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TECHNICAL REPORT

**Digital cellular telecommunications system (Phase 2+) (GSM);
Multiband operation of GSM / DCS 1800 by a single operator
(3GPP TR 43.026 version 17.0.0 Release 17)**

**GLOBAL SYSTEM FOR
MOBILE COMMUNICATIONS**

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Contents

Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

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y   the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

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1 Scope

The purpose of the present document is to describe the functionality of a Multiband GSM/DCS Network operated by a single operator and the Multiband GSM/DCS Mobile Station (MS). It also describes the necessary amendments to the GSM/DCS phase 2 specifications for the technical realization of the function.

The resulting Amendment Requests (AR) and Change Requests (CR) necessary for Multiband Operation are listed in annex A.

1.1 References

Not relevant to the present document.

1.2 Abbreviations

Abbreviations used in the present document are listed in GSM 01.04.

2 General

Multiband operation of GSM/DCS by a single operator enables an operator, with licenses in more than one of the frequency bands specified in the GSM specifications, to support the use of multiband MSs in all bands of the licenses. In addition it also enables the operator to support the use of single band MSs in, at least, one band of the licenses.

Multiband GSM/DCS MSs, are MSs which are capable of using more than one of the frequency bands specified in the GSM specifications. The multiband MS is specified in GSM 02.06. (AR02.06-A001) and in section 2.1.

The use of multiband operation and development of multiband MSs are optional for operators and manufactures.

2.1 Multiband MSs

A MS which supports more than one band and the functionality below is defined as a Multiband MS.

The multiband MS has the functionality to perform handover, channel assignment, cell selection and cell re-selection between all its bands of operation within one PLMN, i.e. when one PLMN code is used in all bands. In addition it has the functionality to make PLMN selection, in manual or automatic mode, in all its bands of operation. The multiband MS shall meet all requirements specified for each individual band supported. In addition it shall meet the extra functional requirements for the multiband MSs.

2.2 Frequency bands of operation

Multiband operation shall be possible with any combination of the frequency bands specified in the GSM specifications. No frequency band is treated as a primary band in the specification. The operators may however use control mechanisms to make the MSs treat one of the bands with priority.

As a first implementation of Multiband operation only operation with GSM 900 (Standard or Extended) and DCS 1 800 is included in the standard. The proposed procedures shall however make it possible for operation between other bands if such are included in the core specifications in the future.

2.3 Backwards compatibility

Backwards compatibility with phase 1 and phase 2 single band mobiles shall be ensured by the specification of multiband operation. A multiband PLMN shall therefore, in addition to support of multiband MSs, be able to support the use of single band mobiles for, at least one of the bands of operation.

Backwards compatibility by the multiband MSs shall also be ensured. The MSs shall therefore be able to, functionally, work as single band mobiles in a single band network.

2.4 PLMN codes

Multiband operation of GSM/DCS by a single operator, with handover and assignment between the bands, implies that only one PLMN code is used in all bands of operation. Handover or assignment between PLMNs is not covered by this document or the work item.

An operator, with license in more than one band, may however support multiband mobiles without handover and assignment between the bands. If so, more than one PLMN code may be used. This is already covered with the phase 1 and phase 2 specifications.

2.5 Other systems

Multiband operation by a single operator does not include multi mode operation, i.e. handover, assignment or roaming between GSM/DCS and systems covered by other specifications or standards. The amendments of the GSM/DCS specifications for multiband operation may however be done in a flexible way so that multi mode operation can make use of the same procedures.

3 Requirements

3.1 User requirements

No special actions by the user shall be necessary to use a multiband MS. The possibility for the user to decide to operate the MS in a single band mode may however be supported. Indications may also be given to the user of which band is being used.

The user of a multiband MS shall be able to roam between PLMNs operating in any of the MS's frequency bands of operation. The MS shall therefore, at PLMN selection, present all available PLMNs within its frequency bands of operation.

3.2 Operator requirements

The use of multiband operation shall be optional for the operator. Multiband MSs must therefore be able to, functionally, work as single band MSs in a single band network.

When multiband operation is used, it shall be possible to provide coverage in one frequency band independently of the coverage in another band..

