3GPP TSG GERAN #36 **Tdoc GP-071849**
Vancouver, CA, 12-16 November, 2007 **Agenda 6.1, 7.1.5.4**

Source: **Motorola, Alcatel-Lucent, RIM, Samsung, Panasonic, Freescale, ZTE**
Title: **Analysis of the Impact of Spectral Mask Relaxation on the Downlink**
Document for: **Discussion**

1. Introduction

The objective of this paper is to consider whether the link improvements associated with the relaxation of the transmit spectral mask will yield a net gain in system performance when weighed against the increase in adjacent channel interference in the system. In order to evaluate this, the impact of relaxation of the spectral mask on the total interference seen at both legacy mobile station receivers well as new high symbol rate receivers must be considered along with the penetration of high symbol rate mobiles .

For RED HOT B, it has been proposed that the transmit spectral mask specification be relaxed such that new pulse shapes may be defined. From a link perspective, the benefits of the new transmit pulses allowed with relaxation of the spectral mask are well understood:

- The time span of the transmit pulse can be reduced, and this will reduce the amount of intersymbol interference associated with the transmitted signal. Such a modification will be beneficial for the 1.2X symbol rate, as given a fixed time span for the transmit filter impulse response, 1.2X more modulation symbols contribute to intersymbol interference for the 1.2X symbol rate than for the legacy symbol rate.
- The peak-to-average ratio (PAR) of the transmit pulse can be reduced, and as a result, link coverage is increased. It should be noted, however, that a reduction in PAR may be of little benefit in interference limited environments.

The impact of a relaxation of the spectral mask of an adjacent channel HSR interferer when seen by a legacy mobile receiver has been considered in [3] and [4]. Simulation results in [3] indicate that relaxation of the ACP can result in an 8dB degradation of link performance of the legacy receiver. It has been argued that the reduction in co-channel interference associated with the use of a wider bandwidth pulse would mitigate this degradation. One system simulation has been provided in [5] in support of the contention that relaxation of the spectral mask and ACP would have only a small impact on legacy services in “real networks,” but a single simulation of a single deployment scenario, without clearly defined simulation assumptions, cannot by itself be considered in any way conclusive.

2. Relevant Scenarios for System Evaluation

The impact of the wideband pulse HSR (**WHSR**) signal on legacy services is only one scenario that must be considered in weighing the overall system impact associated with the introduction of a wideband pulse. Three scenarios which must be considered are:

i) the impact of the wideband pulse HSR transmission as interference to legacy receivers;

ii) the impact of the legacy service transmission as interference to the wideband pulse HSR receiver;

iii) the impact of the wideband pulse HSR transmission as interference to the wideband pulse HSR receiver.

As noted above, the first of these scenarios has been studied in [3] and [4]. This case is extremely important as it relates to the protection of legacy services when WHSR is used, which is a requirement in the work item description. However, to date there have been no link level studies which have studied the impact of increased adjacent channel interference on the WHSR receiver. As the bandwidth of the channel selectivity filter for the WHSR must be wider than that used for the legacy receiver, adjacent channel protection of this receiver is decreased. As a result, the impact of adjacent channel interference from a WHSR transmission on the WHSR receiver will significantly exceed the impact of the adjacent channel WHSR transmission on the legacy receiver. Hence it is the latter two cases involving the WHSR receiver that will see the largest impact from the proposed reduction of adjacent channel protection. The second case considers the impact of the reduction in ACP that the WHSR receiver will suffer when interfered with by a legacy service in the adjacent channel. The third case considers the impact of the reduction in ACP that the WHSR receiver will suffer when interfered with by a WHSR signal in the adjacent channel. It should also be noted that the wider channel selectivity filter used for the WHSR receiver will increase the amount of co-channel interference into the WHSR receiver from LGMSK transmissions.

It is clear that the improvement in WHSR link performance associated with the wideband pulse must be weighed against the increase in both adjacent and co-channel interference at the output of the channel selectivity filter for the WHSR receiver.

3. The Impact of Wideband HSR on Adjacent and Co-Channel Interference Rejection

In previous discussions, there has been no analysis of the impact of increased adjacent channel interference on link performance. Rather, it has been argued that most networks are currently dominated by co-channel interference and as such, the increased adjacent channel interference will have little impact on the link level performance. While, it may be true that co-channel interference is dominant in the current system where adjacent channel protection (ACP) is equal to 18.3 dB, it is not at all clear that the same will be true when the ACP is relaxed to 12 dB as was proposed in [6]. Furthermore, the ACP for a WHSR receiver will be significantly less than 12 dB if the source of the adjacent channel interference is a WHSR transmission.

Performance is determined by the total interference at the receiver. While some sources may dominate the interference environment, it is the total interference that determines performance, and it is the increase in total interference that must be weighed against any improvement in link performance.

The impact of the reduction of ACP on the performance of services at both the legacy symbol rate and high symbol rate can be very difficult to evaluate, as these depend on a variety of factors including:

- the implementation of the legacy receiver;
- the implementation of the WHSR receiver;
- the penetration of the WHSR feature in the system.

Very extensive system simulations are required to understand the full impact of WHSR on system performance. Lacking this information, it has been argued that it is possible to simply extrapolate from the improvements in link performance and infer that the WHSR service will yield a similar overall system benefit. However, given that such a large relaxation in ACP changes the total interference profile significantly, this approach is clearly not reasonable.

