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Source: Qualcomm
Title: L3 Filtering
Agenda item: 8.2.2 & 8.4.2
Document for: Discussion

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1 Introduction

During RAN #18 plenary meeting an issue related to Layer 3 filtering was discussed. It was not clear which method should be used for L3 filtering: Processing averages in the linear or logarithmic domain? It was noted that different companies had different interpretations on this. RAN decided that both options would be allowed in Release 99. RAN4 was tasked to develop a technical correct solution for each measurement no later than for Release 5. In RAN4 meetings #25 and #26, a number of simulation results regarding this issue were presented. The subsequent discussions, however, did not lead to a consensus in this area.

2 Current status of L3 filtering

- L3 filtering: IIR with recursive definition, $F_n = (1-a)*F_{n-1} + a*M_n$, with:
  F_{n-1} previous filter output, a=0.5^(k/2) L3 filter coefficient,
  M_n next measurement result, k=0…19 parameter configured by network
- Two possibilities: 1) Compute L3 filtering in linear domain (e.g. in mW)
  2) Compute L3 filtering in logarithmic domain (e.g. in dBm)
- For R99 both possibilities are acceptable
- No later than for Rel-5 a unique solution shall be defined for each measurement where L3 filtering is applicable

3 Previously presented results

In a number of contributions to RAN4, the aspects of liner versus logarithmic L3 filtering have been investigated; see references [1] through [8]. For a good overview of what was presented before RAN4 #26 see [6]. In [7], Qualcomm compared simulation results for linear versus logarithmic L3 filtering assuming that the **same k parameter is used in both cases**. The following was concluded in [7]:

- It is not possible to estimate triggering delay differences from mean dBm or mean mW values over many simulation runs. Therefore the method used in [5] seems not appropriate to determine triggering time statistics.
- Statistics of triggering times and triggering delay differences for many simulation runs have to be collected by doing individual event evaluations for each simulation run. This is necessary in order to achieve a good understanding of the actual occurring triggering times and delays.
- Differences in triggering time for event 1a when using linear versus logarithmicL3 filtering are in general quite small and in many cases the median is close to 0 seconds.
- Differences in the triggering time for event 1e can get large depending on the environment (up to median of 4 seconds, mean values even larger). In that case linear L3 filtering always reports rising signal levels faster.
- For event evaluation (e.g. event 1a), a UE must perform the computation of the triggering criteria based on mW values (for RSCP) or linear ratios (for Ec/Io) if the parameter W is not equal to 0. This is very clearly stated in TS 25.331. Therefore, a UE implementation needs to calculate linear values before event evaluation in any case. Therefore, complexity cannot be a reason to do L3 filtering in the logarithmic domain.

So even when assuming that the same k parameter is used in both cases, advantages for linear L3 filtering were observed. However, if a network could assume that one unique solution is used, for instance linear L3 filtering, the selection of triggering parameters and k values can be optimised with respect to desired effective reporting regions. Therefore, it is not completely objective to compare L3 filtering performance for the same k parameters in both cases.

4 Simulation results regarding speed sensitivity

One missing piece of information is how sensitive the two filtering methods are with respect to varying UE speeds. Practical deployments can probably not use UE speed specific k parameters. For that reason, it was questioned whether the reporting regions in case of a fixed k parameter irrespective of the mobile speed would vary differently for linear versus logarithmic L3 filtering when UEs move through the network with different speeds. It was commented that logarithmic L3 filtering would be less sensitive to speed in that sense.

Figure 1, left hand side, depicts simulation results for the CDF of the location of triggering event 1a when a UE is moving from one node B to another one that is 1000 m apart. The details of the simulation assumptions are listed in [7]. The curves in red are applicable for liner L3 filtering, the curves in blue hold for logarithmic L3 filtering. The median of the triggering location for 3 km/h and 30 km/h only differs by 1 m for the two filtering methods. Even in the case of 120 km/h the median differs only by 3 m. It can be read from these results that the variation of the reporting regions with UE speed is practically identical for both filtering methods. In Figure 1, right hand side, the corresponding results for event 1e triggering locations are depicted. From this it can be concluded that the reporting regions in case of logarithmic L3 filtering is much more sensitive to UE speed then in case of linear L3 filtering. When changing the UE speed from 3 km/h up to 120 km/h the median for linear L3 filtering changes by 173 m. The change of the median in case of logarithmic L3 filtering is 251 m.

