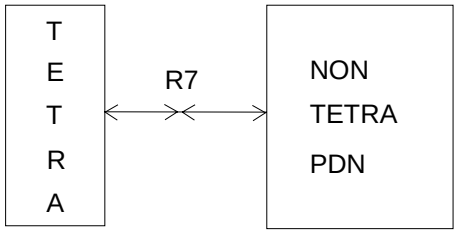


Figure L.4: TETRA to non-TETRA reference point

L.5 Protocol stacks

L.5.1 Protocol stacks at R1 reference point

The protocol stacks at the R1 interface are for operation over a line connection. These may be used for the interface between a TE2 and a MTU2. Refer EN 300 392-5 [i.10] for further details.

L.5.2 Protocol stacks at R2 reference point

Figure L.5 refers. These protocol stacks are the TETRA air interface stack.

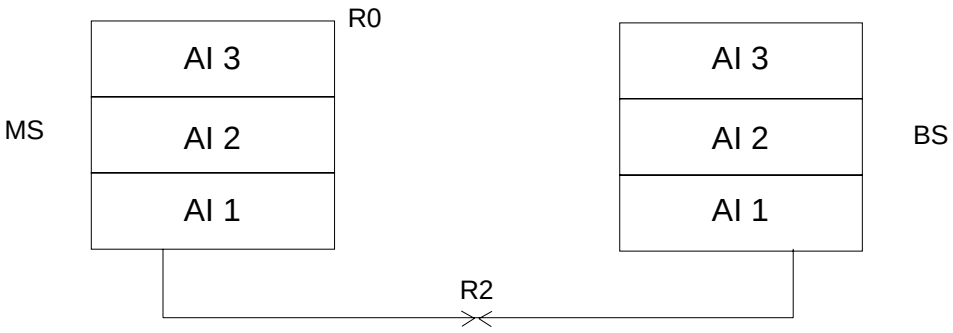


Figure L.5: Protocol stacks at R2 reference point

L.5.3 Protocol stacks at R4 reference point

Figure L.6 refers. These protocol stacks support character mode operation.

This is the character mode equivalent of the packet mode R1 reference.

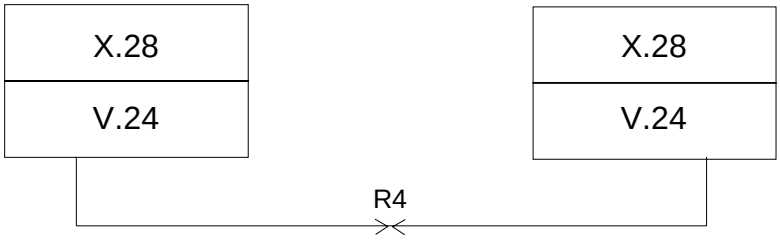


Figure L.6: Protocol stacks at R4 reference point

Annex M (informative): Quality of Service (QoS)

M.1 Introduction

This annex is largely based on ISO/IEC 8348 [i.5] (which is equivalent to ITU-T Recommendation X.213 [i.3]). These two documents have the same section numbering.

Some sections have been shortened, where it was felt that the information was of lower importance, and readers should therefore refer back to these source documents for more details if required.

Some parts of this annex have been specially drafted for TETRA. These clauses are clearly marked as not having any equivalent in the ISO/IEC 8348 [i.5] (or ITU-T Recommendation X.213 [i.3]) source documents.

This annex describes the network connection QoS parameters that will be required for services in TETRA.

The annexes define a number of parameter values based on what is likely to be achievable.

The QoS refers to those characteristics that are observed between the network connection endpoints. The annex is largely based on ISO/IEC 8348 [i.5] and ITU-T Recommendation X.213 [i.3], but has been modified to suit the requirements of TETRA.

M.2 Quality of network service

Refer to ISO/IEC 8348 [i.5] (or ITU-T Recommendation X.213 [i.3]), clause 10.

Quality of network service refers to certain characteristics of a Network Connection (NC) as observed between the NC endpoints. QoS describes aspects of an NC which are attributable solely to the Network Service (NS) provider; it can only be properly determined in the absence of NS user behaviour (which is beyond the control of the NS provider) that specifically constrains or impairs the performance of the network service.

A value of QoS applies to an entire NC. When determined or measured at both ends of an NC, the QoS observed by the NS user at the two ends of the NC is the same. This is true even in the case of an NC spanning several sub-networks where each sub-network offers different services.