4. First Order Analysis Methodology

A simple first order analysis can be used to estimate the impact of a reduction in adjacent channel protection on C/I_{total} at the receiver. In this first order analysis, the following assumptions are made:

- the channel selectivity filter for the legacy receiver is a matched to the LGMSK transmit filter;

- the channel selectivity filter for the WHSR receiver is matched to the WHSR transmit filter;
- to the first order, the receiver performance is a function of C/I_{total}, where I_{total} reflects all sources of interference, including AWGN, adjacent channel interference, and co-channel interference.

For the purpose of this analysis, we consider the "optimized" pulse proposed in Annex A of [7]. As reported in [7] the impact of this pulse on the legacy receiver is captured in Table 1. What was not considered in [7] was the impact of adjacent channel interference on the WHSR receiver from both LGMSK and WHSR transmissions, nor was the increase in co-channel interference from LGMSK transmissions considered. The co-channel and adjacent channel rejection for the WHSR receiver have been provided in Table 2. From Table 2, it can be seen that the WHSR receiver sees an increase in co-channel interference from LGMSK transmissions of 0.6 dB, and has only 11.4 and 8.8 dB of adjacent channel protection from the LGMSK and optimized pulse transmissions, respectively.

Table 1: Co-channel and Adjacent Channel Rejection for Legacy Receiver Using a Using a Linearized GMSK Filter as the Receiver Selectivity Filter (from [7])

dB	CCR	ACR
LGMSK	0.0	-18.3
Optimized	-0.9	-12.9

Table 2: Co-channel and Adjacent Channel Rejection for WHSR Receiver Using the Optimized Pulse Proposed in [7] as the Receiver Selectivity Filter

dB	CCR	ACR
LGMSK	0.6	-11.4
Optimized	0.0	-8.8

Throughout the rest of this contribution, it will be assumed that the optimized pulse from [7] is used for WHSR transmissions, as well as for the channel selectivity filter for the WHSR receiver.

From Tables 1 and 2, the following observations can be made:

- 0.9 dB = the reduction in co-channel interference for the legacy receiver with WHSR co-channel interference (from [7] and Table 1);
- 5.4 dB = the increase in adjacent channel interference for the legacy receiver with WHSR adjacent channel interference, (from [7] and Table 1);
- 0.6 dB = the increase in co-channel interference for the WHSR receiver with LGMSK co-channel interference (relative to 0 dB for WHSR co-channel interference, from Table 2);
- 6.9 dB = the increase in adjacent channel interference for the WHSR receiver from LGMSK adjacent channel interference (relative to 18.3 dB for legacy receiver with LGMSK adjacent channel interference, from Tables 1 and 2);
- 9.5 dB = the increase in adjacent channel interference for the WHSR receiver from WHSR adjacent channel interference (relative to 18.3 dB for legacy receiver with LGMSK adjacent channel interference, from Tables 1 and 2).

From the above, it can be observed that the WHSR receiver will see an increase in co-channel interference of 0.6 dB from LGMSK transmissions in addition to the increase in adjacent channel interference of 6.9 dB and 9.5 dB, respectively, from LGMSK and WHSR transmissions. It can also be observed that the adjacent channel rejection of LGMSK by the WHSR receiver is 1.5 dB less than the adjacent channel rejection of WHSR by the legacy receiver.

4.1. The Impact of Wideband HSR Transmission on the Legacy Receiver

To simplify the presentation, a purely interference limited environment will be assumed for the purposes of this study. Though AWGN is not considered here, it can be readily added to the analysis. As long as the system is strongly interference limited, the results will not be significantly affected. For a particular legacy mobile, the following parameters can be defined:

- C : the power of the desired signal at the input to the receiver;
- α : the fraction of the power of the desired signal that passes to the output of the channel selectivity filter matched to the LGMSK transmit filter;
- I_a : the adjacent channel interference at the input to the channel selectivity filter;
- I_c : the co-channel interference at the input to the channel selectivity filter.

We also let ε denote the penetration of the WHSR transmissions in the system, where $0 \leq \varepsilon \leq 1$.

From the above, the power of the desired signal at the output of the channel selectivity filter is α C. If the adjacent and co-channel interferers are LGMSK, then the power of the desired signal, the co-channel adjacent channel interference at the output of the receive filter are given by

$$I_c \to \alpha\, 10^{0/10} I_c = \alpha\, I_c\,,$$

and

$$I_a \to \alpha\, 10^{-18.3/10} I_a\,.$$

Thus, at the output of the channel selectivity filter, the signal-to-interference ratio is given by

$$C/I_{\text{total}} = \frac{\alpha\, C}{\alpha\, I_c + \alpha\, 10^{-18.3/10} I_a} = \frac{C}{I_c + 10^{-18.3/10} I_a}\,.$$