Two options can be implemented by an operator when operating a multiband network :

   i)   a BCCH in each band of operation;

   ii) a common BCCH in only one of the band of operation when resources across all bands are co-located and synchronized.

   NOTE: For case ii), in order to ensure proper operation of the network, the operator should take into account issues related to the difference of propagation between the different bands, e.g GSM and DCS when performing cell planning. As far as synchronization issues are concerned, the requirements for TA for multiband BTSs may only be fulfilled when the TA is the same in the two bands, i.e. within the tolerance as defined in GSM 05.10. This imposes some restrictions on the cells where the two bands are supported (e.g. small cells).

3.3 Radio requirements

The radio requirements for GSM and DCS in the present GSM/DCS specification differs in some cases. A multiband MS and the multiband network shall meet all requirements for each band of operation respectively. Type approval of multiband MSs will be covered by the respective test specifications and some additional tests for the multiband functionality.

3.4 Relation to frequency hopping

The multiband MS and the multiband network shall support frequency hopping within each band of operation. Frequency hopping between the bands of operation is not required.

4 Functional description

To understand the necessary amendments of the phase 2 specifications functional descriptions of different procedures and solutions are described below. The technical realization are described in clause 5 and the actual amendments are listed in annex 1 with a brief description.

4.1 Idle mode procedures

The idle mode procedures will not be different for multiband MSs or networks. Only the fact that more than one band is available has to be taken into account.

4.1.1 PLMN selection

A multiband MS shall use the normal PLMN selection procedures, as specified in GSM 02.11 and 03.22, with the additional requirement to select from all available PLMNs in all bands of operation. When presenting available PLMNs it shall show all available PLMNs within the MSs bands of operation. A multiband PLMN may have BCCHs available on more than one band but shall still be treated as one PLMN and must therefore only be presented once.

PLMN search time, at switch on, will be the sum of the search times presently specified for each band of operation if no prior knowledge is stored in the MS.

4.1.2 Cell re-selection

The multiband network will send out neighbour cell lists which may contain a mixture of channels from different frequency bands. The multiband MSs shall follow the normal cell-re-selection procedures with the addition to monitor all channels within the neighbour cell list which are within the MS's bands of operation. All MSs shall ignore channel numbers which are outside its bands of operation. Channels within the MS's bands of operation shall be monitored.

Priority at cell re-selection can be given to one of the bands of operation by using existing phase 2 parameters.

Compatibility with phase 1 and phase 2 MSs will be ensured by the procedures described in clause 6.

4.1.3 Location areas

No special requirements are specified for the allocation of location areas among the cells in a multiband network. It shall therefore be possible the use the same or different location areas for cells in different frequency bands irrespective of their location.

4.2 Connected mode procedures

The multiband network will send out neighbour cell lists which may contain a mixture of channels from different frequency bands. The multiband MS shall use the normal monitor and reporting procedures with the additional requirement to monitor and report from all channels within its bands of operation.

4.3   Handover

Based on the measurement reports sent by the multiband MS the network will send handover commands to any channel within the MS's bands of operation.

To ensure that handover is possible to a cell which was not reported to be the strongest candidate, e.g. for traffical reasons, a multiband MS shall report at least the number of strongest candidates on each band measured and identified as indicated by the parameter Multiband_Reporting sent in System Information 2ter/5ter. The coding of this parameter is specified in AR 05.08-A006.

Any MS will only send measurement reports from cells within its bands of operation. Handover commands to cells outside the bands of operation will therefore not occur..

4.4   Frequency and power capabilities

The network will be informed by the MS of its frequency and power capabilities to ensure that all procedures, e.g. the handover algorithm, gets accurate information.

5   Technical realization and amendments

The technical realization, e.g. bit mapping, is described in this clause. Also, the necessary amendment is described and reference is made to the amendment request presented.

5.1   Mixed neighbour cell lists

A multiband network may use System Information 2/5, System Information 2bis/5bis and a new System Information 2ter/5ter to inform the MSs about the available neighbour cell frequencies. The BCCH channel list consists either of only the sub list derived from the neighbour cell description information element(s) in SI 2/5 (and possibly SI 2bis/5bis) or that sub list concatenated with the neighbour cell description information element received in SI 2ter/5ter in case SI 2ter/5ter is also received. Indication that 2ter is available is included in the SI3 rest octets. Channel numbers which are outside the bands of operation of a MS will be ignored. The scheduling of the sending of SI 2ter on BCCH is specified in AR05.02-A001.

