3GPP TSG GERAN #28

GP-060309

Brussels, Belgium, USA
January 16-20, 2006

Source: **Motorola**
Title: **On the Definition of Performance Specifications for Mobile Station Receive Diversity**
Document for: **Discussion**

1. Introduction

This contribution considers issues related to the definition of test scenarios for the mobile station receive diversity (MSRD) work item [1], [2], [3], [4], [5]. To a large extent, it should be possible to exploit the test scenarios previously defined in Annex L of TS 45.005 [6] for DARP. In Table 2.o of [6], the DARP test scenarios defined in Annex L were used to specify the performance only of those logical channels that use GMSK modulation. However, it should be noted that there is no limitation on the test scenarios defined in Annex L such that they cannot be directly applied to logical channels using 8PSK modulation.

The observation is also made that for a mobile station with receive diversity, there are no default specifications for sensitivity, co-channel interference, or adjacent channel interference in TS 45.005 that can be directly applied in the absence of their specification as part of this work item. Thus, the situation here is significantly different than for the specification of DARP performance, since the DARP receiver was required to meet all of the existing specifications in TS 45.005 as well as the new DARP specifications in Table 2.o. Thus, a proposal is made for the interpretation of the performance specifications in TS 45.005 for mobile stations with receive diversity such that MSRD performance will be fully specified.

2. DARP Test Scenarios

Annex L of [6] defines 5 DARP test scenarios for channels using GMSK modulation. Of these, DTS 1-3 apply to synchronous GSM systems, while DTS 4-5 apply to asynchronous systems. DTS 1 and 4 each define a test with a single co-channel interferer but no AWGN component. DTS 2, 3 and 5 all define test environments having two co-channel interferers, a single adjacent channel interferer, and AWGN. Annex L specifies that in interfering signals in each of the test scenarios are to be GMSK modulated, but does not specify the modulation type of the desired signal.

The DARP test scenarios in Annex L do not specify either the propagation channel or the speed of the mobile. The performance specifications in Table 2.o of [6] only address logical channels using GMSK modulation, and values are specified only for the TU50 channel with no frequency hopping.

3. Extension of the DARP Test Scenarios to Mobile Station Receive Diversity

3.1. Receive Diversity Channel Model

As is well understood, the specification of performance for mobile stations with receive diversity requires that the propagation channel model be extended from a single antenna at both the transmitter and the receiver to a single antenna at the transmitter and two antennas at the receiver. As a result of the GERAN Evolution Feasibility Study [7], there seems to be broad agreement that the channel can be adequately modelled such that

i) the desired and interfering signals fade independently;
ii) for any given signal source, the fading processes of the primary and secondary antennas may be correlated
iii) the primary and secondary antennas may have a gain imbalance.

Unless the correlation coefficient approaches unity or the gain imbalance is quite large, only the noise sensitivity of the receiver exhibits a significant dependency on the precise values these two parameters. In general, the performance of mobile station receive diversity in interference-limited environments is insensitive to the values of these parameters.

3.2. Test Scenarios for GMSK and 8PSK Logical Channels

Given that for each test scenario

i) it will likely be necessary to specify performance for multiple (at least two) pairs of values for the antenna correlation and the antenna gain imbalance;

ii) both GMSK and 8PSK logical channels must be tested;

it is important that the number of tests be limited to the greatest extent possible.

A first, and obvious, option might be to use the DARP Test Scenarios DTS 1-5, as defined in Annex L of [6], for both the GMSK- and 8PSK-modulated logical channels. As noted previously, the DARP Test Scenarios in Annex L of [6] specify that all of the co-channel and adjacent channel interferers are to be GMSK modulated, and such test waveforms would be readily generated by DARP-capable test equipment. The predominance of GMSK-modulated logical channels (see [8]) in GSM systems also suggests the continued use of GMSK as a practical test waveform. To elaborate further on this point

i) in the two simulations of Network Configuration 3 (from the DARP Feasibility Study [7]) in [8], 93.2% and 85.8% respectively of the serving cell logical channels used GMSK modulation;

ii) in the two simulations referred to in (i), the dominant interference source for the GMSK-modulated channels was also GMSK modulated with probability 0.92 and 0.85, respectively

iii) in the two simulations referred to in (i), the dominant interference source for the 8PSK-modulated channels was GMSK modulated with probability 0.85 and 0.75, respectively

It is also useful, however, to consider the use of 8PSK interferers since EGPRS networks fully populated with diversity-capable mobile stations might expect to see an increase in 8PSK downlink MCS selection. In this case, a second option would be to select a subset of the DARP tests DTS 1-5. For each test in the subset, a second test could be defined in which each GMSK co-channel and adjacent channel interferer specified in Annex L is replaced with an 8PSK-modulated interferer of the same power. An example of such a set of test scenarios is given in Table 1 below.