With introduction of WHSR transmissions, the co-channel and adjacent channel interferers can be either LGMSK (with probability 1-ε) or WHSR (with probability ε). With frequency hopping, the co-channel and adjacent channel interference at the output of the channel selectivity filter are now random variables, with distributions given by

$$I_c \to I_c \cdot \alpha \cdot \begin{cases} 1 & \text{with probability} \quad 1\text{-}\varepsilon \\ 10^{-0.9/10} & \text{with probability} \quad \varepsilon \end{cases},$$

and

$$I_a \to I_a \cdot \alpha \cdot \begin{cases} 10^{-18.3/10} & \text{with probability} \quad 1\text{-}\varepsilon \\ 10^{-12.9/10} & \text{with probability} \quad \varepsilon \end{cases},$$

where we have used the co-channel and adjacent channel protection values from Table 1. With random interference, two signal quality measures can be considered, and these are the signal-to-average total interference ratio, denoted as $C/\langle I_{\text{total}}\rangle$, and the average signal-to-total interference ratio, which is denoted as $\langle C/I_{\text{total}}\rangle$. The average signal-to-total interference ratio $\langle C/I_{\text{total}}\rangle$ is an appropriate metric only if the scheduler has the ability to adjust the modulation and coding on a burst-wise basis for the instantaneous interference level I_{total}. As EGPRS does not operate in this fashion, it seems that the appropriate measure to be used in assessing the impact of the WHSR transmission on the legacy receiver is the signal-to-average total interference ratio $C/\langle I_{\text{total}}\rangle$.

Given that the probability of a WHSR transmission is ε, the average interference at the output of the channel selectivity filter is given by

$$I_c \cdot \alpha \cdot \left(1-\varepsilon+\varepsilon \cdot 10^{-0.9/10}\right)+I_a \cdot \alpha \cdot \left(\left(1-\varepsilon\right)10^{-18.3/10}+\varepsilon \cdot 10^{-12.9/10}\right),$$

so that the signal-to-average interference ratio is given by

$$C/\langle I_{\text{total}}\rangle_e = \frac{C}{I_c \cdot \left(1-\varepsilon\left(1-10^{-0.9/10}\right)\right)+I_a \cdot \left(\left(1-\varepsilon\right)10^{-18.3/10}+\varepsilon \cdot 10^{-12.9/10}\right)},$$

where we have used $C/\langle I_{\text{total}}\rangle_e$ to denote the signal-to-average interference ratio associated with a probability ε of a WHSR transmission.

The ratio of the two expressions yields the degradation of the signal-to-interference ratio at the output of the channel selectivity filter for the legacy receiver, and this is given by

$$\frac{1+10^{-18.3/10}\left(I_a/I_c\right)}{\left(1-\varepsilon\left(1-10^{-0.9/10}\right)\right)+\left(\left(1-\varepsilon\right)10^{-18.3/10}+\varepsilon \cdot 10^{-12.9/10}\right)\left(I_a/I_c\right)},$$

which is a function of both the interference ratio I_a/I_c at the input to the channel selectivity filter and the penetration ε of WHSR in the system. We now let $\left(I_a/I_c\right)_{O,L}$ denote the ratio of adjacent to co-channel interference at the output of the legacy receiver in the absence of any WHSR transmission, which is given by

$$\left(I_a/I_c\right)_{O,L} = 10\,\mathrm{Log}_{10}\left(I_a/I_c\right)+18.3.$$

In Figure 1, the degradation of the signal-to-interference ratio for the legacy receiver is indicated as a function of $\left(I_a/I_c\right)_{O,L}$ for various penetration levels ε of the WHSR feature.

With 100% penetration of WHSR, the degradation of the signal-to-interference ratio for the legacy mobile at the output of the channel selectivity filter increases to 5.4 dB as the ratio I_a/I_c increases. Conversely, for this same 100% penetration of WHSR, the signal-to-interference ratio for the legacy mobile can be improved by as much as 0.9 dB in the limit of extreme co-channel interference dominance. It should be noted that regardless of feature penetration, it seems that the signal-to-interference ratio for the legacy user will be degraded if $\left(I_a/I_c\right)_{O,L}$ is greater than -11 dB (see the zero crossing in Figure 1). Thus, unless the interference at the output of the channel selectivity filter of the legacy mobile (without any WHSR transmission) is dominated by co-channel interference by at least 11 dB, it will see some performance degradation with WHSR. Furthermore, the potential 5.4 dB degradation of $C/\langle I_{\text{total}}\rangle$ for the legacy receiver far exceeds the maximum 0.9 dB improvement in $C/\langle I_{\text{total}}\rangle$ that can be achieved only in the limit of extreme co-channel interference dominance. Finally, it should be noted that the 0.2 dB degradation observed with 100% WHSR penetration and $\left(I_a/I_c\right)_{O,L}$ = -10 dB is consistent with the link simulation results for DTS-2 in Table 2 of [4].

