Mobile interference measurement in GSM networks

One of the accompaniments of constantly expanding GSM mobile networks is the occurrence of local interference pockets where signal carriers of different mobile cells superimpose on each other. Traffic capacity is then reduced and in the worst case, when no alternative channel is available, a call is disconnected. Specialists localize these pockets, identify the interference and its source and eliminate the cause through antenna adjustment, power adaptation or skilful reassignment of frequency resources.

Rohde & Schwarz has developed a mobile test system for detecting such signals (FIG 1) and tracing them back to the interfering transmitter stations. The system consists of a mobile phone, a test receiver, a navigation system and two computer units. Hardware and software components are integrated in the GSM coverage measurement system [1] and may be used simultaneously for different purposes. Interference measurement involves three steps (FIG 2): detection of the interference situation, analysis of the interference signal and assignment of detected signals to their base stations.

In the first step, detection of the interference situation, calls are set up to the network from one or several mobiles and transmit power and quality (RxLev and RxQual) are measured. If RxQual values increase for a specified period at sufficiently high transmit power, this is a sure sign that interfering signals are present and interference analysis is started. By this time the system has already detected the frequency and time characteristics of the disturbed connection and analyzed various parameters of the useful signal so that the latter can be distinguished from interfering signals in the signal mix.

In interference analysis two different types of GSM signals are searched for in co-channels and adjacent channels of the channel used: C0 interference and Cx interference. C0 is a special base-station channel used by mobiles for power measurement and synchronization. Here a constant level is continuously transmitted, causing interference irrespective of the utilization of the respective cell. A sequence of timeslots with fixed signal content is sent on the C0 for synchronization of mobiles. With the aid of this the interference measurement system can identify the channel type even if its power is considerably below that of the disturbed useful signal. To be able to find the base station of measured C0 interference, the time of arrival of the sync sequence in the MS1 frame structure (TS1) is stored. In the case of adjacent-channel interference, the BCC (base-station colour code) of the interfering signal is also measured.

In contrast to the C0 channel, a timeslot of the Cx channel is only used when information is to be transmitted. Furthermore, the transmitted power can be matched to the reception scenario of the mobile subscriber. For these two reasons, such interference is traffic-dependent. The arrival time of the interfering burst (signal in timeslot) and the TSC (training sequence code) are used as assignment criteria.

To allow assignment of detected interference signals to their base stations with the aid of the selected attributes, the data inventory of the measurement system includes information from the network operator such as site, transmit power and channels of base stations as well as measured results for transmission intervals of sync sequences and timeslots between individual base stations. These values are obtained by the system in a time-offset measurement. The time offset of interfering base stations should be measured directly before or after the interference, as the fixed transmit time pattern of the differ-
ent signals may vary as a result of the different drifts of timebases and base-station resets. For measuring the frame time offset, the C0 carrier of the particular base station must be received undisturbed. Normally and particularly when two C0 carriers superimpose, this measurement cannot be performed in the interference pocket. It is carried out automatically when there is no interference situation and the system has free hardware resources, eg when performing quality measurements on its way into the interference pocket. If the collected data are not sufficient for a new interference measurement to assign signals to their base stations with high probability, the assignment result is improved each time the automatic time-difference measurement produces new data on possible interferers. In this case the interference signal is subsequently assigned with the aid of a displayed map showing possible interferers with time-offset information.

In contrast to those used for stationary interference measurement [2], the new algorithms for mobile interference measurement are highly resistant to fading effects and feature faster processing. The reduced dynamic range that this requires is made possible by the fact that all interfering signals are actually present during the measurement and only concealed by the useful signal, ie C/I values of not much more than 6 dB can be expected. In addition to various methods of signal filtering and probability calculation, a nonlinear classifier was developed for interference identification that responds very well to non-stationary signal variations caused by fading and unfavourable signal configurations.

Operation of the equipment is from a Windows 95 user interface. In addition to starting and stopping a measurement, the operator can activate cartographic output of the data inventory at any time (FIG 3), eg to find out when the time offset for certain stations was last measured or what interferers come into question for a particular base station.

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REFERENCES