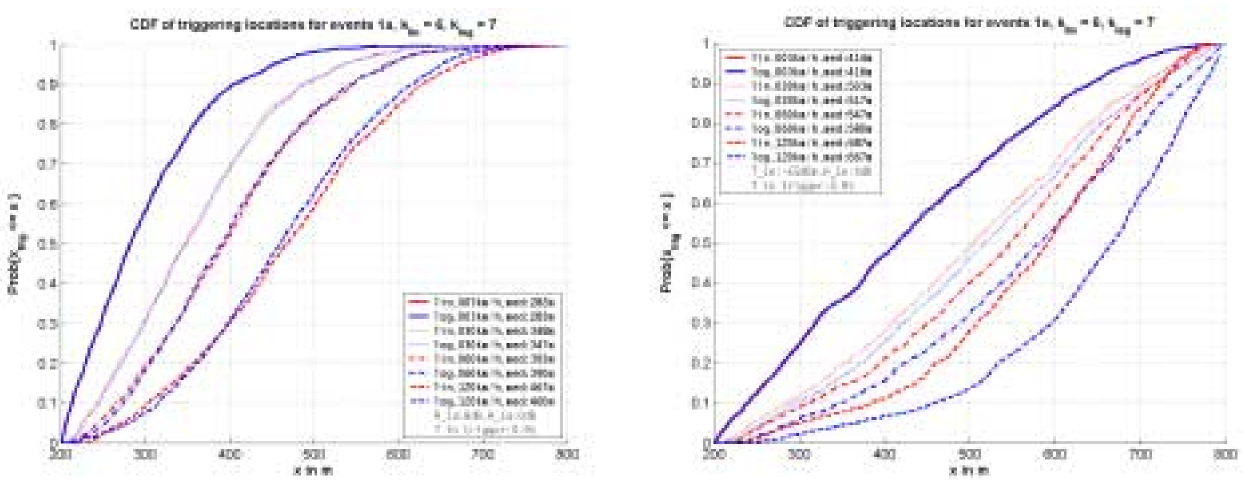

Figure 1 CDF of triggering locations for different UE speeds and different L3 filtering methods

5 Conclusion

From results that have been presented in this and in previous contributions on this matter, we conclude:

- Differences in triggering time statistics for event 1a for linear versus logarithmicL3 filtering are in general quite small and in many cases the median is close to 0 seconds, even if the same k parameter is used. The selection of the k parameter can be optimised in order to fine-tune reporting regions for each of the filtering methods.
- For event 1e triggering linear L3 filtering always reports rising signal levels faster (median differences of up to 4 seconds were observed).
- Complexity cannot be a reason to do L3 filtering in the logarithmic domain, since linear quantities are needed anyway for event evaluation.
- Using pathloss (or to be more specific: the distance-dependent component of the pathloss without the fading component) as a reference for performance comparisons is not justified, as the communication link quality is determined by the energy levels that are received and not by the median of the pathloss.
- Speed sensitivity of reporting regions when using linear or logarithmic filtering in case of event 1a are almost identical.
- Speed sensitivity of reporting regions in case of event 1e is worse when using logarithmic L3 filtering versus liner L3 filtering.

One important aspect has not been raised in the discussion so far: Measurement accuracy. Given that the measurement accuracies of the L1 measurements that are filtered by L3 filter have not been taken into account so far, it is quite questionable whether some of the mentioned performance differences would still be observable in a real world scenario. So far, Rel99, Rel-4 and Rel5 do not contain any test cases that use L3 filtering. Under that aspect it, the significance of the L3 filtering method seems questionable.

Furthermore, we would like to note that in case of logarithmic L3 filtering for RSCP measurements, this measurement would contain the same information as the pathloss measurement (which is assumed to be performed in logarithmic domain). The two measurements would just be offset by the Node B transmit power. So these would be redundant measurements.

From all the information that has been gathered so far, it is our conclusion that L3 filtering for CPICH_RSCP, CPICH_EcIo should be done in the linear domain. Pathloss, UTRA Carrier RSSI and UE Tx Power could be done in logarithmic domain.

References

[1] Nokia: R4-021484 “L3 filtering”, 3GPP RAN WG4 meeting #25, Secaucus, NJ, USA, November 2002.
[2] Motorola: R4-021479 “Unit of layer 3 filtering”, 3GPP RAN WG4 meeting #25, Secaucus, NJ, USA, November 2002.
[3] Qualcomm: R4-021534 “L3 Filtering”, 3GPP RAN WG4 meeting #25, Secaucus, NJ, USA, November 2002.
[4] Ericsson: R4-021446 “Discussion on Linear or Logarithmic L3 Filtering”, 3GPP RAN WG4 meeting #25, Secaucus, NJ, USA, November 2002.
[5] Nokia, NTT-DoCoMo: R4-030113 “Comparison of linear and dB scale L3 filters”, 3GPP RAN WG4 meeting #26, Madrid, Spain, February 2003.
[6] Motorola: R4-030026 “Layer 3 filtering options”, 3GPP RAN WG4 meeting #26, Madrid, Spain, February 2003.
[7] Qualcomm: R4-030201, “L3 filtering”, 3GPP RAN WG4 meeting #26, Madrid, Spain, February 2003.
[8] Nokia: R4-030113 “Comparison of linear and dB scale L3 filters”, 3GPP RAN WG4 meeting #26, Madrid, Spain, February 2003.

TSG-RAN Working Group 4 (Radio) meeting #26 R4-030201

Madrid, Spain, 17th - 21st February 2003

Source: **Qualcomm**

Title: **L3 Filtering**

Agenda item: **6.7**

Document for: **Approval**

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1 Introduction

During last RAN plenary meeting an issue related to Layer 3 filtering was discussed. It was not clear which method should be used for L3 filtering: Processing averages in the linear or logarithmic domain? It was noted that different companies had different interpretations on this. RAN decided that both options would be allowed in Release 99. RAN4 was tasked to develop a technical correct solution for each measurement no later than for Release 5. In the last RAN4 meeting, a number of simulation results regarding this issue were presented, . The subsequent discussion, however, did not lead to a consensus in this area. This document presents further details on simulation results and addresses questions that were raised during the last RAN4 meeting. This should help RAN4 to decide on the way forward.