Mobile Station Receive Diversity Test Scenarios

Reference Test Scenario	Interfering Signal	Interferer relative power level	TSC	Interferer Delay range	Interference Modulation
DTS-1a	Co-channel 1	0 dB	none	no delay	GMSK
DTS-1b	Co-channel 1	0 dB	none	no delay	8PSK
DTS-2a	Co-channel 1 Co-channel 2 Adjacent 1 AWGN	0 dB -10 dB 3 dB -17 dB	none none none -	no delay no delay no delay -	all GMSK
DTS-2b	Co-channel 1 Co-channel 2 Adjacent 1 AWGN	0 dB -10 dB 3 dB -17 dB	none none none -	no delay no delay no delay -	all 8PSK
DTS-5	Co-channel 1 Co-channel 2 Adjacent 1 AWGN	0 dB *) -10 dB 3 dB -17 dB	none none none -	74 symbols no delay no delay -	all GMSK

Table 1: A subset of the DARP test scenarios. Tests 1a, 2a, and 5 use GMSK-modulated interferers, while Tests 1b and 2b use 8PSK-modulated interferers.

If neither of the two options given above is deemed satisfactory in that neither reflects the full complexity of the interference environment with sufficient accuracy, a third alternative would be to consider the definition of test scenarios with a mixture of the two interference types. While this is perhaps the least ad-hoc approach to the definition of interference tests, a mixture of interference modulation types would require further system simulations similar to those in [8], and therefore, would have an associated risk of delaying the standardisation process. On the other hand, the inclusion of only a single mixed modulation test scenario would help ensure testing complexity does not become overly burdensome.

4. Propagation Channel Models for MSRD Performance Specification

All of the DARP performance specifications given in Table 2.o of [6] apply only to the TU50 channel with no frequency hopping. Any risk that the performance of the DARP receiver may not be adequate for other propagation channels, such as the Hilly Terrain (HT) or the Rural Area (RA) channels, in the absence of a performance specification for these channels, is mitigated by the fact that the DARP receiver must meet all of the existing performance specifications in TS 45.005.

Conversely, none of the specifications on receiver performance in TS 45.005 can be directly applied to a mobile station with receive diversity. As a result, there will be no co-channel or adjacent channel performance specifications for a mobile station with receive diversity that are not defined as part of this Work Item. Thus, in defining performance requirements for mobile station receive diversity, it may not be sufficient to follow the example of the DARP specification in which performance is only specified for the TU50 channel without frequency hopping.

Unless a method is identified for re-interpreting the performance specifications in TS 45.005 such that they apply to mobile stations with receive diversity, we must either define an equivalent specification for a mobile station with receive diversity for every specification that currently exists for the non-diversity mobile, or accept that TS 45.005 will have gaping holes with respect to the specification of performance for a mobile station with receive diversity. One possible interpretation of the existing TS 45.005 specification would be to require that a mobile station with receive diversity meet all of the TS 45.005 performance specifications when the test signal defined for the non-diversity mobile is provided to both antenna ports of the mobile station with receive diversity. Note that we intend that the test signal provided to the two antenna ports is identical – it is

not simply equivalent in a statistical sense. While the resulting performance specification might be very loose, the result would be a performance specification which is complete independent of which test scenarios we choose for the MSRD Work Item.

5. Ancillary Functions

An issue that has not been addressed in any of the discussion to date is the interaction of mobile station receive diversity and ancillary functions such as link quality reporting and AMR rate adaptation. Clearly, unless careful consideration is made for proper testing of ancillary functions, the benefits in system performance associated with the improvements in link performance may be significantly compromised. This issue should be addressed as part of the MSRD Work Item.

6. References

[1] TDoc GP-052871, New WID on Mobile Station Receive Diversity (DARP Phase II)

[2] TDoc GP-052872, New WID on MS conformance test of DARP Phase II (MSRD)

[3] TDoc GP-052873, New WID on Performance Requirements for Mobile Station Receive Diversity, DARP Phase II

[4] TDoc GP-052874, New WID on Capability signalling of Mobile Station Receive Diversity, DARP Phase II

[5] TDoc GP-052875, New WID on Test Scenarios for Mobile Station Receive Diversity, DARP Phase II

[6] 3GPP TS 45.005, 3rd Generation Partnership Project; Technical Specification Group GSM/EDGE Radio Access Network; Radio transmission and reception (Release 7).

[7] GP-060133 3GPP TR 45.912 v0.4.0 Feasibility study for evolved GSM/EDGE Radio Access Network (GERAN) (Release 7)

[8] Nokia, GP-041056, SAIC/ARP Feasibility: Modulation distributions with mixed GSM/EDGE traffic, 3GPP TSG GERAN #19, Cancun, Mexico, 19-23 April 2004.

[9] 3GPP TS 51.010-1, 3rd Generation Partnership Project; Technical Specification Group GSM/EDGE Radio Access Network; Digital cellular telecommunications system (Phase 2+); Mobile Station (MS conformance specification; Part1: Conformance specification (Release 6).