



GSM Europe

The European interest group of the GSM Association

GSM Europe
Technical Assessment of Two Case Scenarios for the
Introduction of 3 Digit MNCs

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I. Introduction

It is ECTRA opinion that a shortage mobile of network codes (MNC) will hit the European mobile industry in the near future. As a consequence, the EC started to investigate the feasibility of a migration of the IMSI structure from the currently adopted one in which 2 digits are reserved for the MNC, to a new one, modeled on the North American market, where 3 digits are used for the MNC.

The introduction of 3 digit MNC can be realised following two paths, one is to allow a mixture of 2 and 3 digit MNC behind the same mobile country code (MCC), the other is to assign a new country code that shall be followed by a 3 digit MNC. Both the solutions are problematic due to the fact that when the standards were created, this eventuality was not forecast.

At a workshop organised by ETO in September 2000, GSM Europe was assigned the task to carry out an assessment on the technical impact of introducing 3digit MNCs for the two following case scenarios:

- Co-existence behind the same E.212 country code of mixed 2 and 3 digit MNCs
- The use of separate (discrete) E.212 country codes: one for 2-digit and one for 3-digit.

This paper sets out an assessment of the two case scenarios mentioned above as outlined below:

II. Background

The MNC is a component of the IMSI (International Mobile Subscriber Identity), the other components being the Mobile Country Code (MCC) and the Mobile Station Identification Number (MSIN).

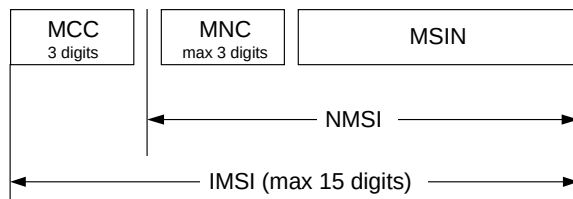


Figure 1 IMSI Structure

The MNC is an inner element in the IMSI with a defined length of 15 digits. The whole IMSI is marked on the SIM-card. To this extend, the IMSI must not be mismatched with the subscriber's number which is e.g. in GSM an E.164 number.

Various GSM entities will interpret the extra MNC digit as part of another field (MSIN), which will consequently lead to inconsistencies within the interaction between various parts of the whole GSM System.

The IMSI is used to:

- Identify a (roaming) customer, for
- Network internal purposes used in all signaling in the PLMN, in
- Interaction with the Mobile Terminal and for
- BackOffice applications like charging, billing and accounting

As the National Regulatory Authorities (NRAs) are responsible for the establishment and publication of conventions for IMSIs (IMSI = MCC + MNC + MSIN), the change of the current MNC allocations (e.g. 03 may become 030 or 003) may lead to severe problems given that the length of the IMSI is fixed and the structure / usage of the MSIN is subject to each individual operator.

It should be noted that for the time being, out of a total of 300 MNCs actually in use, 14 are 3 digit MNCs. Furthermore, there are no assignments for 3 digit MNCs outside the US, where 5 US Operators were assigned such MNCs. In terms of operators this corresponds to 1.7 % of the GSM Operators.

III. Technical assessment of scenario 1 (mixture of 2 and 3 digit MNC)

This scenario envisages the use of both 2 and 3 digits MNC behind the same mobile country code. The 3 digit MNC would be assigned only to whoever requires to allocate IMSI numbers be those mobile operators or other organisations. The allocation of 3 digit MNC will be done in such a way not to interfere with the already assigned 2 digit MNC, this means that if in one country the 2 digit MNC xy is in use, the range of 3 digits MNC from xy0 to xy9 must be reserved.

For what concerns this scenario the technical specification 3GPP TS 23.003 for Release 99, contains the following statement in paragraph 2.2:

- ii) Mobile Network Code (MNC) consisting of two or three digits for GSM applications. The MNC identifies the home GSM PLMN of the mobile subscriber. The length of the MNC (two or three digits) depends on the value of the MCC. **A mixture of two and three digit MNC codes within a single MCC area is not recommended and is outside the scope of this specification.** See 3GPP TS 23.022 [3] for more information.

GSM Europe has analysed some of the technical implications related to the introduction of this scenario and a detailed description of the all the areas affected by this modification are presented in the following paragraphs.