The term quality of service also refers to certain characteristics of a network connectionless-mode transmission as observed between a pair of NSAPs. QoS describes aspects of a network connectionless-mode transmission which are attributable solely to the NS provider; it can only be properly determined in the absence of NS user behaviour (which is beyond the control of the NS provider) that specifically constrains or impairs the performance of the network service.

Whether the view of the QoS during each instance of the use of the network connectionless-mode transmission is the same to each NS user associated with the service depends on the nature of their association and the type of information concerning the nature of the service that is made available to the NS user(s) by the NS provider prior to the invocation of the service.

M.2.1 Determination of quality of network service

Refer to ISO/IEC 8348 [i.5] (or ITU-T Recommendation X.213 [i.3]), clause 10.1.

QoS is described by means of QoS parameters. The definition of each of these QoS parameters specifies the way in which the QoS parameters value is measured or determined, making reference (where appropriate) to primitive events of the NS.

Information about the QoS is exchanged among the NS provider and NS users in terms of QoS parameters.

M.2.1.1 Connection oriented quality of network service

Connection oriented QoS parameters can be classified as:

1) those which are conveyed between peer NS users by means of the NS during the establishment phase of an NC. As part of this conveyance a three-party negotiation may take place among the NS users and the NS provider, for the purpose of agreeing upon a particular QoS parameter value;

2) those values which are not conveyed. (i.e. they are purely requested by the NS user from the NS provider). For these QoS parameters, however, information about the values which is useful to the NS provider and each NS user may be made known by local means.

The connection oriented NS QoS parameters are defined in clause M.2.3.

M.2.1.2 Connectionless quality of network service

A basic characteristic of a connectionless mode service is that no peer-to-peer negotiation of the QoS for a transmission takes place at the time that the service is accessed. No dynamic association is set up between the parties involved as during a NC establishment; thus, characteristics of the service to be provided during the transfer are not negotiated on a peer-to-peer basis. An a priori agreement is assumed to exist between the NS users and the NS provider concerning those parameters, formats and options that affect the transfer of data.

The NS QoS parameters associated with each network connectionless-mode transmission are described in clause M.2.13.

M.2.2 QoS negotiation and non-negotiation

Refer to ISO/IEC 8348 [i.5] (or ITU-T Recommendation X.213 [i.3]), clause 12.2.7.

QoS parameters may be negotiated or non-negotiated. The negotiation is between the NS users and the NS provider. Non-negotiated parameters apply to both directions of data transfer. Negotiated parameters may be different for each direction of data transfer. Negotiation takes the form of a QoS parameter set, where each parameter has a set of "sub-parameters" defined from the following possibilities;

a) a target value which is the QoS value desired by the calling user;

b) the lowest quality acceptable value which is the lowest QoS value agreeable to the calling user;

c) an available value which is the QoS value that the network is willing to provide;

d) a selected value which is the QoS value to which the called user agrees.

M.2.3 QoS parameter set for connection oriented services

M.2.3.1 Summary

Refer to ISO/IEC 8348 [i.5] (or ITU-T Recommendation X.213 [i.3]), clause 10.2.

The connection oriented QoS parameters may be classified as:

a) QoS parameters which express network service performance;

b) QoS parameters which express other network service characteristics.

Tables M.1 and M.2 summarize the QoS parameters:

Table M.1: Classification of performance QoS-parameters

Phase	Performance Criterion	
	Speed	Accuracy/Reliability
NC establishment	NC establishment delay	NC establishment failure probability
Data transfer	Throughput Transit delay	Residual error rate NC resilience Transfer failure probability
NC release	NC release delay	NC release failure probability

Table M.2: QoS-parameters not associated with performance

NC protection
NC priority
Maximum acceptable cost
NC resilience

M.2.3.2 NC establishment delay

Refer to ISO/IEC 8348 [i.5] (or ITU-T Recommendation X.213 [i.3]), clause 10.2.1.

NC establishment delay is the maximum acceptable delay between a TN-CONNECT request and the corresponding TN-CONNECT confirm primitive.

M.2.3.3 NC establishment failure probability

Refer to ISO/IEC 8348 [i.5] (or ITU-T Recommendation X.213 [i.3]), clause 10.2.2.

NC establishment failure probability is the ratio of total NC establishment failures to total NC establishment attempts in a measurement sample.