2 Statement of the problem

- Measurements from physical layer may be filtered before event evaluation if L3 filtering is switched on.
- L3 filtering: IIR with recursive definition, $F_n = (1\text{-}a)*F_{n-1} + a*M_n$, with:
  F_{n-1} previous filter output,
  M_n next measurement result,
  a=1/2^(k/2) L3 filter coefficient,
  k=0…19 parameter configured by network
- Two possibilities:
  1) Compute L3 filtering in linear domain (e.g. in mW)
  2) Compute L3 filtering in logarithmic domain (e.g. in dBm)

3 Simulation set-up

List of simulation assumptions (new items in bold):

- Scenario: UE driving away from Node B No.1 (only cell in active set) and towards Node B No. 2. Distance between Node Bs: 1000m. Minimum distance between UE and Node B: 200 m
- UE speeds of 3 km/h, 30 km/h, 60 km/h and **120 km/h**.
- Slow fading according to macro cell pathloss model in TS25.942
  [PL=128.1 dB + 37.6 log(R/km) + lognormal_fading]
- Correlation of slow fading over distance according to model in UMTS 30.03:
  Correlation-0.5 distance 20 m, exponential correlation function for all speeds;
  Additionally: Correlation-0.5 distance 50 m for 120 km/h.
- Node B Tx power: +43 dBm
- Antenna gains: Node B 11 dBi, UE 0 dBi
- Minimum coupling loss: 70 dB
- CPICH transmit Ec/Ior: -10 dB
- L1 reporting rate to L3 filtering: 1 measurement per 200 ms.
- L3 filtering output rate: 1 measurement per 200 ms.
- **Pramaters for event 1a evaluation**:
  $CIO_{New} = 0$ dB; $W = 0$; $R_{1a} = 8$ dB; $H_{1a} = 0$ dB; time to trigger: 0.8 seconds.
- **Pramaters for event 1a evaluation**:
  $CIO_{New} = 0$ dB; $T_{1e} = -65$ dBm; $H_{1e} = 0$ dB; time to trigger: 0.8 seconds.

Computed results (new items in bold):

- Computation of actual CPICH_RSCP received from Node B No.1 and Node B No.2 in dBm for 200ms measurement periods (4 samples taken per measurement period)
- Two ways for computation of output of L3 filter for CPICH_RSCP:
  - o Input values are in mW (linear L3 filtering)
  - o Input values are in dBm (logarithmic L3 filtering).
- **Mean power levels** at the output of L1, L3 linear and L3 logarithmic over all simulation runs.
  For each measurement period i , the **actual mean power** over all simulation runs is computed. This means that the following quantities are calculated:

$$\overline{L1\_CPICH\_RSCP_i} = \frac{1}{N_{\text{runs}}} \cdot \sum_{n=1}^{N_{\text{runs}}} \left\{ L1\_CPICH\_RSCP_i(n) \text{ in mW} \right\}$$

$$\overline{L3lin\_CPICH\_RSCP_i} = \frac{1}{N_{\text{runs}}} \cdot \sum_{n=1}^{N_{\text{runs}}} \left\{ L3lin\_CPICH\_RSCP_i(n) \text{ in mW} \right\},$$

$$\overline{L3log\_CPICH\_RSCP_i} = \frac{1}{N_{\text{runs}}} \cdot \sum_{n=1}^{N_{\text{runs}}} \left\{ L3log\_CPICH\_RSCP_i(n) \text{ in mW} \right\}$$

  where
  - o N_{runs} is the number of simulation runs
  - o i is the index of the measurement period,
  - o n is the index of the simulation run,
  - o $L1\_CPICH\_RSCP_i(n)$ is the L1 power level for the i -th measurement period in the n -th simulation run,
  - o $\overline{L1\_CPICH\_RSCP_i}$ is the **mean L1 power level** for the i -th measurement period over all simulation runs,
  - o $L3lin\_CPICH\_RSCP_i(n)$ is the power level after linear L3 filtering for the i -th measurement period in the n -th simulation run,
  - o $\overline{L3lin\_CPICH\_RSCP_i}$ is **mean the power level after linear L3 filtering** for the i -th measurement period over all simulation runs,
  - o $L3log\_CPICH\_RSCP_i(n)$ is the power level after logarithmic L3 filtering for the i -th measurement period in the n -th simulation run,
  - o $\overline{L3log\_CPICH\_RSCP_i}$ is **mean the power level after logarithmic L3 filtering** for the i -th measurement period over all simulation runs.
- **Mean of dBm values** at the output of L1, L3 linear and L3 logarithmic over all simulation runs.
  For each measurement period i , the **mean of dBm values** over all simulation runs is computed. **This mean is not equal to the mean power level over all simulation runs!** The following quantities are calculated:

$$\overline{\overline{L1\_CPICH\_RSCP_i}} = \frac{1}{N_{\text{runs}}} \cdot \sum_{n=1}^{N_{\text{runs}}} \left\{ L1\_CPICH\_RSCP_i(n) \text{ in dBm} \right\}$$

