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1. Introduction

During last 12 months the handling of an early mobiles has been extensively discussed within RAN plenary and working groups. Several proposals has been presented and discussed, and some conclusions have been made. However in the area of how to identify differently behaving UE's in the system, it is still open and extensively discussed.

This contribution address the areas of RRC signalling and handling of bit map over Iu, providing an analysis on the situation and suggestions of a possible and viable way forward.

2. Discussion

In this section we provide an analysis of the proposals presented addressing this area.

Especially proposals are analysed against requirements that are seen essential for well working Early UE Handling mechanism:

- Global roaming needs to be ensured
- Approach needs to be such that any addition to the Release'99 protocols is backward compatible
- Existing release'99 functionality shall not be disabled due to the adding of error handling mechanisms
- It must be possible to separate faulty and non-faulty UEs
- The solution shall be such that it can be applied early enough in the signalling to cover all situations – ie. When first connecting to UTRAN or entering UMTS from another system (GERAN)

2.1 RRC hooks proposal

As known here the idea is to add a bit string into relevant RRC messages, which could be used as some problems are found, and appropriate correction in the specification and to the UE implementation is made. Hence bits would indicate corrected behaviour of an UE. In addition the information would be available only for RAN and no information is transferred over the Iu.

To be useful these bits should be sent in an early RRC connection establishment phase to be available in RNC for special treatment as early as possible. In earliest possible messages these bits may impact also other UTRAN features like neighbour measurements, e.g. it is apparent that the length of the bit string can't be very long. This is limiting the number of errors possible to handle with this scheme. Hook bits can't be binary coded, because same terminal may have more than one problem in error handling procedure, which is limiting further the number of errors possible to handle with this scheme (e.g. with 4 hook bits it's possible to handle 4 errors and not 16). Hence it has also been proposed that extension of other messages could be considered, making estimation of the duration of this procedure a bit difficult.

The general problem with RRC Hooks is that with this scheme it is never possible to separate the working terminals from the faulty ones. This is important to note, since even though the specification may include some ambiguities, there is still the possibility to implement a correct and working solution. Any indication linked to the clarification in the specifications would penalise using already working solutions, due the fact that the indication bit can't be retrospectively set for terminals in the market. This is a severe disadvantage causing increasing problems for well behaving implementations, for an unknown time period in the market. Penalising good implementations does not serve the interest of the industry as a whole.

Hook bits can't be used to prevent functionality, which is essential for the system. Consider the case where some terminals in the field have error with their essential functionality, naturally this functionality can't be disabled with hooks from all these terminals already in the field.

As an example IMSI Attach procedure is essential for the system. If this procedure has some problems it can be regarded a very fundamental for whole system point of view. Surely this is one of the most tested procedures since it's usually needed before any other testing can proceed. In case some terminals may have problems to send IMEISV to CN (i.e. IMSI Attach procedure does not work), then it's questionable how RRC hooks would solve this either, due the possibility of impacting already working terminals. Hence RRC Hooks won't give any additional value compared to IMEISV based solution even in this case.

Another good example of this is ciphering; if we apply here a hook indication, and there is already working solutions not needing it, this will result that in order to get them both working, no ciphering is possible to use in the system. Even this may be claimed not to be mandatory requirement, would still be a severe threat to WCDMA reputation.

For this reason RRC hooks is not a viable to solve the problems for early terminals.

2.2 IMEISV and bit map proposal

This solution addresses the problem of how to distinguish different UE models currently in the market, and only address special treatment to the UEs having an actual problem with a particular functionality. IMEISV is transferred to CN from the terminal, and this information is converted to a bit map indicating errors and possibly work around in the network, and forwarded over the Iu to the RNC(s). This solution has several features, which makes it interesting.

- Firstly it is possible to target only the UE models including any particular problems.
- The error correction can be progressed also for the terminals in the market as well if needed.
- This is a generic solution taking into account also GERAN issues, and which can take care also inter RAT HO before the actual procedure is established.
- Does not require any changes to the UE or Uu interface.

In this solution the conversion is done in CN, and bitmap information is then forwarded to RNC. It has the benefit that overall memory needed for this functionality is considered to be less, and more flexible upgraded than in the case that IMEISV is stored in every RNC. In that case upgrading of memory may be more difficult for various reasons.

During the discussions it has been noted that receiving the bitmap information from CN may take time, and this may not be sufficient solution alone.

2.3 (Reduced) IMEISV/Manufacturer+Date over Uu

Another proposal has been that the IMEISV, a reduced form of the IMEISV, or a Manufacturer+Date could be transferred over the Uu interface between RRC peers, and subsequently between RNCs.

As discussed above there seems to be a requirement that solutions based on the transfer of information over the Uu utilise the earliest possible RRC message. Due to the size of the IMEISV it is considered too big to add to the RRC CONNECTION REQUEST. Even if a reduced from were calculated, it is believed that it would still be impossible to include it in the RRC CONNECTION REQUEST without preventing the inclusion of neighbour measurements as is currently possible. Not only is it desirable that this functionality be maintained, but this can be viewed as a non-backward compatible change to UTRAN implementations, which may currently be using this measurement. It is also possible that this will negatively impact system performance when initial neighbour measurements are delayed.

To avoid these problems the IMEISV information can only then be transferred at the earliest in the RRC CONNECTION SETUP COMPLETE. It has not yet been shown that this will provide the information to the RNC any earlier than can be achieved via the CN and Iu method.

Another drawback of this scheme is that any database involved in the translation of IMEISV to potential UE faults would have to be replicated in every RNC. It should also be noted here that the RNC does not currently handle the IMEISV and so information usually stored in the CN may have to be duplicated into the RNC.