NC establishment failure is defined to occur when a requested NC is not established within the maximum acceptable time period as a result of NS provider behaviour such as misconnection, NC refusal, or excessive delay. NC establishment attempts which fail as a result of NS user behaviour such as error, NC refusal, or excessive delay are excluded in calculating NC establishment failure probability.

NOTE: This parameter is defined in terms of establishment failure as reported at the network layer service boundary. Certain lower layer failures may not contribute to this failure probability (e.g. if the protocol includes automatic recovery procedures).

M.2.4 Throughput (User information transfer rate)

M.2.4.1 Throughput for constant delay services

Refer to ISO/IEC 8348 [i.5] (or ITU-T Recommendation X.213 [i.3]), clause 10.2.3.

Throughput is defined, for each direction of transfer, as the maximum rate the NS provider can continuously sustain, when unconstrained by flow control applied by the receiving NS user.

Given a sequence of n NSDUs (where n is greater than or equal to 2), throughput is defined to be the smaller of:

a) the number of NS-user data octets contained in the last (n-1) NSDUs divided by the time between the first and last TN-DATA requests in the sequence; and

b) the number of NS-user data octets contained in the last (n-1) NSDUs divided by the time between the first and last TN-DATA indications in the sequence.

Successful transfer of the octets in a transmitted NSDU is defined to occur when the octets are delivered to the intended receiving NS user(s) without error, in the proper sequence, prior to release of the NC by the receiving NS user.

Throughput is specified separately for each direction of transfer. Each throughput specification will specify both the desired "target" value and the minimum acceptable value (i.e. the "lowest quality acceptable") for the NC.

M.2.4.2 Throughput for variable delay services

This parameter does not appear in ISO/IEC 8348 [i.5] or ITU-T Recommendation X.213 [i.3].

Throughput for variable delay services differs from the constant delay case due to the existence of automatic retransmission protocols.

Throughput for variable delay services defines the average user data rate that can be achieved over the relevant service coverage area. This average throughput should be expected to reduce for operation outside the stated coverage area.

NOTE: The actual throughput that is achieved may be further reduced by certain user protocols (e.g. synchronous modems). The stated figure will only be achieved with ideal user protocols.

M.2.5 Transit delay

M.2.5.1 Transit delay for constant delay services

Refer to ISO/IEC 8348 [i.5] (or ITU-T Recommendation X.213 [i.3]), clause 10.2.4.

Transit delay is the elapsed time between a TN-DATA request and the corresponding TN-DATA indication. Elapsed time values are calculated only on NSDUs that are successfully transferred.

Successful transfer of an NSDU is defined to occur when the NSDU is transferred from the sending NS user to the intended receiving NS user without error, in the proper sequence, prior to release of the NC by the receiving NS user.

Specification of transit delay will define a pair of values: the desired "target" value and the maximum acceptable value (i.e. the "lowest quality acceptable"). The specified values will be averages and will be based on an NSDU size of 128 octets.

The pair of transit delay values specified for an NC applies to both directions of transfer. That is, the transit delay in each direction is expected to be no worse than that specified.

M.2.5.2 Transit delay for voice services

Transit delay for voice services is based on the definition for a constant delay service, where the NSDU is defined to be a single speech frame.

Transit delay for voice services is specified in terms of the one way delay time corresponding to a single transmission across the air interface.

M.2.5.3 Transit delay for variable delay services

This parameter does not appear in ISO/IEC 8348 [i.5] or ITU-T Recommendation X.213 [i.3].

Transit delay for variable delay services can vary due to the existence of automatic retransmission protocols.

Transit delay for variable delay services refers to the delay that will apply under ideal conditions, when no automatic retransmissions have occurred. Any automatic retransmissions will increase this delay.

M.2.6 Residual error rate

Refer to ISO/IEC 8348 [i.5] (or ITU-T Recommendation X.213 [i.3]), clause 10.2.5.

The residual error rate (RER) is the ratio of total incorrect, lost and duplicate NSDUs to total NSDUs transferred across the NS boundary during a measurement period. The RER may be represented by the following formula:

$$RER = \frac{N(e) + N(l) + N(x)}{N}$$

where:

N is the total number of NSDUs transferred;

N(e) is the number of incorrect NSDUs received;

N(l) is the number of NSDUs lost;

N(x) is the number of extra NSDUs received.

M.2.7 Transfer failure probability

Refer to ISO/IEC 8348 [i.5] (or ITU-T Recommendation X.213 [i.3]), clause 10.2.6.