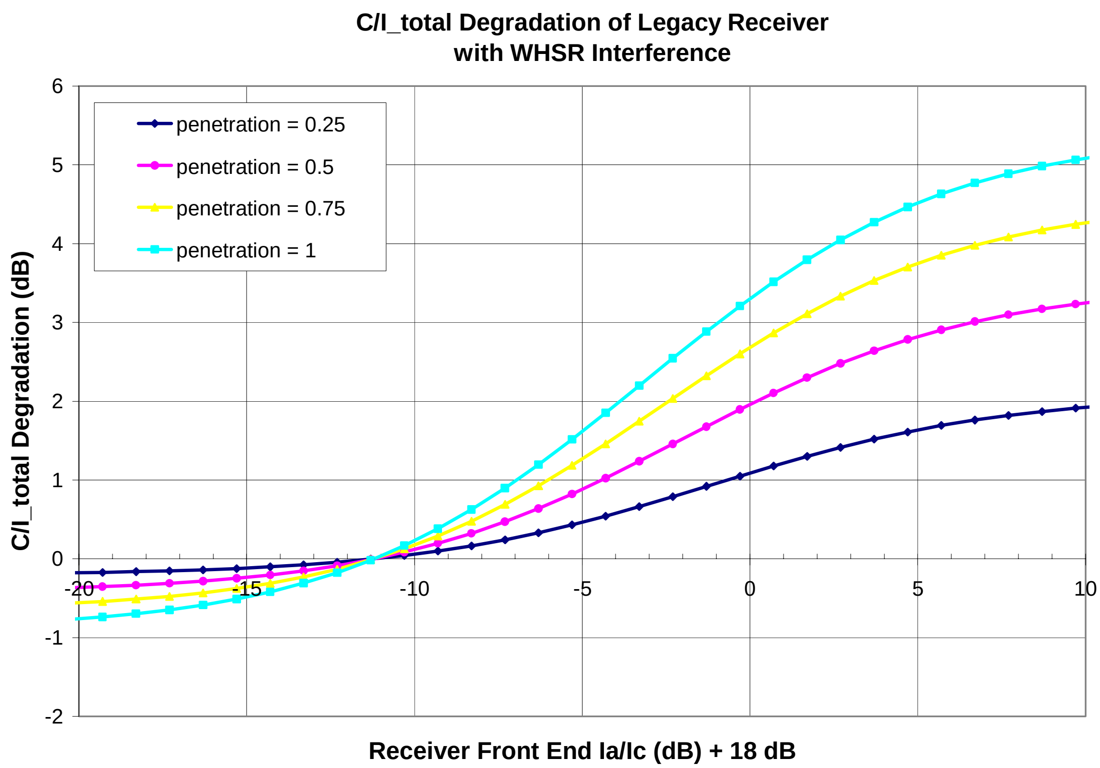

Figure 1: Degradation of $C/\langle I_{\text{total}}\rangle$ of legacy mobile as a function of the ratio of adjacent to co-channel interference I_a/I_c and the penetration of the WHSR feature for the optimized pulse in [7]. Degradation is measured relative to a legacy mobile with no WHSR transmissions

4.2. The Impact of Reduced Adjacent and Co-Channel Interference Protection on the WHSR Receiver

As in the previous section, it is assumed that the levels of the adjacent and co-channel interference at the input to the channel selectivity filter are known. As in the previous section, the following parameters are defined:

- C : the power of the desired signal at the input to the receiver;
- β : the fraction of the power of the desired signal that passes to the output of the channel selectivity filter matched to the optimized pulse from [7];
- I_a : the adjacent channel interference at the input to the channel selectivity filter;
- I_c : the co-channel interference at the input to the channel selectivity filter.

The power of the desired signal at the output of the channel selectivity filter is βC. Following the analysis in the previous section and using the values from Table 2, the co-channel interference at the output of the channel selectivity filter is a random variable given by

$$I_c \to I_c \cdot \beta \cdot \begin{cases} 10^{0.6/10} & \text{with probability} \quad 1-\varepsilon \\ 1 & \text{with probability} \quad \varepsilon \end{cases}.$$

Similarly, the adjacent channel interference at the output of the WHSR channel selectivity filter is also a random variable, with distribution given by

$$I'_a \to I_a \cdot \beta \cdot \begin{cases} 10^{-11.4/10} & \text{with probability} \quad 1\text{-}\varepsilon \\ 10^{-8.8/10} & \text{with probability} \quad \varepsilon \end{cases},$$

where we have used the fact that adjacent channel protection for the WHSR channel selectivity filter is 11.4 dB for LGMSK transmission, and 8.8 dB for WHSR transmissions.

With the above, the average interference at the output of the channel selectivity filter is given by

$$I_c \cdot \beta \cdot \left((1-\varepsilon)\cdot 10^{0.6/10} + \varepsilon\right) + I_a \cdot \beta \cdot \left((1-\varepsilon)10^{-11.4/10} + \varepsilon \cdot 10^{-8.8/10}\right).$$

The signal-to-average interference ratio $C/\langle I_{\text{total}}\rangle_e$ is then given by

$$C/\langle I_{\text{total}}\rangle_e = \frac{C}{I_c \cdot \left((1-\varepsilon)\cdot 10^{0.6/10} + \varepsilon\right) + I_a \cdot \left((1-\varepsilon)10^{-11.4/10} + \varepsilon \cdot 10^{-8.8/10}\right)}.$$

From the previous section, the signal-to-interference ratio for the legacy receiver in the absence of any WHSR transmissions is given by

$$C/I_{\text{total}} = \frac{C}{I_c + 10^{-18.3/10} I_a},$$

Thus, the signal-to-interference ratio degradation associated with the WHSR receiver relative to that of the legacy receiver (without WHSR interference) is given by the ratio of these two signal-to-interference ratios, which can be expressed as

$$\frac{1 + 10^{-18.3/10}\left(I_a/I_c\right)}{\left((1-\varepsilon)\cdot 10^{0.6/10} + \varepsilon\right) + \left((1-\varepsilon)10^{-11.4/10} + \varepsilon \cdot 10^{-8.8/10}\right)\left(I_a/I_c\right)}.$$

As in the previous section, the degradation can be expressed as a function of the ratio I_a/I_c of the adjacent to co-channel interference at the receiver front end, and the penetration ε of the WHSR feature.

