

Source: CN1 chairman on behalf of drafting group
Title: Some considerations on the use of RAT in PLMN selection
Agenda item: 6.1.2
Document for: Discussion

1. Introduction

The discussion on the use of Radio Access Technology (RAT) by the UE in PLMN selection and in particular background scan has been ongoing for some time with no decision yet. It was decided during TSGN #23 to document in more detailed level any identified problems related to the use of RAT in the background scan procedure and which working groups and 3GPP technical specifications outside CN would be affected.

The UE user and the HPLMN operator can define in user controlled or operator controlled PLMN selector lists the priorities of PLMNs with associated access technology.

This document outlines the interactions with some other existing 3GPP system features with the assumption that RAT is used by the UE during background scan and PLMN selection.

The statements in section 2 and 3 in this document outside proposed conclusions are concerns raised by some companies within CN and the proposed conclusions represent what was assumed to be the correct behaviour in CN.

2. Interactions with other features

2.1 Scenario under study

The following roaming scenario has been studied both in the CN1 WG and TSGN:

In Table 1 the user roams in a foreign country where PLMN A and PLMN B are available. Both PLMN A and PLMN B support 2G and 3G accesses.

The 'PLMN/RAT Priority Order List' columns correspond to the PLMN selector list priority as defined on the USIM.

The Status column indicates if this PLMN with the corresponding RAT is available.

The two columns under title 'After Background Scan' indicate if the user will change of network or not after this procedure (depending on the fact that PLMN only information in the Priority list is considered or if the RAT information is also taken into account).

Table 2 depicts another case using the same notation.

PLMN/RAT Priority Order list		Status	Registered PLMN	After Background Scan	
PLMN	Radio Access			PLMN only (N1-040494)	PLMN/RAT (N1-040478)
A	UMTS	Not Av.			
B	UMTS	Available	X		X
A	GSM	Available		X	
B	GSM	Available			

Table 1

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B	GSM	Available			

Table 2

3. Interactions with other features

3.1 *Impact on 2G and 2.5G mobiles*

For a GSM only mobile it would seem that the PLMN list to be used should only consist of those PLMNs which are on the GSM frequency.

Assuming the following PLMN selector list on the USIM:

PLMN A UMTS

PLMN B UMTS

PLMN B GSM

PLMN A GSM

Which PLMN priority does a GSM-only UE now use:

PLMN B

PLMN A

PLMN A

OR

PLMN B

This question was seen valid whether RAT is used in PLMN selection or not.

Proposed conclusion: A single mode mobile shall ignore those PLMN + access technology entries on the PLMN selector list where the associated RAT is not supported by the ME.

3GPP WG affected: CN1

3GPP TS affected: 23.122

3.2 *Registration failure due to radio conditions etc.*

The current proposal includes the following requirement: “If the PLMN of the highest available PLMN/access technology is the current serving VPLMN or it is in the “Equivalent PLMNs” list, the MS shall remain on its current PLMN/access technology”.

What is not clear is what actions the MS is expected to take if a previous registration attempt on the higher priority RAT failed due to either radio conditions or registration rejection.

Is the higher priority RAT to be considered as available or not?

What about the case that the cell in the higher priority RAT is barred?

Should the mobile consider the different settings of CBA, CBQ and CBQ3 relative to its own capabilities and use these as a measure of availability?

In the case that the LA of the higher priority is on the list of forbidden LAs should the mobile consider the RAT as available or should it look for the RAT in another LA?

Proposed conclusion: The term available PLMN is not necessarily needed. But the handling of barred cells and the handling of LA based reject causes is already specified. If the UE finds a higher priority PLMN + RAT combination, then if it is the other RAT of the same PLMN, then the UE stays in the current PLMN+RAT and it does not matter whether the other cells are accessible or not. If, on the other hand, it is another PLMN, then the UE shall attempt to register to it and then it will treat the response according to the current specifications.

The side effect of this is that even a cell in a forbidden LA (of the higher priority RAT of the serving VPLMN) does override the the priority of the other PLMN + RAT entries, see table 1 and 2.