Transfer failure probability is the ratio of total transfer failures to total transfer samples during a performance measurement.

A transfer sample is a discrete observation of NS provide performance in transferring NSDUs between a specified sending and receiving user. A transfer sample begins on input of a selected NSDU at the sending NS user boundary, and continues until the outcome of a given number of NSDU transfer requests has been determined. A transfer sample will normally correspond to the duration of an individual NC.

A transfer failure is a transfer sample in which the observed performance is worse than a specified minimum acceptable level. Transfer failures are identified by comparing the measured values for performance parameters with specified failure thresholds. The three supported performance parameters are throughput, transit delay and residual error rate.

In systems where QoS is reliably monitored by the NS provider, transfer failure probability can be estimated by the probability of an NS provider invoked TN-DISCONNECT during a transfer sample.

This parameter only applies to packet mode services.

M.2.8 NC resilience

Refer to ISO/IEC 8348 [i.5] (or ITU-T Recommendation X.213 [i.3]), clause 10.2.7.

NC resilience parameters specify the probability of:

a) a NS provider invoked NC release (i.e., issuance of an TN-DISCONNECT indication with no prior TN-DISCONNECT request); and

b) a NS provider invoked reset (i.e. issuance of a TN-RESET indication with no prior TN-RESET request); during a specified time interval on an established NC.

M.2.8.1 NC release delay

M.2.8.1.1 NC release delay at the peer user

Refer to ISO/IEC 8348 [i.5] (or ITU-T Recommendation X.213 [i.3]), clause 10.2.8.

NC release delay at the peer user is the maximum acceptable delay between an NS user invoked TN-DISCONNECT request and the successful release of the NC at the peer NS user. NS release delay does not apply in cases where NC release is invoked by the NS provider.

Issuance of a TN-DISCONNECT request by either NS user starts the counting of the NC release delay for the other NS user. Successful NC release is signalled to the NS user not initiating the TN-DISCONNECT request by a TN-DISCONNECT indication.

M.2.8.1.2 NC release delay at the invoking user

This parameter does not appear in ISO/IEC 8348 [i.5] or ITU-T Recommendation X.213 [i.3].

NC release delay at the invoking user is the maximum acceptable delay between an NS user invoked TN-DISCONNECT request and the successful acknowledgement of the release of the NC at that same NS user. NS release delay does not apply in cases where NC release is invoked by the NS provider.

Issuance of a TN-DISCONNECT request by either NS user starts the counting of the NC release delay for the other NS user. Successful NC release is signalled to the NS user initiating the TN-DISCONNECT request by a TN-DISCONNECT confirmation.

M.2.8.2 NC release failure probability

Refer to ISO/IEC 8348 [i.5] (or ITU-T Recommendation X.213 [i.3]), clause 10.2.9.

NC release failure probability is the ratio of total NC release requests resulting in NC release failure to total NC release requests included in a measurement sample. NC release failure probability is normally specified independently for each NS user.

A release failure is defined to occur, for a particular NS user, if that user does not receive a TN-DISCONNECT indication within the specified maximum NC release delay of the NS user issuing the TN-DISCONNECT request (given that the former NS user has not issued a TN-DISCONNECT request).

This will only be specified as a network performance figure.

M.2.8.3 NC protection

Refer to ISO/IEC 8348 [i.5] (or ITU-T Recommendation X.213 [i.3]), clause 10.2.10.

NC protection is the extent to which an NS provider attempts to prevent unauthorized masquerading or monitoring or manipulation of NS-user-data. NC protection for an NC is specified by selecting any combination of the following features:

a) confidentiality of an entire NSDU sequence on the NC;

b) detection of modification, deletion, replay, or insertion of data within the NSDU sequence on an NC;

c) peer entity authentication. The NS user may request that the NS provider should confirm the identity of the remote NSAP such that there is protection against masquerading T-entities;

d) authentication of the origin of an NSDU such that there is protection against the unauthorized insertion or replay of the NSDU;

e) authentication of the NS provider to guard against masquerading entities.

M.2.8.4 NC priority

Refer to ISO/IEC 8348 [i.5] (or ITU-T Recommendation X.213 [i.3]), clause 10.2.11.

NC priority specified independently the relative importance of an NC with respect to the following:

a) priority to gain an NC;

b) priority to keep an NC;

c) priority of data on the NC.