$$\overline{\overline{L3lin\_CPICH\_RSCP_i}} = \frac{1}{N_{\text{runs}}} \cdot \sum_{n=1}^{N_{\text{runs}}} \left\{ L3lin\_CPICH\_RSCP_i(n) \text{ in dBm} \right\},$$

$$\overline{\overline{L3log\_CPICH\_RSCP_i}} = \frac{1}{N_{\text{runs}}} \cdot \sum_{n=1}^{N_{\text{runs}}} \left\{ L3log\_CPICH\_RSCP_i(n) \text{ in dBm} \right\}$$

  where

- N_{runs} is the number of simulation runs
- i is the index of the measurement period,
- n is the index of the simulation run,
- $L1\_CPICH\_RSCP_i(n)$ is the L1 power level for the i -th measurement period in the n -th simulation run,
- $\overline{\overline{L1\_CPICH\_RSCP_i}}$ is the **mean of the dBm values of the L1 power measurements** for the i -th measurement period over all simulation runs,
- $L3lin\_CPICH\_RSCP_i(n)$ is the power level after linear L3 filtering for the i -th measurement period in the n -th simulation run,
- $\overline{\overline{L3lin\_CPICH\_RSCP_i}}$ is **mean of the dBm values after linear L3 filtering** for the i -th measurement period over all simulation runs,
- $L3log\_CPICH\_RSCP_i(n)$ is the power level after logarithmic L3 filtering for the i -th measurement period in the n -th simulation run,
- $\overline{\overline{L3log\_CPICH\_RSCP_i}}$ is **mean of the dBm values after logarithmic L3 filtering** for the i -th measurement period over all simulation runs.

- **Evaluation of event 1a after L3 filtering according to the triggering parameters listed under assumptions** for each simulation run separately for linear and logarithmic L3 filtering:
  - **Recording of time when triggering condition is met** after linear L3 filtering for each simulation run.
    This time is denoted $t_{\text{lin}}^{\text{1a}}$
  - **Recording of time when triggering condition is met** after logarithmic L3 filtering for each simulation run.
    This time is denoted $t_{\text{log}}^{\text{1a}}$
  - **Recording of triggering delay of events triggered after logarithmic L3 filtering versus linear L3 filtering** for each simulation run.
    This time difference is denoted $\Delta t^{\text{1a}} = t_{\text{log}}^{\text{1a}} - t_{\text{lin}}^{\text{1a}}$.
- **Computation of the CDF of the triggering delay** Δt^{1a} over all simulation runs.
- Evaluation of event 1e after L3 filtering **according to the triggering parameters listed under assumptions** for each simulation run separately for linear and logarithmic L3 filtering:
  - Recording of time when triggering condition is met after linear L3 filtering for each simulation run.
    This time is denoted $t_{\text{lin}}^{\text{1e}}$
  - Recording of time when triggering condition is met after logarithmic L3 filtering for each simulation run.
    This time is denoted $t_{\text{log}}^{\text{1e}}$
  - Recording of triggering delay of events triggered after logarithmic L3 filtering versus linear L3 filtering for each simulation run.
    This time difference is denoted $\Delta t^{\text{1e}} = t_{\text{log}}^{\text{1e}} - t_{\text{lin}}^{\text{1e}}$.
- Computation of the CDF of the triggering delay Δt^{1e} over all simulation runs.

4 Simulation results

4.1 Speed 3 kmph

In Figure 1, the results are depicted for the L1, L3 linear and L3 logarithmic power levels for one single exemplary simulation run at 3 kmph using a L3 filtering parameter of k=11. The triggering times for events 1a and 1e are indicated with vertical solid black lines. Since the speed is quite low, the time to move 600 m is rather long (720 seconds). The variations of power levels in Figure 1 become difficult to see. In order to get a better visual impression of the power levels around the trigger times, the range between 90 s and 190 s is enlarged in Figure 2.