3GPP WG affected: CN1

3GPP TS affected: 23.122?, 24.008? (to be checked for impact)

3.3 Possible problem with new definitions

The proposal introduces a definition of an available PLMN/RAT but it would seem that the definition should be included in the relevant radio specifications.

Also, GERAN Iu mode does not appear to be covered by the proposed new definition. References to GERAN and RAN specifications can no longer be based on A/Gb and Iu Mode alone.

Proposed conclusion: This may be true but it is not related with background scan only.

3GPP WG affected: CN1

3GPP TS affected: 23.122, 24.008 ?, any radio specs ?

3.4 What about mobile behaviour in networks which are not coordinated

The introduction of the requirement that the presence of one RAT causes the mobile to stay on another RAT of the same PLMN will impact those operators who are effectively running independent networks (i.e. same PLMN code but no cell re-selection between the different RATs) and will prevent the behaviour that they might expect if the RAT is to be used as part of the periodic PLMN scan.

Proposed conclusion:

A CR has been agreed at last SA1 meeting on 22.011. This CR inhibits the so called ping pong between the different RATs of a single PLMN.

The current stage 1 requirement not to change in background scan between the different RATs of the same PLMN does inhibit the possibility to guide the user back from nationwide GSM coverage to (patchy) UMTS coverage if the UMTS coverage has been lost momentarily.

3GPP WG affected: SA / SA1

3GPP TS affected: 22.011

3.5 Equivalent PLMN list interactions

The 3GPP specifications, including the Equivalent PLMN list concept, have been drafted with the assumption that the RAT should not be used for the periodic PLMN background scan, amongst other reasons to avoid a ping-pong effect between RATs of the same PLMN. Therefore the EPLMN list does not include RAT information.

If the EPLMN list is used then all RATs of a PLMN will be considered to have the same priority. For example, what would happen if at some future date an operator decided to use the EPLMN list to coordinate his FDD and TDD networks?

In the case a VPLMN is using an EPLMN list there is the likelihood that the use of the list will nullify the proposed use of RAT in the periodic PLMN scan.

The proposal to CN1 clarifies how the EPLMN list is to be used, i.e. all RATs of a PLMN are considered to have the same priority, but there is a risk that its use could have unforeseen effects in other areas.

Proposed conclusion: EPLMN can only indicate the equivalent PLMN. Therefore it is not possible to indicate any preferences between the current or future access technologies.

3GPP WG affected: CN1

3GPP TS affected: 23.122, 24.008

3.6 Impact on other specifications

At present there is an assumption that the proposal only impacts TS 23.122 however it is not clear that this is the case.

TS 24.008 has a number of instances where Location Area Update and Routing Area Update attempts can be rejected with causes that instruct the mobile to perform a “PLMN selection as defined in TS 23.122.”

With the introduction of the use of RAT into the PLMN selection procedures there needs to be a clear definition in TS 24.008 as to whether PLMN or PLMN+RAT is to be used in the cases where the mobile is rejected from registering in a particular Location Area or Routing Area.

This is probably a minor issue but must be considered when trying to elaborate a complete solution.

Proposed conclusion:

3GPP WG affected: CN1, RAN2, GERAN1

3GPP TS affected: 23.122, 24.008, 43.022, 45.008, 25.304

3.7 Need to break RAT into the different frequency bands

If the RAT is going to be used in the periodic PLMN scan then it would seem that the RAT should be identified not just as UMTS but rather as FDD, TDD high rate and TDD low rate. If this is not done then it is possible that once TDD is launched that a request to introduce this requirement into the specifications will be raised.

Within GERAN, for example TS 45.008 (section 8.1.5), it is clear that FDD, TDD and cdma200 are already treated as separate radio access technologies. As an example:

- i. For UTRAN FDD cells the measurement quantities to be used are CPICH Ec/No and CPICH RSCP and RSSI.
- ii. For UTRAN TDD cells, the measurement quantity to be used is PCCPCH RSCP.
- iii. For cdma2000 cells, the measurement quantity to be used is PILOT_STRENGTH of the pilot.