NC priority QoS-parameters a) and b) together define the order in which the NCs are broken to recover resources if necessary. The NS provider is required to accept new requests for NCs with a high priority type a) if it can, even if NCs with a lower priority b) have to be released to do so.

NC priority QoS-parameter c) defines the order in which NCs have their QoS degraded. The NCs with a high priority c) are to have their requests serviced within the required QoS first and remaining resources are then used to satisfy requests on lower priority NCs.

M.2.9 Maximum acceptable cost

Refer to ISO/IEC 8348 [i.5] (or ITU-T Recommendation X.213 [i.3]), clause 10.2.12.

The maximum acceptable cost QoS-parameter specifies the maximum acceptable cost for an NC. The cost may be specified in absolute or relative cost units. The cost of an NC is composed of communications and end-system resource costs.

M.2.10 Air interface parameters

These parameters do not appear in ISO/IEC 8348 [i.5] or ITU-T Recommendation X.213 [i.3]. Therefore they are only applicable to circuit-mode services.

M.2.10.1 Duration of interruption of user traffic due to call restoration

The duration of interruption of user traffic due to call restoration is the total time for which a traffic channel is interrupted due to a single call restoration event. If there are several short interruptions during this process, the sum total of all these interruptions applies.

Different figures may apply depending on the type of the call restoration. The following different cases are identified:

- change of cell;
- change of RF carrier at the same cell (with or without a change of slot position);
- change of slot position on the same RF carrier at the same cell.

M.2.10.2 Call restoration success rate

The call restoration success rate is the probability of a call restoration being successful within a defined service coverage area. A successful call restoration is defined to occur when all established calls are maintained.

M.2.10.3 Interruption of user traffic due to slot stealing

This parameter applies only to circuit-mode services.

This parameter specifies the duration of any single continuous interruption of user traffic due to slot stealing, and the interval between successive interruptions.

M.2.11 Supplementary service parameters

M.2.11.1 Maximum time to activate a supplementary service

This parameter does not appear in ISO/IEC 8348 [i.5] or ITU-T Recommendation X.213 [i.3].

This parameter should only apply to circuit mode services.

The maximum time to activate a supplementary service is the time from the issuing of the service request to the time when the service has become available.

M.2.12 Connection oriented QoS negotiation

The initial negotiation between NS user and NS provider utilizes the QoS-parameter set field in the TN-CONNECT request message. This will contain both "target" and "lower quality acceptable" values. The NS provider will send the QoS-parameter set with the "available" values in the TN-CONNECT confirm message. Where negotiation involves the called party, the TN-CONNECT indication message includes the "target" and "lower quality acceptable" values that are agreeable to the NS provider (and the calling NS user). The TN-CONNECT response includes the "selected" value. The "selected" value is transmitted to the calling user in the TN-CONNECT confirm message.

M.2.13 QoS parameter set for connectionless services

M.2.13.1 Summary

Connectionless QoS parameters can be classified as:

1) those which are fixed in advance: either fixed characteristics of the network (i.e. non-negotiable) or negotiated in advance of the packet submission;

2) those which are requested at the time of packet submission (i.e. they are purely requested by the NS user from the NS provider on a per-packet basis).

The QoS parameters can be further classified as:

a) QoS parameters which express network service performance;

b) QoS parameters which express other network service characteristics.

Tables M.3 and M.4 summarize the connectionless QoS parameters:

Table M.3: Classification of performance QoS-parameters

Phase	Performance Criterion	
	Speed	Accuracy/Reliability
Data transfer	Transit delay	Residual error probability

Table M.4: QoS-parameters not associated with performance

Protection from unauthorized access
Cost determinants
Priority

M.2.13.2 Transit delay

Connectionless packet transit delay is the elapsed time between a TN-UNITDATA request and the corresponding TN-UNITDATA indication. Elapsed time values are calculated only on NSDUs that are successfully transferred.

Successful transfer of an NSDU is defined to occur when the NSDU from the sending NS user is delivered to the intended receiving NS user without error.

Transit delay should be specified independently for each network connectionless-mode transmission. Transit delay defines the value expected for the completion of the transmission of a particular NSDU. Its specification should be based on an average NSDU size. It should be determined by the NS provider and made known to the NS user prior to the invocation of the service.

Transit delay for an individual NSDU may be greatly increased if local interface flow control is exercised at either the transmitting or receiving service provider to service user interface. Occurrences of local interface flow control should be excluded in calculating transit delay values.