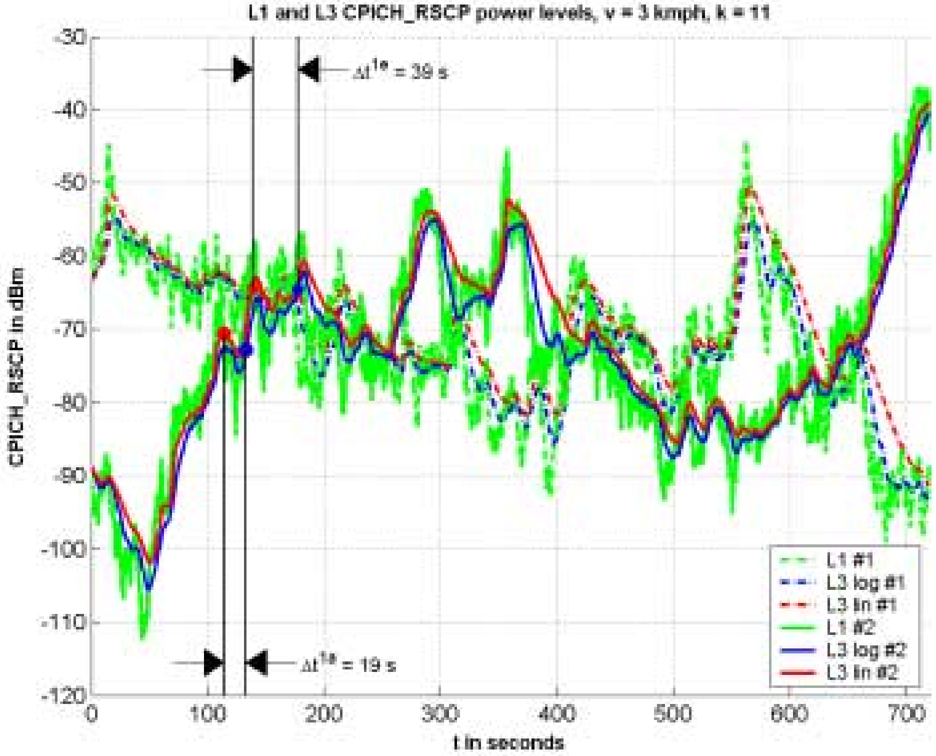

Figure 1 Example of simulation run for 3 kmph, k=11

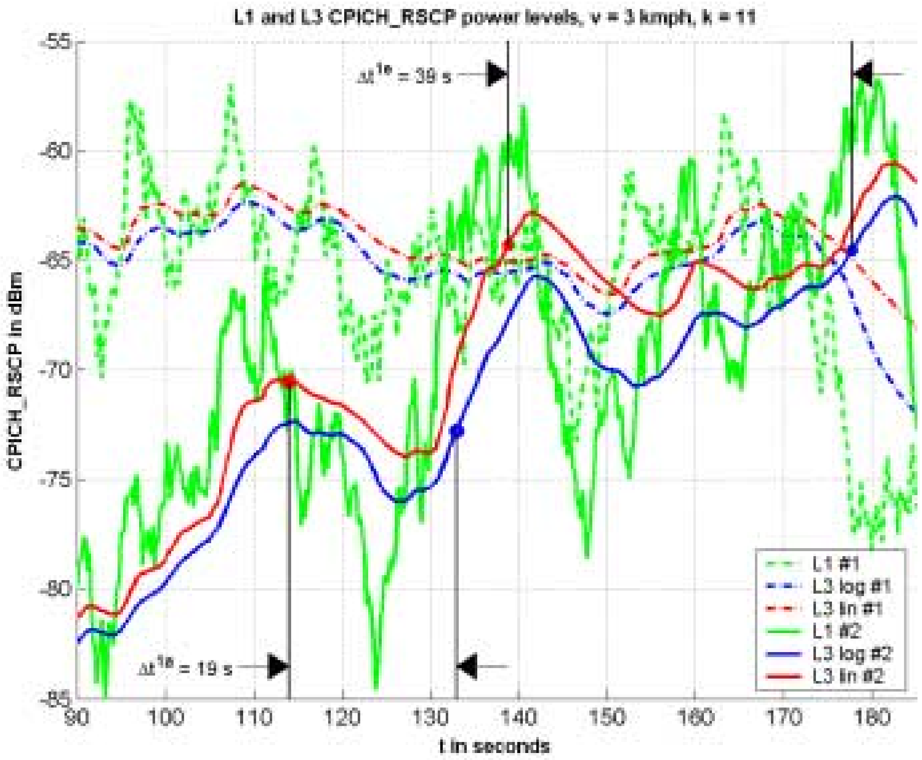

Figure 2 Enlarged section of Figure 1

For this example, the delay between triggering of event 1a after logarithmic L3 filtering relative to the triggering after linear L3 filtering in 19 s. This translates into a spatial distance 15.8 m. The corresponding delay for event 1e is 39 s, which translates into a distance of 32.5 m.

In the previous example, the filtering parameter k was 11, which results in a rather long memory in the L3 filtering. This kind of L3 filtering parameter would be appropriate for rather low speeds. Since the logarithmic L3 filtering is significantly slower (for that k value) in following rising signal levels, this caused also relatively long triggering delays between linear and logarithmic L3 filtering before event evaluation. In order to demonstrate how these delays change with smaller L3 filtering parameter k, results for the same speed of 3 kmph and k =7 were also produced.

In Figure 3, results are depicted for the L1, L3 linear and L3 logarithmic power levels for the same simulation run that was used for the previous example (3 kmph). Now a L3 filtering parameter of k=7 is assumed. Like in the previous example, the triggering times for events 1a and 1e are indicated with vertical solid black lines. For a better visual impression of the power levels around the trigger times, the range between 100 s and 140 s is enlarged in Figure 4.