Once RAT is used, then not only will there be a need to separate FDD and TDD, there is a strong possibility that some operator will present a requirement for choosing PLMNs based on the different GSM frequencies (e.g., 1800, 1900, 900, 850 etc). In fact this has already been proposed within 3GPP2.

Additions of new code points to the specifications are needed to identify the different RATs.

A clear decision needs to be taken by TSG SA WG1 regarding the need or not to separate out the different RATs and frequency bands. In Motorola's view there should be a clear statement that the GSM frequencies are not separated out while it seems reasonable to identify the different UMTS access technologies (i.e. FDD, TDD (high and low)).

Proposed conclusion: CDMA2000 can not be another RAT in this respect since the network selection specification is maintained by 3GPP2 and WLAN is not just another RAT either, since the WLAN PLMN selection is not reusing the 22.011 and 23.122 PLMN specification but a separate procedure.

At the moment there are no requirements to distinguish between different frequency bands.

However, it would be possible now to take the existing WCDMA RAT code point for FDD use and to define a new RAT code point for WCDMA TDD, if needed. This can not be done any more once the TDD implementations exist.

Proposed conclusion:

3GPP WG affected: SA1

3GPP TS affected: None

3.8 Mobile behaviour in case of manual selection

If the RAT is to be included in the background search it would imply that the user should be able to enter the PLMN RAT via the user interface (see following section 5.11).

Also if RAT is to be considered it seems reasonable that for Manual mode and for Automatic mode user selection should be clarified to be specific with respect to PLMN/RAT combinations.

In the case of Manual mode selection should the mobile attempt to register on another RAT of the serving PLMN, if it is available, or should the mobile behave as proposed for Automatic Mode and remain on the current RAT?

To ensure consistent behaviour of mobiles this issue needs to be reviewed by TSG SA WG1 and a clear service requirement identified.

Proposed conclusion: RAT is not meaningful in manual mode PLMN selection and background scan is not performed either.

3GPP WG affected: CN1

3GPP TS affected: 23.122, 24.008 ?

3.9 Relationship to other activities ongoing within 3GPP

3.9.1 Network Sharing

Given the work that is currently being done within 3GPP on Core Network Sharing it needs to be clarified what relationship, if any, the use of RAT in the periodic PLMN scan will have with the work being done. It should also be considered what relationship there is, if any, to 'private' access networks.

Proposed conclusion: Network sharing will need to follow the PLMN selection rules, so whatever decision is made on the use of the RAT in PLMN selection procedures must apply to network sharing case as well.

3GPP WG affected: None

3GPP TS affected: None

3.9.2 WLAN

The work on WLAN is also specifying requirements for PLMN selection and a check needs to be made to identify the relationship, if any, that exists between the proposal and the WLAN work.

The potential interactions between WLAN and multiple access networks on a core network needs to be considered. Perhaps the way forward on this would be to organise a workshop on access network selection.

Proposed conclusion: In Rel-6 interworking between 3GPP and WLAN does not use the same PLMN selection procedure as we are talking about here. To reflect this, 23.122 is cellular PLMN selection and the WLAN part is covered in separate 24.234. No background scan has been specified for WLAN PLMN selection.

In Rel-6 environment this leads to the restriction that there is no specified mechanism for an operator or the user to prioritise between cellular and WLAN access.

3GPP WG affected: None

3GPP TS affected: None

3.10 Impact on User Interface

3.10.1 User ability to enter RAT information

If the RAT is to be taken into account then there is likely to be an impact on the user interface.

If the RAT is going to be part of the periodic PLMN scan then there may be a need to ensure that the facility is provided for the user to enter PLMN + RAT combinations.

Proposed conclusion: Currently there is very little specified about the user interface for editing e.g. pre-R99 SIM PLMN selector list. Similarly also the manipulation of the user controlled and operator controlled PLMN selector list with access technologies should be left outside of the scope of protocol specifications.