M.2.13.3 Protection from unauthorized access

Refer to ISO/IEC 8348/Addendum 1 [i.5], clause 10.3.2.

The extent to which a NS provider attempts to prevent unauthorized monitoring or manipulation of NS user-originated information is specified qualitatively by selecting one of four options:

a) no protection features;

b) protection against passive monitoring;

c) protection against modification, replay, addition and deletion; and

d) both (b) and (c).

M.2.13.4 Cost determinants

Refer to ISO/IEC 8348/Addendum 1 [i.5], clause 10.3.3.

A class of parameter values and options may exist which provide a NS user with:

a) the ability to indicate to the NS provider that it should choose, for example, the least expensive means available to it, even in situations where this may not be the most expedient means; or

b) the ability to specify maximum acceptable cost.

The cost may be specified in absolute or relative cost units. The cost of a network connectionless-mode transmission is composed of communications and end system costs.

M.2.13.5 Residual error probability

Refer to ISO/IEC 8348/Addendum 1 [i.5], clause 10.3.4.

Residual error probability describes the likelihood that a particular NSDU will be lost, duplicated, or delivered incorrectly. This probability is estimated as the ratio of lost, duplicated, or incorrectly delivered NSDUs to the total NSDUs transmitted by an NS provider during a measurement period.

An incorrectly delivered NSDU is one in which the user data are delivered in a corrupted condition, or the user data are delivered to an incorrect NSAP.

Lost data includes all NSDUs which are discarded by the NS provider due to congestion, transmission error, or some other error. NSDUs which are lost due to error by the NS user are not included.

M.2.13.6 Priority

Refer to ISO/IEC 8348/Addendum 1 [i.5], clause 10.3.5.

This parameter allows the NS user to specify the relative priority of an NSDU in relation to any other NSDUs acted upon by the NS service provider. An NSDU of higher priority is serviced by the NS provider before one of lower priority. The priority information is conveyed to the receiving NS user.

This parameter specifies the relative importance of network connectionless-mode transmission with respect to:

a) the order in which NSDUs are to have their quality of service degraded, if necessary; and

b) the order in which NSDUs are to be discarded to recover resources, if necessary.

This parameter has meaning only in the context of some management entity or structure able to judge relative importance. The number of priority levels is limited to 15.

M.2.13.7 Connectionless QoS negotiation

Not applicable.

M.3 Applicability of QoS parameters to TETRA services

Table M.5: Applicability of connection oriented QoS-parameters

	CONS	cct data protected	cct data unprotected	voice
NC establishment delay	n	n	n	f
NC establishment failure probability	s	s	s	s
Throughput	N	N	N	f
Transit delay	n	f	f	f
Residual error rate	n	n1	f	f
Transfer failure prob.	s	s	s	s
NC resilience	s	s	s	s
NC release delay	s	s	s	s
NC release failure prob.	s	s	s	s
NC protection	N see note 2	N see note 2	N see note 2	N see notes 2 and 3
NC priority	n see note 4	n see note 4	n see note 4	n see note 4
Maximum acceptable cost	n see note 2	n see note 2	n see note 2	n see note 2

Table M.6: Applicability of connectionless QoS-parameters

	S-CLNS	SDS
Transit delay	s	s
Protection from unauthorized access	n	n
Cost determinants	n see note 2	n see note 2
Residual error probability	s	s
Priority	n see notes 4 and 5	n see note 4

Key and notes:

- f fixed relative to type of call;
- n negotiable only between NS user and NS provider;
- N negotiable between NS users (calling and called) and NS provider;
- s network performance figure;
- x not applicable/not specified.

NOTE 1: Not applicable to unprotected services.

NOTE 2: May not be implemented on all systems.

NOTE 3: Negotiable only between calling NS user and NS provider for point-to-multipoint calls. Called NS users not able to meet protection requirements will be excluded from the call.

NOTE 4: The negotiation only uses a limited set of parameters (see clause M.2.8.4).

NOTE 5: Negotiation only supported by full version of S-CLNS.

Annex N (normative): TETRA type approval code information element

This annex defines TETRA Type Approval Code (TAC) information element application.

N.1 Encoding of the TAC information element

Clause 7.5 defines in figure 5 contents of TEI. The TAC comprises the first 24 bits of that field. The TAC is a binary encoded number.

When the TAC is presented for human reader e.g. printed on the equipment the value shall be presented using hexadecimal digits indicating the same value as the binary value. Leading zero bits shall be present in the TAC so that the total length is always 6 digits.