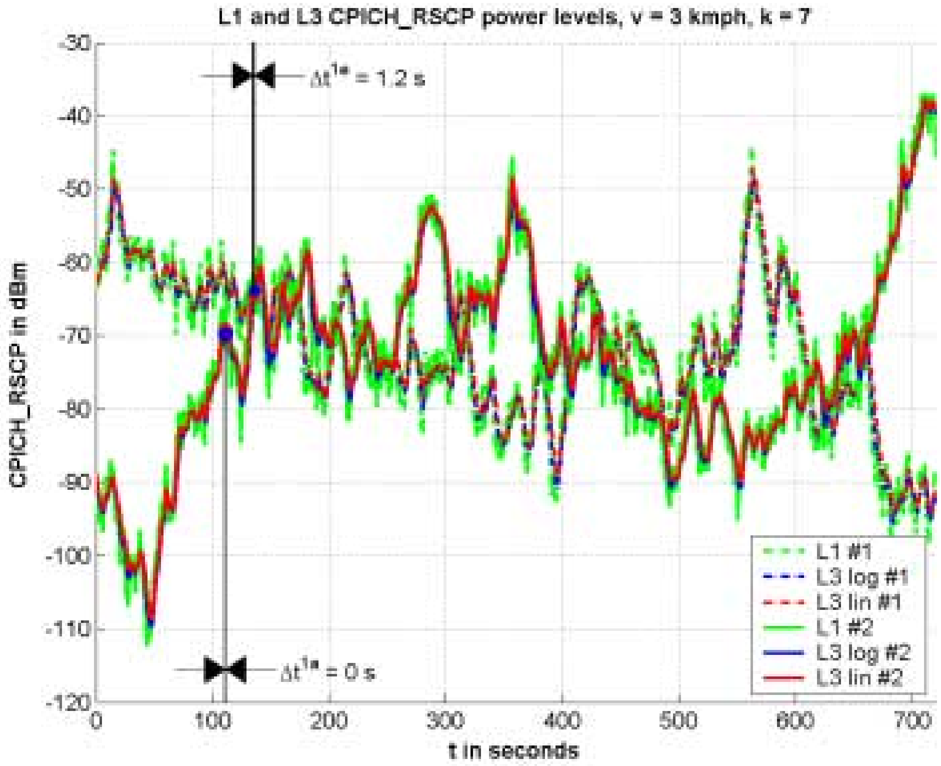

Figure 3 Example of simulation run for 3 kmph, k=7

For this k value, the delay between triggering of event 1a after logarithmic L3 filtering relative to the triggering after linear L3 filtering in 0 s. The corresponding delay for event 1e is 1.2 s. Obviously the delays reduced quite a bit due to the different k value. For low speeds like 3 kmph or smaller, it appears quite important to have a sufficient long averaging in the L3 filter. However, it is also quite important to know whether the UE is using linear or logarithmic L3 filtering in order to decide on the appropriate k value. One important property of the logarithmic L3 filtering is that it will always be slower to detect the raising signal levels in terms of absolute power (event 1e) as opposed to falling signal levels (event 1f). This will become more evident later on.

In [5] it is proposed to use some form of averaging the power levels at each UE position over many simulation runs in order to derive an estimate of when the triggering of events (1a or 1e) would occur for the two different ways of L3 filtering (liner versus logarithmic).

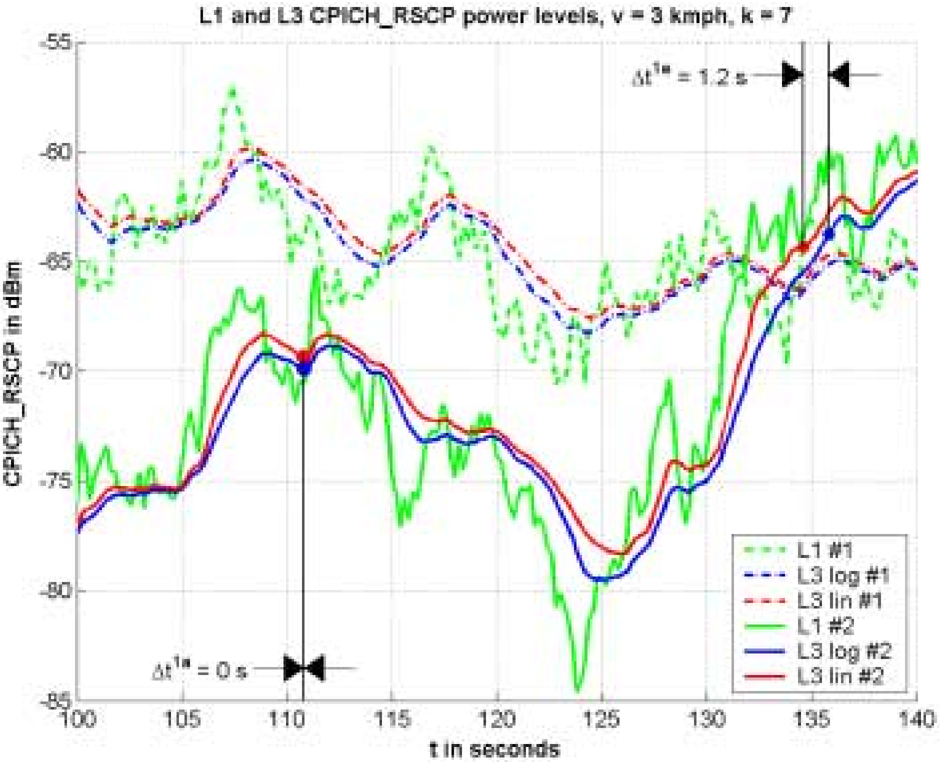

Figure 4 Enlarged section of Figure 3

In the following, some of the results presented in [5] were reproduced in order to better understand how one could gain some better insight into the respective triggering behaviour of event 1a. If many examples – like the one in Figure 3 above – are generated for the L1, L3 linear filtered and L3 logarithmic filtered power levels, it can be analysed how an average over all of these power levels for each UE position looks. It was noted that, in [5] the **mean over the dBm values** for each UE position over all simulation results was computed to accomplish the averaging. This leads to the power levels depicted in Figure 5. It is not clear how that way of averaging can indicate the delay difference for triggering event 1a for the two L3 filtering methods. Just keep in mind: Figure 5 **does not depict the mean power level over all simulation runs**. The results in Figure 5 seem to line up well with the results depicted in the left side of Figure 3 in [5].