In Figure 2, the degradation of the signal-to-average total interference ratio $C/\langle I_{\text{total}}\rangle$ for the target WHSR mobile is indicated as a function the adjacent to co-channel interference ratio for various WHSR feature penetration levels ε. As the ratio I_a/I_c increases, the asymptotic degradation of $C/\langle I_{\text{total}}\rangle$ is between 6.9 and 9.5 dB, where the 9.5 dB degradation is associated with 100% penetration of the WHSR feature. With a WHSR penetration of only 25%, the degradation of $C/\langle I_{\text{total}}\rangle$ is approximately 1.7 dB even if the interference at the mobile is heavily dominated by co-channel interference such that $\left(I_a/I_c\right)_{O,L}$ = -10 dB at the output of the channel selectivity filter for the legacy mobile (without WHSR interference). This degradation of $C/\langle I_{\text{total}}\rangle$ must be weighed against any improvement in link performance associated with the WHSR transmit filter. It should also be noted that the maximum degradation of $C/\langle I_{\text{total}}\rangle$ by 9.5 dB associated with the WHSR transmit filter is more than 7 dB greater than the maximum improvement in link performance observed with the use of the WHSR transmit filter in co-channel interference (see Figure 7 in [1]). As a result, it would seem that the potential loss in performance associated with the WHSR transmit filter could significantly exceed any potential performance benefits.

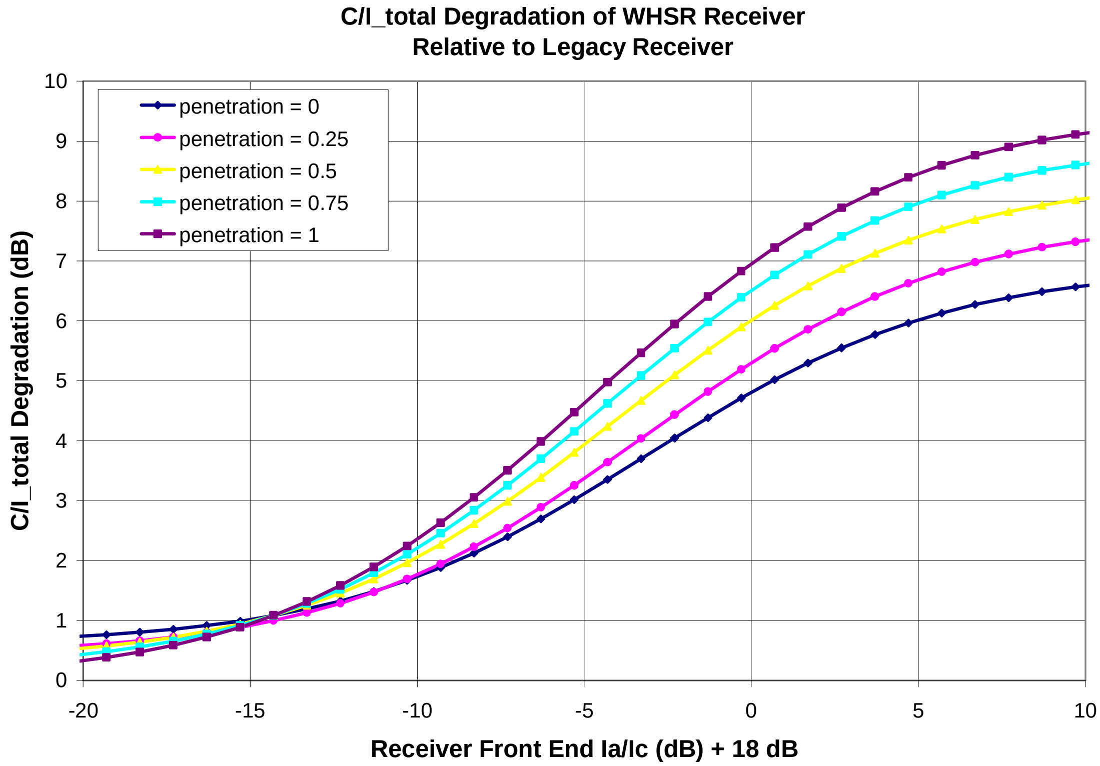

Figure 2: Degradation of $C/\langle I_{\text{total}} \rangle$ for the WHSR mobile as a function of the ratio of adjacent to co-channel interference I_a/I_c and WHSR feature penetration for the optimized pulse in [7]). Degradation is measured relative to a legacy mobile with no WHSR transmissions.

5. Cumulative Distribution of $C/\langle I_{\text{total}} \rangle$ Degradation for a 4/12 Frequency Reuse Pattern

From the previous section, the $C/\langle I_{\text{total}} \rangle$ degradation of the legacy and WHSR receivers (relative to the legacy receiver in the absence of any WHSR transmissions) can be completely characterized as a function of the ratio of adjacent to co-channel interference I_a/I_c at the front end of the receiver and the penetration ε of the WHSR feature. In order to evaluate the impact of this degradation on the system, the distribution function of I_a/I_c for the particular deployment scenario of interest must be known. Towards this end, we again consider the simple standard 4/12 reuse pattern using the usual hexagonal tessellations, as done previously in [8]. The cells are corner-excited, and statistics are collected in one central site only (3 cells). The experiment consists of collecting co-channel and adjacent channel downlink interference statistics for mobiles whose best server is found to be within one of these 3 cells. Randomizations of mobile positions and shadowing are implemented in order to obtain sufficiently meaningful data. The relevant parameters are provided in Table 1.