N.2 Application for the TAC value

Type Approval Code (TAC) shall be allocated by ETSI. ETSI shall assign individual TACs and keep register of the assigned codes. Allocation of individual TACs will remain private within ETSI.

1(2)

PROVISION OF AND RESTRICTED USAGE UNDERTAKING

relating to

a **Type Approval Code, TAC,** to be used in mobile and line stations and in TETRA SwMIs for Terrestrial Trunked Radio (TETRA) systems.

Between

(COMPANY NAME).....

(COMPANY ADDRESS).....

.....

hereinafter called: the BENEFICIARY;

and

(COMPANY NAME).....European Telecommunications Standards Institute

(COMPANY ADDRESS).....06921 Sophia Antipolis CEDEX, France

hereinafter called: the PROVIDER.

Whereas

The BENEFICIARY has alleged that he fulfils the following criteria:

- He is a manufacturer of TETRA equipment.

The PROVIDER undertakes to give to the BENEFICIARY:

- One globally unique TAC, registered by the PROVIDER.

The provided TAC is filled in below by the PROVIDER when he has received and approved two signed originals of this agreement.

TAC:							=						
	Hexadecimal number							Binary number					

The code above is given as a six hexadecimal (0-F) number, and as a 24 bit binary number. The most significant digit and bit are positioned to the left.

On presentation of the code to the equipment user it shall be presented in hexadecimal digit format.

Example:
The hexadecimal number "9 F 7 1 0 A" equals the binary number "1001 1111 0111 0001 0000 1010".

2(2)

The BENEFICIARY undertakes:

1. To apply and use the TAC in accordance with rules in ETSI EN 300 392-1 [1], clause 7.5.

2. To return the TAC to the PROVIDER, within 5 years, if these has not been used.

Ref [1]: ETSI EN 300 392-1: "Terrestrial Trunked Radio (TETRA), Voice plus Data (V+D), Part 1 General network design".

In case the BENEFICIARY violates any of the obligations incurred on him by the present undertaking, he shall be liable of indemnifying ETSI for all losses suffered directly or through claims from legitimate TETRA users.

All disputes which derive from the present undertaking or its interpretation shall be settled by the Court of Arbitration of the International Chamber of Commerce situated in Paris, in accordance with the procedures of this Court of Arbitration and with the application of French Law regarding questions of interpretation.

Made in two originals, one of which is for the PROVIDER, the other for the BENEFICIARY; both originals signed by a legal representative of his company/organization.

For the PROVIDER	For the BENEFICIARY
	(signed).....
	(Name, Title (typed)) .....
	.....
Walter Weigel, Director General	(signed).....
	(Name, Title (typed)) .....
	.....
(Date)	(Date)

Annex O (normative): TETRA final assembly code information element

This annex defines TETRA Final Assembly Code (FAC) information element application.

O.1 Encoding of the FAC information element

Clause 7.5 defines in figure 5 contents of TEI. The FAC comprises the 8 bits of that field after the 24 bits long TAC code. The FAC is a binary encoded number and its value is presented in the applications for human beings as a hexadecimal number.

When the FAC is presented for human reader e.g. printed on the equipment the value shall be presented using hexadecimal digits indicating the same value as the binary value. Leading zero bits shall be present so that the total length of FAC information element shall be two digits.

O.2 Application for the FAC value

Final Assembly Code (FAC) shall identify the manufacturer and may identify the place of final assembly. These shall be allocated by ETSI. ETSI shall assign individual FACs and keep register of the assigned codes. ETSI maintains a public Web page of allocation of FACs.

O.3 WEB page contents for FAC data base

The WEB page should contain information as presented in table O.1. For clarity the FAC number may be presented in hexadecimal and binary codes.

Table O.1: WEB page information contents

Date of issue		Hexadecimal code	Binary code		Allocated to Manufacturer, Name and Place of Final Assembly
		00	0000	0000	(Not to be allocated to any manufacturer)
		01	0000	0001	

1(2)

PROVISION OF AND RESTRICTED USAGE UNDERTAKING

relating to

a **Final Assembly Code, FAC,** to be used in mobile and line stations and in TETRA SwMIs for Terrestrial Trunked Radio (TETRA) systems.

Between

(COMPANY NAME).....

(COMPANY ADDRESS).....