The “hypothetical” delay difference for triggering event 1a is indicated in Figure 5. This is a hypothetical value, since none of the simulation runs actually follows that set of curves – it is just an average of dBm values. So it remains unclear what this set of curves actually demonstrates. Since for this speed, the difference between linear and logarithmic L3 filtering seems not to be very large (for the same k value), it looks like also the hypothetical delay for triggering event 1a would be rather small. From Figure 5 it would seem to be –0.4 s, which could suggest that logarithmic L3 filtering would trigger 0.4 seconds earlier than linear L3 filtering. This is just an assumption derived from the mean of dBm values that lacks any further rationale. For reference it is also indicated what the delay of level crossing between cell 1 and 2 would be for linear versus logarithmic L3 filtering. In this case it looks like the difference would be 0 seconds.

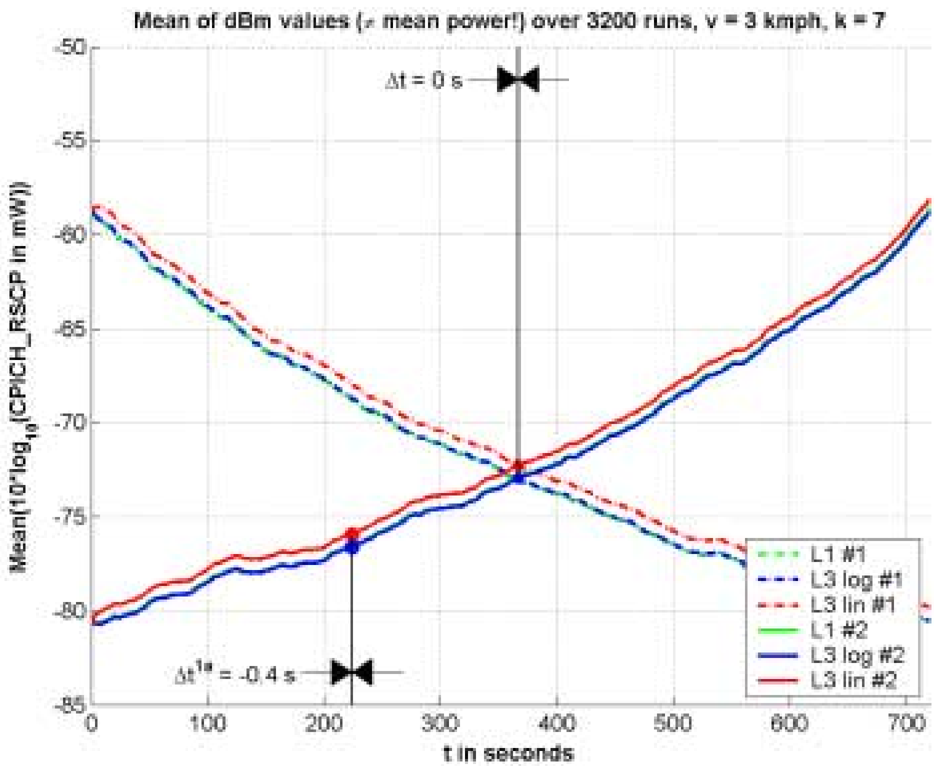

Figure 5 Averageing of dBm values over all simulation runs

Since it was suggested to look at average signal levels (L1, L3 linear, L3 logarithmic) over all simulation runs, we also computed the **actual mean power levels over all simulation runs** (mean of mW values, then converted into dBm). The corresponding results are depicted in Figure 6. According to Figure 6, the hypothetical delay of event 1a triggering would be 0.2 seconds, i.e. the linear L3 filtering would trigger 0.2 seconds earlier that the logarithmic L3 filtering.