This scenario has good spacing between co-channel cells, similar to what might be implemented in BCCH planning, or generally in an area which is not capacity limited. In addition, the attribution of adjacent frequencies has been done so that the six adjacent cells (“neighbors”) do not have adjacent frequencies. This is therefore expected to be a high quality scenario. Note that the effects of the mobile noise floor and transmit power settings are not considered. Effectively this means that in practice the distributions are likely to be truncated at the higher values, but this should not affect the general indications from the results.

Table 3: Simulation Parameters

Parameter	Value
Site-to-site distance	1 km
Propagation loss model	L=141.6+ 36.6 $\log_{10}$(d-km) Based on COST-231 Urban @ 1800 MHz, with h_b=20m
Shadow fading standard deviation	8 dB
Shadow fading site-to-site correlation	0.5
Handover margin	6 dB
Sector antenna horizontal beamwidth	90 degrees

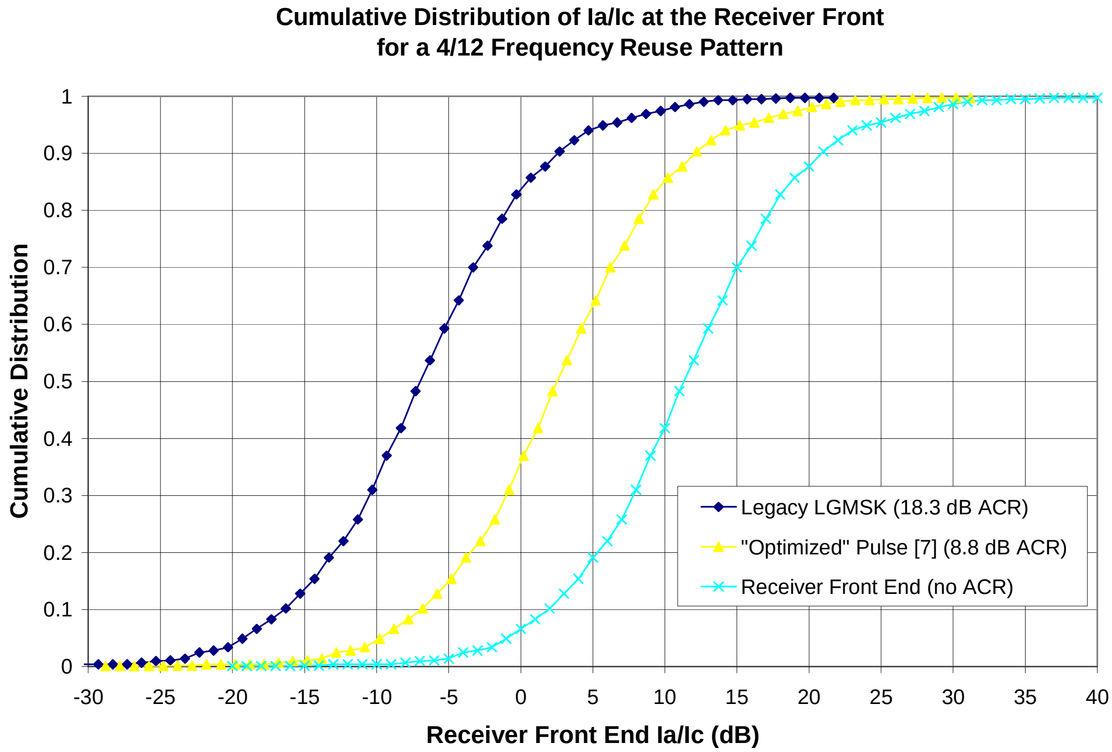

Figure 3: Cumulative distribution function of the ratio of adjacent to co-channel interference for a 4/12 frequency reuse pattern.

The cumulative distribution from [8] of the ratio I_a/I_c at the front end of the receiver is provided in Figure 3, as is the cumulative distribution of the ratio of adjacent to co-channel interference after the channel selectivity filter for the legacy receiver with legacy LGMSK transmissions (18.3 dB ACR). A third curve shows the cumulative distribution of adjacent to co-channel interference ratio that would result at the output of the WHSR channel selectivity filter with 100% WHSR transmissions (8.8 dB ACR rejection). It can be observed that for the legacy system, co-channel interference is dominant 85% of the time at the output of the channel selectivity filter. Conversely, with the optimized WHSR pulse proposed in [7] and 100% WHSR penetration, the situation is reversed such that adjacent channel interference is dominant at the output of the channel selectivity filter 65% of the time.

By mapping first from the $C/\langle I_{total}\rangle$ degradation in Figure 1 to the ratio I_a/I_c, and then from the ratio I_a/I_c to the cumulative distribution using Figure 3, it is possible to generate the cumulative distribution function of the $C/\langle I_{total}\rangle$ degradation for the legacy user as a function of the penetration of WHSR. The resulting distribution of $C/\langle I_{total}\rangle$ degradation for the legacy users is provided in Figure 4. Note that even with a WHSR penetration of only 25%, the C/I degradation will exceed 1 dB for 18% of the legacy mobiles. Conversely, with this same 25% penetration of the feature, no more than 25% of the legacy mobiles will see a $C/\langle I_{total}\rangle$ improvement, and this improvement does not exceed 0.2 dB.