III (a) Core network

The IMSI analysis would need to be redefined.

All subscriber records would need to be modified to change the MNC from 0X to 0X0 or 00X. In the case of multiple Home Location Registers (HLRs), as is the case with nearly all operators, the level of planning and coordination would be substantial.

In the case of redundant HLRs, the data would need to be changed on both the live and backup locations.

In addition to this, many of the operators would have to reconfigure their Base Station Subsystem so that it transmits a Location Area Identity (LAI) which contains the new 3 digit MNC. This causes operational costs. In addition it would demand additional operational capacities to respond to customer expectations, which especially operators, who are still in the phase of 2G network rollout or who have (some additionally) plans to built up a 3G network may not be able to manage in a sufficient way.

III (b) Billing & Customer Care Systems

The billing systems of most networks use the IMSI for the generation and gathering of billing information. The introduction of 3 digit MNC alongside the existing 2 digit MNC would require severe modifications to billing systems and to the rules that the billing systems use to identify the HPLMN of the roamer. The billing system must also be more flexible in identifying the correct operator in case this operator uses both 2 and 3 digit MNC.

III (c) Roaming

Regarding roaming, the IMSI analysis for all European operators will have to be changed in every MSC.

All roaming testing would have to be redone and would be more complex.

Finally, operators would have to change their roaming contracts with each of their roaming partners. This will have an effect on nearly every country using GSM. Hence, if the roamed-to network cannot scrutinise 3-digit MNCs, roaming would stop overnight.

A possible procedure for the renewal of the roaming agreement could look as follows:

1. The roaming partner exchange the new simcards, with an overview about the necessary data.
2. Adaptation of the necessary parameters for the SCCP-connection in the home PLMN and if necessary by the fixed network provider.
3. The roaming partners will fix a date for the test scenario.
4. Single Test with the roaming partner simcard in the home PLMN. -> the result will be exchanged.
5. Single Test with the home simcard in the foreign PLMN. -> the result will be exchanged.
6. Check of the delivered TAP-files under TADIG guideline by both roaming partner.
7. Check and sign of the test sheet.

GSM Europe has estimated that the procedure could take an average of 3 man-days for each of the roaming agreement. Considering that the average number of roaming partners for any GSM operator is in the region of 200, the workload required would represent a burdensome task.

III (d) Conclusive remarks for scenario 1

From a procedural point of view, the introduction of 3 digit MNC following this scenario does not present particular difficulties: the national regulators could start assigning 3 digit MNC straight away, however from a technical point of view, this introduction would cause serious problems to the existing network operators, both those in the country where the 3 digits MNC is introduced and in that of their roaming partners. Particularly, the impact on the roaming agreement cannot be underestimated.

GSM Europe cannot find, under a technical point of view, any clear benefit that the introduction of 3 digit MNC in this fashion could generate, and the amount of work required does not seem proportionate to the problem of MNC shortage foreseen by ECTRA.

IV. Technical assessment of scenario 2 (New MCC followed by 3 digit MNC)

This scenario envisages the assignment to each country wanting to introduce 3 digit MNC of a new Mobile Country Code that can be used in association with 3 digit MNC. The new MCC + 3 digit MNC would be assigned only to whoever requires IMSI numbers to be allocated, be those mobile operators or other organisations.

IV (a) Problems Identified

The main problem preventing a smooth adoption of this solution lays in the fact that at the moment there is a one to one association between a country and a mobile country code (i.e. one country, one MCC), and all the standards have been created with this assumption in mind. The special case of countries where more than one MCC has been allocated such as the USA, are covered by specific exception handling from GSM R98 specifications onwards.

On the other hand the USA case shows that it is feasible to adopt the new MCC approach: billing systems are up and running, terminals behave correctly, both national and international roaming are handled appropriately. However it must be remembered that the USA case constitutes an exception implying that work is required in the standardisation bodies to transform this exception in the rule and the implications on legacy equipment cannot be overlooked.