Solution to problems with backwards compatibility are described in clause 6.

Different encoding of the BCCH frequencies in the BA list give different numbers of possible combinations and number of neighbour cells in the list. The limitations are given below:

1024 range
This allows to encode 2 - 16 frequencies, the frequencies being spread among up to 1024 ARFCNs. This cover more than P-GSM, E-GSM and DCS 1800 together.

512 range
This allows to encode 2-18 frequencies, the frequencies being spread among up to 512 consecutive ARFCNs. This would cover the E-GSM and DCS for instance.

256 range
This allows to encode 2-22 frequencies, the frequencies being spread among up to 256 consecutive ARFCNs.

128 range
This allows to encode 2-29 frequencies, the frequencies being spread among up to 128 consecutive ARFCNs.

Variable bit map
This allows any combination among 112 consecutive ARFCNs.

Bit map 0
This allows to encode 124 frequencies among ARFCNs 1-124.

5.2 Frequency and power capabilities

The network has to be informed of the frequency capabilities and the associated power capability of the multiband MS, on each frequency band, at call set up to ensure a reliable functionality. A multiband mobile shall therefore send a classmark change message with CM3 information as early as possible according to the procedure described in AR 04.08-A069 and AR 04.08-A071 (Early Classmark Sending). In order to give an early indication to the network that the MS is capable of using the Early Classmark Sending, one bit in CM1 and CM2 is used (the spare bit in front of the A5/1 bit).

The network may forbid the MS to use Early Classmark Sending by setting the Early Classmark Sending Control (ECSC) bit in the SI3 rest octets to "L".

The requirement on the timing of the Classmark Change message, such that the MS send CM change in the empty uplink block following the reception of the L2 UA frame, is specified in AR 04.13-A001.

An operator may decide to delay or inhibit the sending of the Classmark Change message from the BSC to the MSC if it was received immediately after the initial L3 message. This is described in AR08.08-A013.

Any combination of frequency bands and power capabilities in the GSM specifications shall be possible. The coding of frequency and power capabilities according to the solution in AR04.08-A007 ensure this flexibility and also give room for further evolution.

5.3 Measurement reports

The multiband MS will normally report the signal strength of six strongest and identified neighbour cells as a normal MS. These cells may however not use the same frequency band.

To ensure that handover is possible, e.g. for traffical reasons, to a cell which was not reported to be the strongest candidate, a multiband MS shall, for each band, report at least the number of strongest candidate cells measured and identified as indicated by the MultibandReporting parameter. This parameter is sent in the 5ter and 2ter messages with two bits from the Skip Indicator, which will not be used in 2ter/5ter. The maximum of six cells reported is still unchanged.

The sending of the MultibandReporting parameter is specified in AR04.08-A015.The coding of the two bits in the parameter is specified in AR 05.08-A006.

6 Backwards compatibility

Multiband operation will be specified to be backwards compatible so that no harm is made to existing networks and that phase 1 and phase 2 single band mobiles will work in a multiband network.

6.1 Support of single band operation

6.1.1 Single band MSs

A multiband network will normally support single band mobiles in each of the bands of operation but in some cases (common BCCH in one band), it will only support single band mobiles in one of the bands of operation. Single band signalling will be present as well as multiband signalling.

6.1.2 Single band networks

The multiband MSs will, functionally, work as single band mobiles in a single band network.

6.2 Mixed neighbour cell lists

6.2.1 Phase 1 MSs

Some phase 1 DCS mobiles ignores the whole BA list if frequencies outside the DCS band is contained in the BA list. System Information 2ter/5ter are therefore introduced to solve this problem. In multiband PLMNs, where phase 1 DCS MSs will be present, SI 2ter/5ter will be used to indicate the ARFCNs outside the DCS1800 band. SI 2ter/5ter will then be ignored by the phase 1 MSs but SI2/5 and 2bis/5bis will still be used.

6.2.2 Phase 2 MSs

Phase 2 mobiles will only ignore channel numbers, i.e. not the whole BA list, which are outside the bands of operation of the MS. This is already included in the phase 2 specifications (CR-04.08-665).