2.4 Operability considerations

Even though a significant amount of documents and analysis has been presented around this area, the operability analysis of the schemes has not been discussed much.

When considering how the UE identity information can be obtained, and especially how many times the procedure needs to be performed, we can see here two clearly separate issues.

- Phase #1 when UE is attaching to the network, and
- Phase #2 when UE or UTRA requests a connection to establish needed radio links for service.

In this first phase the criticality of fast availability of bit map over Iu is not justified. We consider that requirement for fast attachment procedure is not well justified; since this procedure requires updates in core network databases anyway before the attachment procedure is completed. In addition all transactions for this purpose are possible to do with well-tested UEs (either IOT testing or protocol testing), and hence with these simple procedures between NW and UE the necessary information of IMEISV is possible to obtain from UE.

Hence after this procedure IMEISV is present, and can be applied in all cases in phase #2 when the end users request services. When considering this is in the context of RRC hooks, the generic solution using only for hooks increases the number of transmitted bits in all procedures when these messages are applied. We consider this as transfer of redundant information, which is not necessary to the system at the end.

We consider that there is a possibility of applying the best parts from both proposals.

3. Early RRC bit(s) and bit map over Iu

In order to be viable solution to address all aspects in early mobile handling, merging the best parts from both proposals should be considered. Hence it is our view that we should utilize these proposals as follows

- A few bits should be reserved in the very first RRC messages to indicate what basic signalling and related other features work to obtain IMEISV from UE to CN and relevant bit map information from CN to RNC. During this time only very basic functions are used. This could be understood as a kind of indication of tested procedures of the UE. We consider that natural indication for these bits could be referred to the content of T1/GCF packages 1, 2, etc. and what testing coverage UE may have.
- Based on this information UTRAN can utilize procedures for this specific UE during “bitmap request” procedure.
- Only very limited amount of bits are reserved for this purpose, and so possibility to do neighbour measurement in all cases is maintained, i.e. this is backwards compatible from the perspective of UTRAN measurement configurations.
- IMEISV from the UE is applied for indicating UE errors, corrections, specific treatment, etc. that are seen as feasible and agreed within RAN.

This proposal has several benefits. It is addressing the concerns about early connection set-up, and allows possible tools to indicate what the UE can support at this phase. Indication of errors in this phase does not require too many bits, since this is supposed to be reasonably well tested in the UE before entering into the market.

Secondly it is possible to identify in UE specific manner all problems that may appear when new features are introduced into the system. Hence working terminals are not penalized, and good implementations can have a gain in the market place, which should be to everyone’s benefit in this industry.

For this purpose a set of endorsed CR has been provided by RAN2 and RAN3.

R2-023239 Technically endorsed CR 1758 Rev2 to 25.331 [R'99] on Early UE Specific Behaviour Information in RRC Connection Request / inter RAT info.

The content of this CR is to have 4 bits in RRC Connection Request, and 8 bits reserved for InterRatHandoverInfo message. We believe this will be sufficient solution to indicate testing aspects and guarantee inter operability in early connection set up phases. This is also backwards compatible to rel-99 still keeping the neighbour measurement capability working.

R3-022497 Technically endorsed CR 520 Rev 1 to 25.413 R99 Transfer of Faults Bitmap over Iu for the handling of early mobiles.

This CR introduces signalling elements for bitmap transfer over the Iu to RNC.

4. Logical Error Correction

In addition to the mechanisms discussed above, which are kind of last resort of solution, there are also the proposed TR(s) and the extension container mechanism. These additional "tools" complete the methods we may use to solve problems that arise. It is then possible to think about prioritising so that the method for correction utilises the mechanism that has the least impact, for example:

1. Can we only describe the problem in TR? E.G. Can the error be handled purely internally in UTRAN, maybe the problem is just an unexpected response from the UE (one could regard this a kind of unsuitable parameter combinations, as an example) that must be documented so that UTRAN can handle it and proceed.

2. Can this be solved using a non-critical extension? E.G. In cases where a parameter that is signalled between UE and UTRAN must be modified or extended, it may be possible to utilise the extension container mechanism to correct signalling errors. This has been done for some time in RAN2 to make backward compatible corrections.

3. Does the problem occur in a procedure that can be handled with IMEISV?

These are arranged in the order they should be considered as possible solutions, but it may be that (1) and (2) can be considered roughly equal as one or other may be more suitable for a particular problem, and both have relatively small impact

Hence generic rules to be used with Early UE errors is that every early UE handling need to be agreed in 3GPP and reported to TR. Generic solutions (1) and (2) (i.e. all legacy terminals will behave correctly in the field after fix) shall always have highest priority and IMEISV based solution (3) shall be used only if generic solution is not viable. RRC Hooks are used for optimise the capability to send IMEISV correctly to CN.

We believe that in general there isn't any method, which could address UE specific problems related to common channels, and how to deal different UE behaviour in those cases. This covers cases where common parameters are shared among all users in the system, and network can't change its behaviour without affecting to other users. For this reason IOT and protocol testing are very essential to ensure that this phase is working reliable. If a problem occurs in this area, the only solution is not use problematic settings or features.

5. Conclusion

It is proposed that the hybrid solution detailed in section 3, along with the TR(s) and extension mechanism should be adopted. This is the only solution, which it can be argued solves the problems which each of the different solutions faces when considered alone. This solution in combination with the proposed TRs and extension container mechanism can provide a structured procedure for solving all foreseen categories of problem.