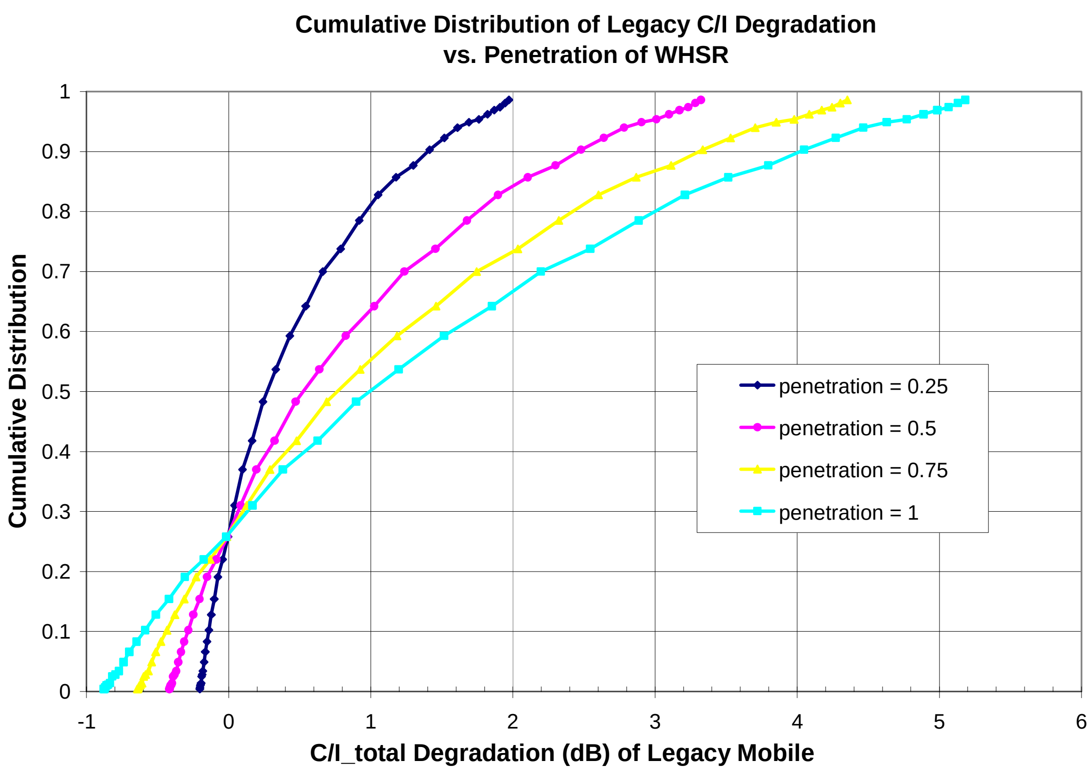

Figure 4: Cumulative distribution of $C/\langle I_{total}\rangle$ degradation for the legacy mobile as a function of WHSR penetration for the 4/12 reuse pattern (for the optimized pulse in [7]). Degradation is measured relative to a legacy mobile in a system with no WHSR transmissions.

In a similar manner, it is possible to generate the cumulative distribution function of the $C/\langle I_{\text{total}}\rangle$ degradation for the WHSR user for the 4/12 frequency reuse pattern as a function of the WHSR feature penetration, and this is presented in Figure 5. From this figure, it is apparent that the median degradation for the WHSR mobile will exceed 2.5 dB and 3.1 dB, respectively, with 0% and 50% penetration of the WHSR feature. For these same 0% and 50% WHSR penetration levels, the C/I degradation for 20% of the WHSR mobiles will exceed 4.5 and 5.6 dB, respectively. It is perhaps unlikely that that the link gains associated with the WHSR transmit filter will exceed C/I degradations of this magnitude.

