Straightforward solution: neighborhood analysis in 2G and 3G networks

Advanced, complex 3rd generation mobile radio networks require measurement methods that easily and conveniently provide information about potential trouble spots and offer remedies. The R&S®TSMx radio network analyzers fully meet these requirements. Together with the R&S®ROMES coverage measurement software, they offer a sophisticated algorithm to analyze neighborhood relationships and have been tried and tested for half a year in the existing network.

Crucial: neighbor cell properties

Every cellular network must be able to perform a handover from one cell to another if a call has been set up, for example, between a mobile phone and the network. In a GSM network, a handover involves only two cells (source cell and target cell). In UMTS networks, however, a group of cells that is managed in the active set may be involved. This article takes a closer look at UMTS networks.

To be able to hand a call over to another cell, you have to know which UMTS cells are available in the neighborhood of a base station. These "neighbor lists" are stored in all the base stations and are usually generated by the network operators using planning tools; results are based on simulations. The lists are then compared with the real conditions in the network and are optimized accordingly.

Avoiding dropped calls

If relevant base stations are missing in the neighbor list, the call may be dropped if a mobile phone has a certain moving profile (FIG 1). Entering every neighboring cell into the list would therefore seem to be the most obvious solution. Yet this cannot be done, since the length of the list is limited and mobile phones should not be used to perform unnecessary measurement tasks. Practical neighbor lists thus contain only those base stations whose receive field strength is large enough to justify inclusion in the active set.

At the peripheries of a UMTS network, the base stations of a GSM network are also entered into the lists and subjected to a neighborhood analysis.

Detecting interference

Detecting potential network interference is just as important as finding missing neighborhood relationships. Active sets have a limited space, and only base stations stored there may contribute to setting up a call. Since all base stations emit at the same frequency, unstored base stations must be regarded as potential interferers – this is referred to as pilot pollution.

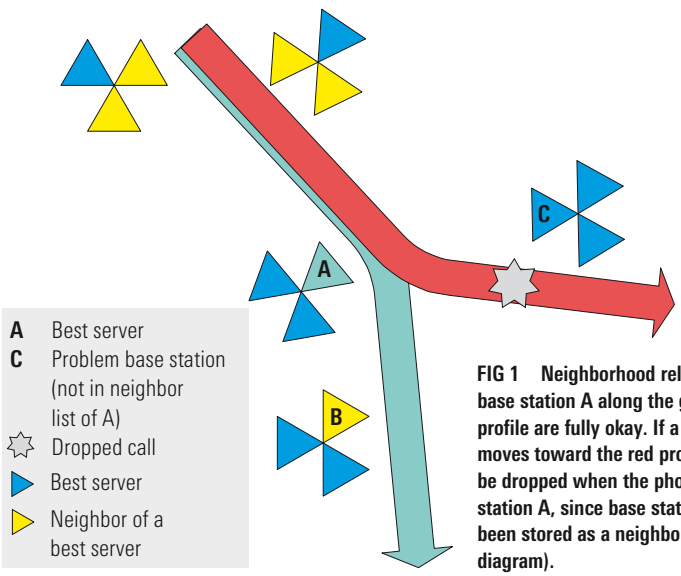

FIG 1 Neighborhood relationships of base station A along the green moving profile are fully okay. If a mobile phone moves toward the red profile, the call will be dropped when the phone leaves base station A, since base station C has not been stored as a neighbor of A (simplified diagram).

The R&S®TSMx as neighborhood analyzers

The R&S®TSMx radio network analyzers from Rohde&Schwarz can automate and simplify these relatively lengthy measurements to a very high degree. Owing to their high dynamic range and measurement speed, the optional R&S®TSMU-K13 GSM network scanner and R&S®TSMU-K11 WCDMA network scanner provide a sound basis for accurate neighborhood relationship analyses.

The algorithm

Neighborhood analysis is based on the assumption that the conditions in a network are fine when every base station meets the requirements for neighborhood relationships. To start the analysis, you first have to find out whether an entry is available in the top N pool, which includes the N qualitatively best base stations found by the UMTS PN scanner in a defined time window. To limit the analysis to relevant base stations, only base stations received with a minimum strength and quality will be considered (received signal code power, or RSCP, and E_c/I_0). The ideal base station for meeting these requirements (top 1 in top N pool) is called "best server"; it will be the reference for further analysis.