6.3 Detected compatibility problems and their solutions (when possible)

6.3.1 New messages on the BCCH

Some GSM 900 phase 1 mobiles will not operate properly if new SI messages with a L2 pseudolength greater than 1 are received. To be able to provide service to these mobiles in a multiband 900-1800 network with P-GSM 900 phase 2 mobiles, the handling of the pseudolength received in SI messages have been modified and some measures to avoid the situation have been defined in ETR 09.94. The changes introduced are:

- Phase 2 mobiles are recommended to ignore the L2 pseudolength received in all SI messages. For the System Information 2ter message mobiles are required to ignore the received L2 pseudolength. (CR -04.08-A239 rev 2 and 238 rev 2)

- Networks shall set the L2 pseudolength in the SI 2ter message to 0. SI 2bis must not be used in the P-GSM band. (CR -09.94-A007 rev 1)

6.3.2 New messages on the SACCH

Some phase 1 mobiles may experience performance degradations if the network sends SI messages not defined in phase 1 on the SACCH. The recommended measures to avoid this degradation have been defined in ETR 09.94 (CR -09.94-A007 rev 1):

- Networks shall not send SI 5ter messages on the SACCH to phase 1 GSM or DCS mobiles or SI 5bis messages on the SACCH to phase 1 GSM mobiles.

Annex A:
List of amendments necessary

A.1 Approved by TC SMG for Phase 2

A.1.1 CR-04.08-665 on mixed frequency lists

Compatibility ensured for phase 2 mobiles in a multiband PLMN.

A.2 Approved by TC SMG and put on HOLD

A.2.1 AR 08.58-A005r4 "Sending of SACCH System Information on a call-by-call basis"

Procedures to send SI on SACCH based on the MS capabilities. This is part of WI "Technical Enhancements" and was approved at SMG#14.

A.3 Proposed for WI "Technical enhancements" and required by WI "Multiband operation"

A.3.1 AR 04.08-069 "Early Classmark Sending" and AR 04.08-071 "Early Classmark Sending"

The multiband MS shall automatically send the CLASSMARK CHANGE message as soon as the main signalling link is established (Early Classmark Sending) if so permitted by the network, as indicated in the last reception in the accessed cell of the SYSTEM INFORMATION 3 message.

A.3.2 AR 04.13-A002r1 "Performance requirements on the sending of the CLASSMARK CHANGE message"

Requirements on the MS to send CM Change in the first uplink block after receiving UA-frame in downlink.

A.3.3 AR 08.08-A013r3 "Early sending of CLASSMARK CHANGE"

Inclusion of the option for the BSS to delay or suppress the sending of the CLASSMARK UPDATE message to the MSC in case the CLASSMARK CHANGE message was received at initial connection establishment.

A.3.4 CR 09.90-033 "Early sending of Classmark change indication in CLASSMARK IE"

A phase 2 MS uses one bit in Classmark 1 and 2 IE to indicate its capability in terms of early sending of classmark change message. This bit was associated to another meaning and its use leads to the use of a former reserved value.

A.4 Proposed for WI "Multiband operation"

A.4.1 AR 02.06-A001r2 "Definition of multiband MS type"

Inclusion of multiband possibilities and definition of the multiband MS.

A.4.2 AR 02.11-A004 "Clarifications for multiband operation"

Clarifications about the possibilities to use multiband operation and presentation of available PLMNs.

A.4.3 AR 03.22-A004 "Support of multiband operation by a single operator"

Removal of inconsistencies with multiband operation.

A.4.4 AR 04.08-A007r2 "Multiple band MSs in a dual band network"

Extended coding of frequency and power capabilities in CM3.

A.4.5 AR 04.08-A015r5 "New SI messages 2ter and 5 ter"

Introduction of the two new SI messages 2ter and 5ter to ensure backwards compatibility.

A.4.6 AR 05.01-A004 "Amendments for multiband operation"

Clarification of the functionality of, and radio requirements on, multiband MSs.

A.4.7 AR05.02-A001 "Inclusion of System Information 2ter for multiband operation"

Scheduling of the sending of System Information 2ter on BCCH.

A.4.8 AR 05.05-A008 "Amendments for multiband operation"

Specification of possible frequency bands and the functionality of the multiband MS.