.....

hereinafter called: the BENEFICIARY;

and

(COMPANY NAME).....European Telecommunications Standards Institute

(COMPANY ADDRESS).....06921 Sophia Antipolis CEDEX, France

hereinafter called: the PROVIDER.

Whereas

The BENEFICIARY has alleged that he fulfils the following criteria:

- He is a manufacturer of TETRA equipment.

The PROVIDER undertakes to give to the BENEFICIARY:

- One globally unique FAC, registered by the PROVIDER.

The provided FAC is filled in below by the PROVIDER when he has received and approved two signed originals of this agreement.

FAC:			=		
	Hexadecimal number			Binary number	

The code above is given as a two digit hexadecimal (0-F) number, and as an 8 bit binary number. The most significant digit and bit are positioned to the left.

On presentation of the code to the equipment user it shall be presented in hexadecimal digit format.

Example:
The hexadecimal number "9 F" equals the binary number "1001 1111".

2(2)

The BENEFICIARY undertakes:

1. To apply and use the FAC in accordance with rules in ETSI EN 300 392-1 [1], clause 7.5.

2. To return the FAC to the PROVIDER, within 5 years, if these has not been used.

Ref [1]: ETSI EN 300 392-1: "Terrestrial Trunked Radio (TETRA), Voice plus Data, Part 1 General network design".

In case the BENEFICIARY violates any of the obligations incurred on him by the present undertaking, he shall be liable of indemnifying ETSI for all losses suffered directly or through claims from legitimate TETRA users.

> All disputes which derive from the present undertaking or its interpretation shall be settled by the Court of Arbitration of the International Chamber of Commerce situated in Paris, in accordance with the procedures of this Court of Arbitration and with the application of French Law regarding questions of interpretation.

Made in two originals, one of which is for the PROVIDER, the other for the BENEFICIARY; both originals signed by a legal representative of his company/organization.

For the PROVIDER	For the BENEFICIARY
	(signed).....
	(Name, Title (typed)) .....
	.....
	(signed).....
Walter Weigel, Director General	(Name, Title (typed)) .....
	.....
(Date)	(Date)

Annex P (normative): TETRA electronic serial number information element

This annex defines TETRA Electronic Serial Number (ESN) information element usage.

P.1 Encoding of the ESN information element

Clause 7.5 defines in figure 5 contents of TEI. The ESN comprises the 6 digits of that field after the 24 bits long TAC code and 8 bits long FAC code. The ESN shall be a hexadecimal number.

NOTE: The BCD coding uses 4 bits for each digit and only values "0" to "9" were utilized in the previous document. The present document uses all possible 16 values "0" to "F" in each 4 bits.

When the ESN is presented for human reader e.g. printed on the equipment the value shall be presented using hexadecimal digits. Leading zero bits shall be present so that the total length of the ESN is 6 digits.

P.2 Usage of the ESN

Electronic Serial Number (ESN) shall be an individual serial number that uniquely identifies each equipment within each TAC+FAC. ESN should be allocated by manufacturers in sequential order.

NOTE: As the previous and the current presentation of this field are different manufacturer may choose to apply binary encoded decimal presentation up to 999 999 and start to use hexadecimal encoding from A00 000 so that the hexadecimal presentation always contains at least one digit from values "A" to "F".

P.3 Usage of check sum of the equipment identity

A check sum may be applied to the TEI. The algorithm of the check sum calculation and the check sum presentation are outside the scope of the present document.

Annex Q (informative): Change requests

The present document contains Change requests as identified in table Q.1.

Table Q.1: Change requests

No	CR vers.	Standard Version	Clauses affected	Title	Remarks
001	APP	Ed. 1	2, 7.5	TAC and FAC encoding	EPT approved 010329
101	10	V1.2.1	2, 7.2.4, 7.8.4	Update due to publication of ITU-T Recommendation E.218 [2]	WG3 approved 040929
201	10	V1.3.1	2, 7.2.5	Clarification on the MNC length in decimal format	WG3 approved 070524
202	10	V1.3.1	7.5.3, annex N, annex O	Use of TAC and FAC	TETRA approved 071010

History

Document history		
Edition 1	February 1996	Publication as ETS 300 392-1 (Historical)
V1.2.1	January 2003	Publication
V1.3.1	June 2005	Publication
V1.4.0	July 2008	One-step Approval Procedure OAP 20081127: 2008-07-30 to 2008-11-27
V1.4.1	January 2009	Publication