Another problem that could appear once the new country code is introduced is that in some special situations only terminals manufactured after this introduction would work correctly. In particular those situations are

- national roaming
- background scan of higher priority PLMNs

IV (a) 1. National Roaming

The national roaming problem appears to be the most concerning. Suppose that a new operator A is assigned an MNC behind a different MCC than the one used by an incumbent operator B with which a national roaming agreement is in place. If a subscriber of A roams into B, under the mobile point of view this situation corresponds to international roaming (change of MCC) and there shall be no periodic attempt made to return to the home PLMN (of operator A) even when the latter network becomes available.

IV (a) 2. Selection of a preferred PLMN

Another problem identified with the introduction of a new MCC is the possible failure for a subscriber of a network using the new country code to automatically select the preferred network when in national or international roaming.

When the user is in country A (MCC = abc) the mobile checks the user and the operator preferred PLMN list¹ to see if there is another network with MCC = abc having higher priority than the currently selected one. If such network is listed, the mobile will try to register on it. The problems lies in the fact that in GSM standards there is no difference between saying "the same MCC" or "the same country" and, when a new MCC is introduced, higher priority

¹ The SIM (or USIM) contains a list of preferred PLMNs, those are entered either by the user in the "User Preferred PLMN selector list" and by the operator in the "Operator Preferred PLMN selector list".

networks in the same country (but with different MCC) will not be searched for, hence causing the failure of the algorithm.

Below is an example of a possible failure:

User preferred PLMN list:

MCC MNC (COUNTRY NETWORK)

262 01 (Germany , T-Mobil)

234 30 (UK, One 2 One)

In the case where a user is registered on 235 001 (suppose 235 is the second MCC for the UK), the user should select 234 30 since this is a preferred network in the UK. However, this fails to happen because the terminal only considers the networks in the list with MCC = 235. If the user was registered on 234 10 (UK BT Cellnet) then the terminal would have looked for 234 30 and selected it.

This problem is similar to the one concerning the failure to return to the home network when in national roaming, since the return to the home PLMN is attempted only when registered in the same country as the home network, bearing in mind that in GSM standards one country = one MCC.

IV. (b) Conclusive remarks for scenario 2

Based on the assumption that the new country code will be used only by new operators while the incumbents will still use the original MCC and a 2 digit MNC, the advantages of introducing 3 digit MNC in Europe only behind a new mobile country code are:

- avoid the mixture of 2 and 3 digit MNC behind the same MCC (i.e. scenario 1)
- free the whole addressing space i.e. 1000 MNC are available whereas with the other solution only a subset of the MNC space can be used
- minor modifications are needed in the GSM networks (only extension to the scope for the existing handling of North American roaming customers)
- the handling of international roaming can be modeled on the current agreements with North American companies and it is thus simple
- simple modifications are required for the new GSM terminals, those modifications have already been realised for terminals intended to be sold in the North American market.

The disadvantages are due to the difficulty for a terminal to understand that there is not a one to one relation between the country and the MCC, i.e. the difficulty of associating multiple MCC to the same country.

- Legacy terminals will not be able to understand the new MCC + MNC.

- Failure to return to the home network - when in national roaming - where the two roaming partners use different country codes.
- Possible failure to select the preferred network when roaming for a subscriber of a network using the new country code.

V. Conclusions

GSM Europe has performed a technical assessment of the two possible scenarios for the introduction in Europe of 3 digit MNC. GSM Europe has identified a number of problems that would derive from the introduction of 3 digit MNC following scenario 1, whilst the impact on the existing operators if scenario 2 is selected would seem to be less severe.

Having carried out this assessment, GSM Europe is of the opinion that the introduction of 3 digit MNC would in either case require a technical effort which is not proportionate to the foreseen shortage of MNC that this introduction would solve.

It should be recognised that this shortage of MNC will not be experienced as a result of the coming into the market of UMTS operators since:

- a) most of the existing GSM operators who have been granted a UMTS license will want to reuse the already allocated 2 digit MNC for the UMTS part of their network;
- b) the allocation of UMTS licenses has shown that a maximum of between 4 and 6 UMTS network can be deployed in each country

Note finally that GSM Europe has been liaising with 3GPP regarding the feasibility and impact of the two scenarios. The response from 3GPP has been incorporated as an annex to the GSME assessment, as set out below.