The algorithm described as follows is used for every base station (top M (M = 2 to N)). It first checks whether a base station, with reference to the best server, was received strongly enough to make an analysis worthwhile. If this is the case, the base station list is used to check whether this base station is planned to be a neighbor of the best server. If it is, you have to find out whether sufficient space is left in the active set. If so, network planning is fine, since the network could ask the mobile phone to save this base station in its active set. If the active set is already occupied, this base station cannot contribute anything to the call and will be handled as a potential interferer (PI type 2).

If the base station is not listed as a neighbor of the best server, the algorithm checks whether its field strength is sufficient for being stored in the active set ("Add Window" in FIG 2). If the field strength is not sufficient, the base station is regarded as a potential interferer (PI type 1). If the interference caused by the base station is strong enough – i.e. if it falls into the "Interferer Window" – and further examination is thus called for, an alarm will be triggered.

If the receive strength and receive quality of the base station fall into the "Add Window", the base station may always contribute to the call even if it is not entered as a neighbor. A precondition for this, however, would be a free space in the active set. If space is left, a "missing neighbor" alarm is triggered. If the active set is occupied, it has to be checked whether the base station is to be regarded as a potential interferer.

Neighborhood to GSM networks

At the peripheries of a UMTS network, the R&S®TSMx radio network analyzers additionally check the neighborhood to GSM networks. This check is performed in a similar way as that of the algorithm described above. Instead of the top N pool elements, the GSM base stations measured by the GSM network scanner are checked for a correct implementation as neighbors to the 3G network.

Result: base station couples

The result of the analysis are base station couples – one being the best server, the other being the problematic cell. For each couple, R&S®ROMES lists the corresponding spots indicating type, length, and duration of the problem (FIG 3). The software can also display the critical spots in a map.

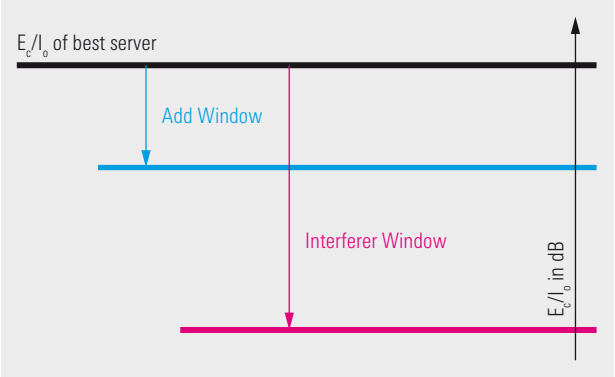

FIG 2
Depending on receive strength and quality, a base station falls into "Add Window" or "Interferer Window".

SIB11 analyzer

Apart from detecting interference sources and missing neighbors, the method provides further information about problems in network planning and configuration. The R&S®TSMx radio network analyzer decodes the network parameters included in the received system information block (SIB). These parameters also contain the neighborhood relationships of a base station. It automatically compares the neighbor lists received via the air interface with those stored in the test system. If they do not match, the user will receive detailed information about the specific differences in the two lists (FIG 4).

Summary

The R&S®TSMx radio network analyzers together with the versatile R&S®ROMES coverage measurement software offer an automated measurement method that allows network operators to quickly and easily gain important information about neighborhood relationships of their network and potential interferers. This information is essential for network planning and thus largely contributes to quality assurance. You can perform neighborhood analysis in parallel with the measurements used so far – with no extra effort and thus no additional costs.