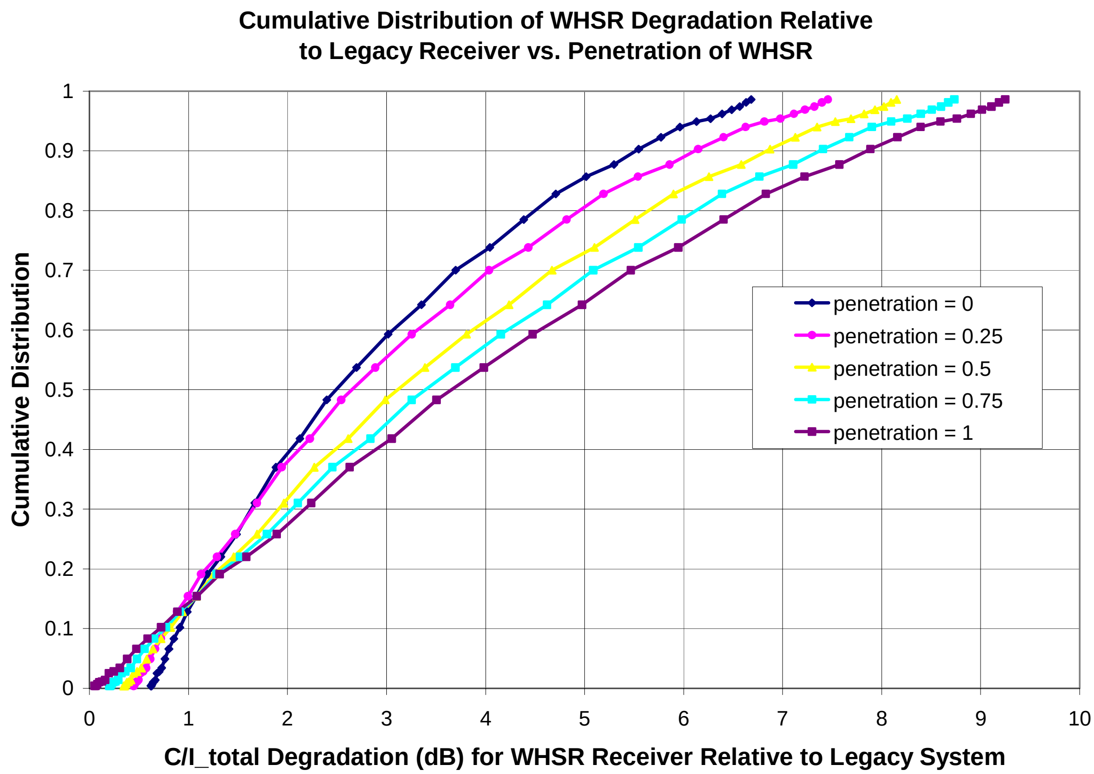

Figure 5: Cumulative distribution of $C/\langle I_{\text{total}}\rangle$ degradation for the WHSR mobile as a function of WHSR penetration for the 4/12 reuse pattern (for the optimized pulse in [7]). Degradation is measured relative to a legacy mobile in a system with no WHSR transmissions.

6. Discussion and Conclusion

From the above, it can be seen that there are significant risks associated with the deployment of WHSR on the downlink, and there is significant doubt as to whether such a deployment would yield a system benefit in most deployments.

From this first order analysis, several conclusions can be drawn:

i) Deployment of a WHSR service will have an impact on legacy mobiles. Whether that impact is positive or negative will depend on the ratio I_a/I_c at the front-end of the particular mobile. Unless the mobile is in an environment that is heavily co-channel interference limited (by at least 11 dB after the channel selectivity filter for the legacy receiver), the legacy mobile will likely suffer some loss in the signal-to-interference ratio at the output of the channel selectivity filter. Thus, the impact of the introduction of the WHSR service on legacy mobiles requires further study.

ii) While the legacy mobile will see some reduction in co-channel interference from a WHSR transmission, the WHSR mobile will see no such reduction in co-channel interference. Furthermore, the WHSR mobile will see an increase in co-channel interference by 0.6 dB (optimized pulse in [7]) if the source of the interference is an LGMSK transmission.

iii) The WHSR receiver will be much more affected by adjacent channel interference than will the legacy receiver. For the transmit filter proposed in [7], the adjacent channel protection will never exceed 11.4 dB, and can be as low as 8.8 dB. The degradation of $C/\langle I_{\text{total}} \rangle$ associated with such poor adjacent channel protection will likely exceed the approximately 2 dB improvement in link performance reported for WHSR in interference limited environments.

It should be noted that the first-order analysis in this paper can be combined with both link performance curves and distributions of ACI/CCI measurements from “real networks” to better understand the potential benefits and drawbacks of the introduction of the WHSR feature into RED HOT B. However, there is currently a clear risk that the reduction of adjacent channel protection by 6 dB as proposed in [6] would result in a feature that is of little benefit.

7. References

[1] TDoc GP-071243, “Spectrum mask design for Higher Symbol Rate”, 3GPP TSG GERAN #35, August 27-31, 2007, source Ericsson.

[2] TDoc GP-071242, “Additional simulation results for RED HOT and HUGE”, 3GPP TSG GERAN #35, August 27-31, 2007, source Ericsson.

[3] TDoc AHG1-070017, “*Impact of Higher Symbol Rate to Legacy Terminal Receiver Performance”*, 3GPP TSG GERAN WG1 AdHoc, July 19-21, 2007, source Research in Motion.

[4] TDoc GP-071229, “*Changing the Spectral Mask for Advanced Modulation Techniques for GERAN Evolution – A Discussion*”, 3GPP TSG GERAN #35, August 27-31, 2007, source Research in Motion, Motorola, Samsung, Freescale, Alcatel-Lucent.

[5] TDoc GP-071483, “System performance evaluation of candidate pulse shapes”, 3GPP TSG GERAN #35, August 27-31, 2007, source Nokia Siemens Networks.

[6] AHG1-070050, “Proposed working assumptions for design of Tx pulse shapes for higher symbol rate”, Nokia Siemens Networks, June 2007.

[7] TDoc GP-071340, “Optimised Pulse Shapes”, 3GPP TSG GERAN #35, August 27-31, 2007, source Nokia Siemens Networks.

[8] GP-071486, “Open issues on system performance of HSR with relaxed pulse shape”, 3GPP TSG GERAN #35, August 27-31, 2007, source Motorola, RIM, Samsung, Freescale, Alcatel Lucent, Panasonic, June 2007.