ANNEX: 3GPP Liaison Statement to GSME

3GPP TSG CN Plenary Meeting #12
Stockholm, Sweden, 13th - 15th June 2001

Tdoc NP-010350

Title: Liaison statement on Mobile Country Code and 3 digit Mobile Network Code
Source: 3GPP TSG CN
To: SPAN11 WP NAR, GSM Association, 3GPP PCG
Cc: 3GPP TSG SA WG1
Contact: **Hannu Hietalahti, Nokia**
Hannu.Hietalahti@nokia.com

3GPP TSGN thanks SPAN11 WP NAR for the liaison statement in document SPAN11(01)TD048 / NP-010242 asking about consequences of potential introduction of new MCC codes or 3-digit MNC codes outside the USA.

These technically different alternatives were studied with the following outcome.

3-digit MNC code:

3GPP TSG CN WG1 reviewed the proposal relating to the introduction of 3 digit MNCs and provided the following observations which are supported by 3GPP TSGN:

- 3 digit MNC were first defined in R98. All implementations that are based on releases older than that do not support 3 digit MNC.
- The mixture of 2 and 3 digit MNCs in the same MCC has been explicitly defined only for the MCC codes 310-316 which have been assigned for the USA.

In general the system implications of having mixed 2-digit and 3-digit MNCs under the same MCC are significant:

1. Mobiles implemented to specifications earlier than R98, which check the validity of any received MNC, will fail these checks if 3 digit MNCs are introduced.
2. Existing Mobile stations and SIM cards would have to be either upgraded or replaced.
3. Existing mobile implementations could potentially have problems with the displaying of 2 and 3 digit MNCs
4. While the cost of incorporating these changes in new equipment is not significant, the cost of upgrading ALL legacy equipment (which is necessary to support roaming) will be significant.
5. The introduction of 3 digit MNC will cause roaming, billing, and service outages if existing equipment (mobile and network) is not upgraded.
6. Any update to existing networks will require the change to be implemented country wide, in all PLMNs, to avoid inconsistent mobile behaviour within the networks.

7. Even though the software changes required are themselves not significant, it is possible that all currently deployed GSM/GPRS equipment will have to be upgraded. This will be a daunting task.

Introduction of new MCC code:

1. Using a new MCC in a country where none was used before

This can happen when a new political country is formed but it applies to all cases where a new MCC is allocated to a country which for one or another reason did not use an MCC code before. For a mobile which is registered in a PLMN under any other MCC the new PLMNs under the new MCC will be considered to be abroad. In this scenario this will be true. So allocating an MCC to the new country causes no problems in UMTS system.

2. Using a new MCC in a country where at least one MCC is already in use

The use of additional MCC code(s) to a country which already has got at least one MCC will effect the operation of mobiles which have been manufactured before the addition. The following points were identified:

- **National roaming:** Periodic HPLMN search is mandatory when roaming in home country. As the old mobiles will not know that the new MCC is in the same country as the old MCC(s) of that country, they will not perform HPLMN search when it would be needed as the new MCC will be assumed to be abroad, which in this case will not be true. Periodic HPLMN search is defined already in GSM Phase 2+ Release 96 (GSM 03.22 v. 4.b.0 / 4.4.3.3) The consequence of this is that these old mobiles will not return to the HPLMN until they lose coverage from the network with the new MCC code.
- **Background scan of higher priority PLMNs:** When mobiles are roaming they perform the mandatory background scan of higher priority PLMNs in the same country. Any Mobile Network Code (MNC) will be ignored by the old mobiles if it is associated with the new MCC as it will be assumed to be in a different country. Background scan is defined for the first time in R99 specification (TS 03.22 v.3.6.0 / 4.4.3.3) The consequence of this is the old mobiles will not move to the higher priority PLMN until they lose coverage from the network with the new MCC code.

TSGN is aware that there are several countries to which multiple MCC codes have been allocated. But the only specified case on support of multiple MCC in one specific area corresponds to North America. This case has been explicitly covered by specific exception handling for Country Codes in range of 310 to 316 which has been defined in GSM 03.22 from R'98 onwards.

Deletion of an existing MCC was also discussed briefly and that has got no side effect on the system behaviour.

To keep behaviour of all terminals homogenous (legacy ones and new ones supporting a potential evolution of MCC meaning) before and after a PLMN starts using new MCC in area where one MCC was already in use, it will be necessary to update all legacy terminals.