A.4.9 AR 05.08-A006 "Amendments for multiband operation"

Specification of the radio requirements, e.g. measurement reporting, on the multiband MS.

A.4.10 AR08.58-A006r1 "Introduction of SI 2ter and 5ter"

New code points for SI 2ter and 5ter included in GSM 08.58.

A.4.11   CR11.10- 846 "Introduction of new section 26.11 for Multiband specific signalling tests"

A.4.12   CR11.10- 847 "Inclusion of reference to new section 26.11 in introduction to section 26"

A.4.13   CR11.10- 848 "Immediate assignment procedures: multiband"

A.4.14   CR11.10- 849 "Handover procedure: Multiband MSs"

A.4.15   CR11.10- 850 "Structured procedures, multiband"

A.4.16   CR11.10- 851 "Default message contents for section 26.11"

A.4.17   CR11.10- 852 "Modification of section 26.3 for Multiband MSs"

A.4.18   CR11.10- 853 "Received signal measurements for multiband MSs"

A.4.19   CR11.10- 854 "Measurement reporting for Multiband MS"

A.5   Change Requests related to WI "Multiband operation" after 1996

NOTE: This may not be a complete list, and is provided for indicative purposes only.

A.5.1   CR04.08-A178 "Handling of multiple frequency redefinitions"

A179 was the matching CR for the phase 2 specification.

A.5.2   CR04.08-A154r2 "Indication of multislot class"

A.5.3   CR03.26- A002r1 "Amendment for multiband Operation (common BCCH for the different bands of operation)"

A001r1 was the matching CR for the phase 2 specification.

A.5.4   CR05.08-A035 "Amendment for multiband operation (common BCCH for the different bands of operation)"

A034 was the matching CR for the phase 2 specification. Linked to CR03.26 A002r1 above.

A.5.5   CR04.08-A214 "Coding of classmark information for multiband mobiles"

A210r1 was the matching CR for the phase 2 specification.

A.5.6   CR04.08-A207r1 "Handling of classmark information at band change"

A204r2 was the matching CR for the phase 2 specification.

A.5.7   CR 04.08-A239r2 "Clarification of use of L2 Pseudo Length in SYSTEM
                INFORMATION messages" (phase 2 , release -95)

A.5.8   CR 04.08-A238r2 "Clarification of use of L2 Pseudo Length in SYSTEM
                INFORMATION messages" (phase 2+, release -96)

A.5.9   CR 09.94- A007r1 "Handling of new phase 2 BCCH and SACCH messages by phase
                1 MS"

Annex B:
Change History

Change history					
SMG No.	**TDoc. No.**	**CR. No.**	**Section affected**	**New version**	**Subject/Comments**
SMG#23				4.3.0	Phase 2 version
SMG#23				5.2.0	Phase 2+ version
SMG#27				6.0.0	Release 1997 version
SMG#29				7.0.0	Release 1998 version
SMG#31				8.0.0	Release 1999 version

Change history						
Date	**TSG GERAN#**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
2001-04	4				Release 4 version		4.0.0
2002-06	10				Release 5 version	4.0.0	5.0.0
2002-07					Editorial change in the front page (TS -> TR)	5.0.0	5.0.1
2005-01					Release 6 version	5.0.1	6.0.0
2007-08	35				Release 7 version	6.0.0	7.0.0
2008-12	40				Release 8 version	7.0.0	8.0.0
2009-12	44				Release 9 version	8.0.0	9.0.0
2011-03	49				Release 10 version	9.0.0	10.0.0
2012-09	55				Release 11 version	10.0.0	11.0.0
2014-09	63				Release 12 version (frozen at SP-65)	11.0.0	12.0.0
2015-12	68				Release 13 version (frozen at SP-70)	12.0.0	13.0.0

Change history							
Date	**Meeting**	**TDoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
2017-03	RP-75					Release 14 version	14.0.0
2018-06	RP-80					Release 15 version	15.0.0
2020-07	RP-88e	-	-	-	-	Upgrade to Rel-16 version without technical change	16.0.0
2022-03	RP-95e	-	-	-	-	Upgrade to Rel-17 version without technical change	17.0.0

History

Document history		
V17.0.0	May 2022	Publication