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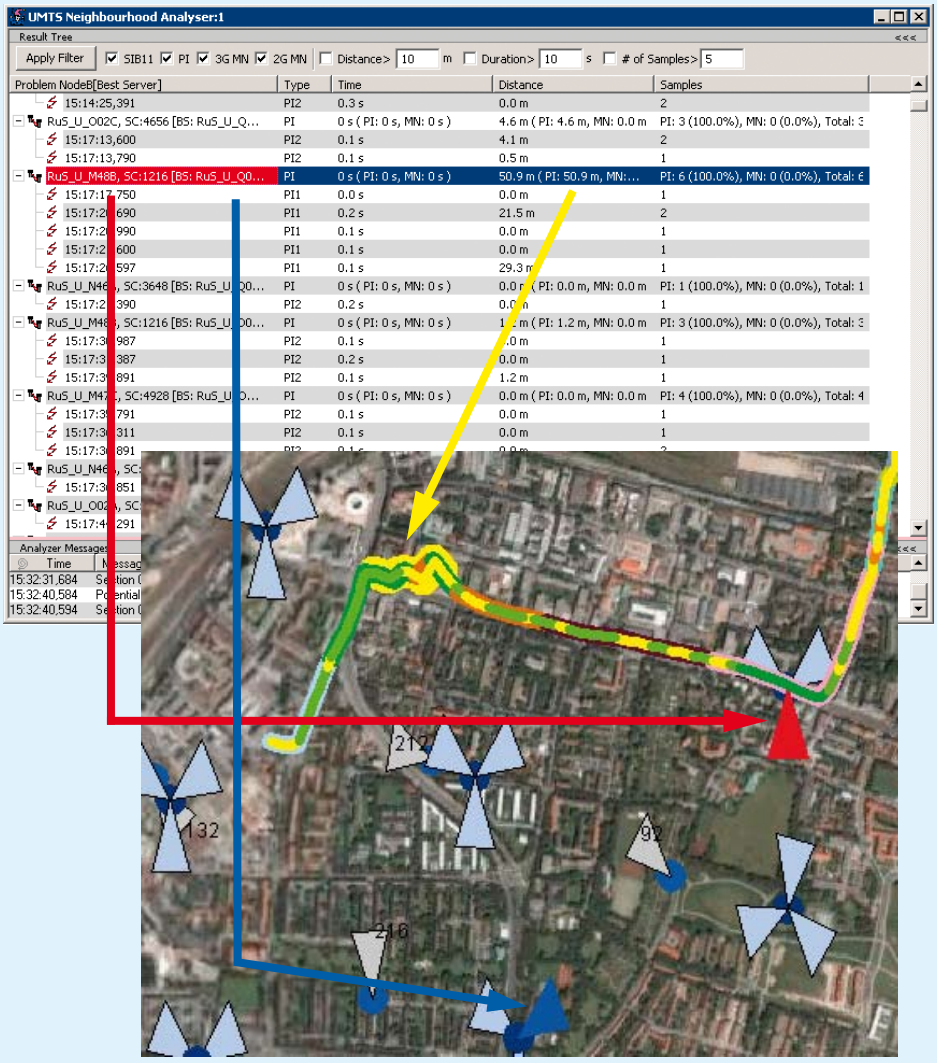
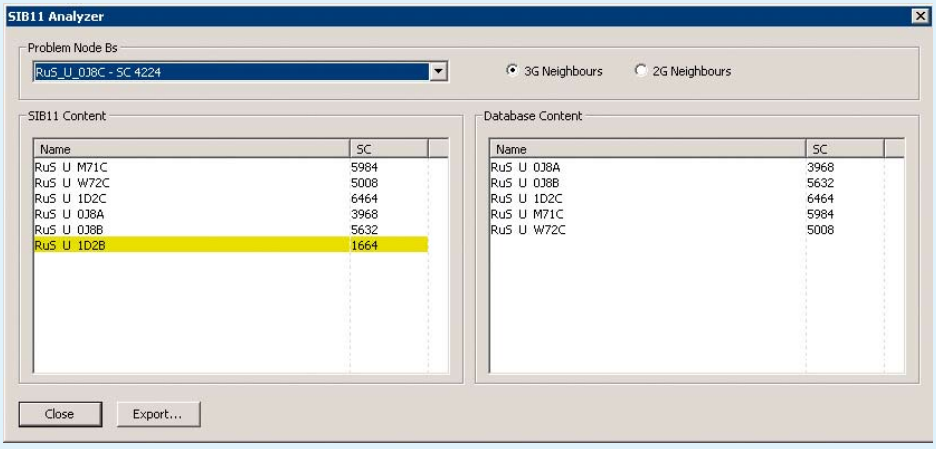


FIG 3 List of potential trouble spots. If required, the corresponding node is marked on the map.

FIG 4 The SIB11 analyzer displays the differences between the neighbor list in the base station and the received neighbor list.



More information at www.rohde-schwarz.com (search term: TSMU)

REFERENCES

Radio Network Analyzer R&S®TSMU – Automatic detection of interferences in GSM networks. News from Rohde & Schwarz (2006) No. 190, pp 4–9