3GPP WG affected: None

3GPP TS affected: None

3.10.2 Impact of user input on operator's choice

Any user input (i.e. User Preferred PLMN list) is given higher priority than operator input (i.e. User Preferred PLMN list) which potentially means the user determined priority can override the operator choices.

Proposed conclusion: The user controlled PLMN selector list has been specified in 22.011 and 23.122 to take higher precedence than the operator controlled list. The maintenance of neither of these lists has been specified.

3GPP WG affected: None

3GPP TS affected: None

3.11 Interaction with RRC Connected States

In some RRC Connected States the mobile is required to perform periodic PLMN scanning using the procedures defined in TS 23.122. It needs to be ensured that changes in TS 23.122 do not impact the expected RRC behaviour defined in TS 25.331.

Also, when the mobile is in the CELL_DCH and CELL_FACH states the periodic PLMN scan is disabled which means that these states have an impact on how quickly a mobile returns to a higher priority PLMN. While this issue is not directly related to the proposal it is worth noting that the mobile can be in the CELL_DCH or CELL_FACH state for a considerable amount of time (measured in hours).

Proposed conclusion: The UE can stay in RRC state where it is not able to perform the idle mode procedures for long time. The intention is not to force any change on the RRC procedures due to background scan. The RRC handling of the PLMN scan (by RAT or by PLMN) needs to be checked.

3GPP WG affected: RAN2

3GPP TS affected: 25.304, 25.331

3.12 Other general issues

There have been suggestions in the past to have the RAT introduced into the different location update rejection causes and proposed limitations in the call set-up based on the RAT. All of these have been seen to break the fundamental principle of layer independence, and have been rejected.

Proposed conclusion:

The UE shall already use RAT in the initial PLMN selection and when recovering from out-of radio coverage.

The use of RAT in background scan shall not affect the cell re-selection procedure in radio layer.

Consequently the use of RAT in background scan does not affect the operator's possibility to set the cell-reselection parameters to bias the camping of the UE to any RAT of operator choice.

3GPP WG affected: None

3GPP TS affected: None

4. Questions

Following the discussion which took place in CN plenary working group, there were no CN blocking issue identified with the use of RAT in the Background Scan procedure. However to proceed with the matter, the following questions need to be answered, based on the above analysis a working assumption was made that RAT will be used in the Background Scan procedure:

1. Can the above working assumption be confirmed?
2. Does a single mode UE 'pack' the PLMN selector lists to get a single priority for all PLMNs or does it ignore those entries on PLMN selector lists where the PLMN is associated with a non-supported RAT? (see 3.1).
3. Is it acceptable that the presence of a high priority PLMN + RAT combination can give a high priority for the other access technology of the same PLMN, even though this cell may be part of a forbidden LA? (see table 1 and 2). It should be noted that this case falls in two alternatives, a cell in a forbidden LA which the UE knows to be forbidden, since it is on the forbidden LA list and a cell which the UE does not know whether it would be forbidden or not, since it is part of the other RAT of the same PLMN and the UE is not allowed to access it.
4. Does the introduction of the mechanism to prevent 'hopping' between different RATs of the same PLMN lead to undesirable behaviour which means that it would be better to allow for the 'hopping' situation?
5. For those items not included in the specification (e.g. comments in 3.12 above) how will they be clearly documented to ensure that everyone is aware of the decisions taken by 3GPP?

Potential changes depending on chosen solution are foreseen in the area of the following 3GPP WGs:

WG	TS	Reason
SA1	22.011	Clarified requirements on that PLMN / access technology is used in background scan (22.011 subclause 3.2.2.2 and 3.2.2.5)
CN1	23.122	PLMN selector list handling by a single mode mobile
CN1	24.008	Terminology checking to see that 'PLMN' and PLMN / access technology' is used consistently
RAN2	25.304	Definition of the availability of RAT, Interface to indicate what kind of scan to perform.
RAN2	25.331	Procedures to handle different PLMN scans based on above
GERAN1	43.022	Definition of the availability of RAT
GERAN1	45.008	Definition of the availability of RAT