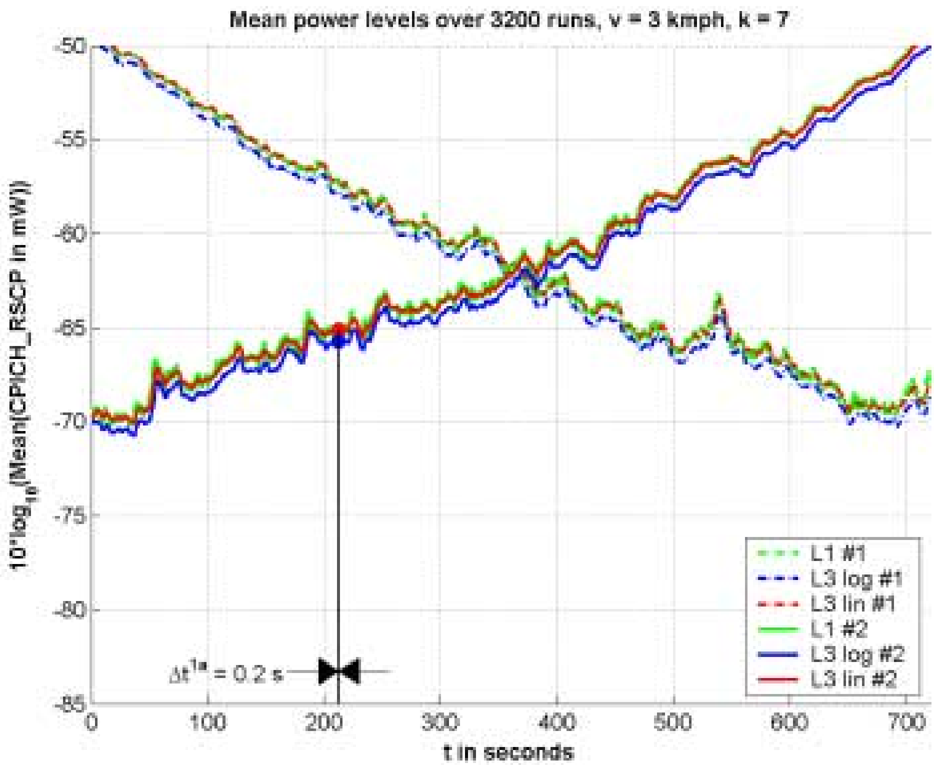

Figure 6 Averaging of mW values over all simulation runs

Note that the linear L3 filtering matches quite well with the mean L1 power levels. Also in this case it is not clear how the hypothetical delay of triggering an event that is derived from an averaged power level correlates with the delays that are actually observed in the different simulation runs. For that reason we conducted an **event 1a and event 1e evaluation for each simulation run separately** as opposed to one evaluation for average power levels. After that, one can look at the statistics of the triggering delays between linear and logarithmic L3 filtering. We believe that this is giving a much more precise estimation of what the actual delays are. The CDF of the delays between event triggering after linear and logarithmic L3 filtering is depicted in Figure 7. Positive triggering delays indicate cases in which linear L3 filtering triggered first, negative delays indicate cases when logarithmic L3 filtering triggered first.

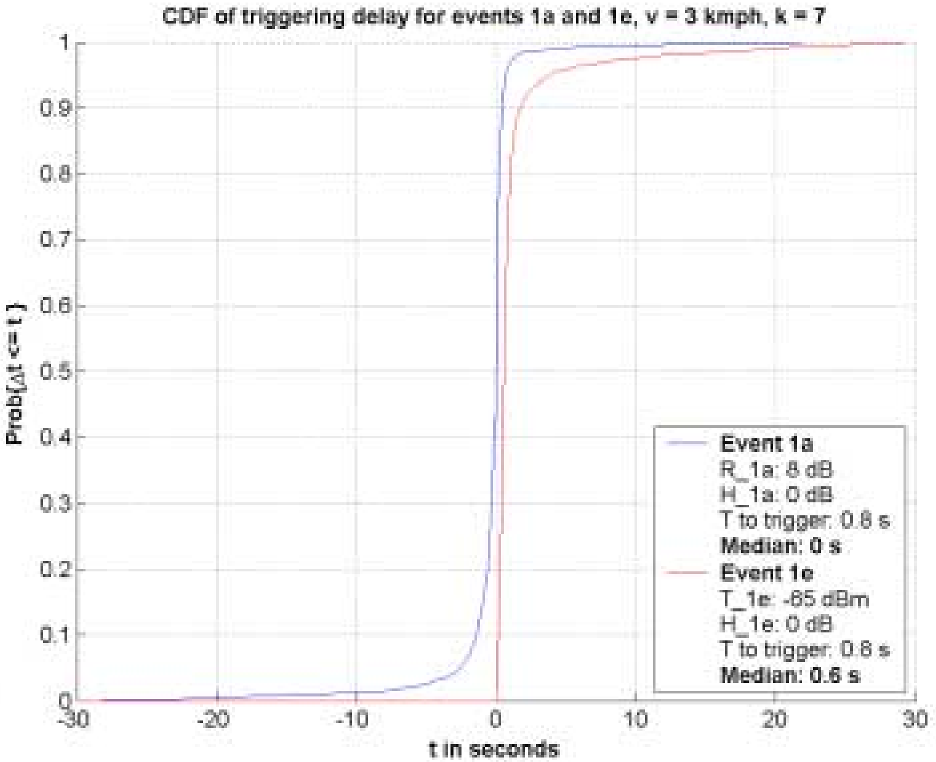

Figure 7 CDF of triggering delays, v = 3 kmph, k = 7

According to the CDFs in Figure 7, the median of the event 1a triggering delay is 0 seconds. This means that in 50% of the cases linear L3 filtering triggered first and also in 50% of the cases logarithmic L3 filtering triggered first. For event 1e, the linear L3 filtering always triggered first. The median is 0.6 seconds.

In Figure 8 the corresponding CDFs for a larger L3 filtering parameter k = 11 are depicted. The median for event 1a evaluation is still 0 seconds. However, the median for event 1e evaluation increased to 3.2 seconds. This indicates that long averaging (low filter bandwidth) in case of logarithmic L3 filtering causes problems with identifying events 1e fast enough.

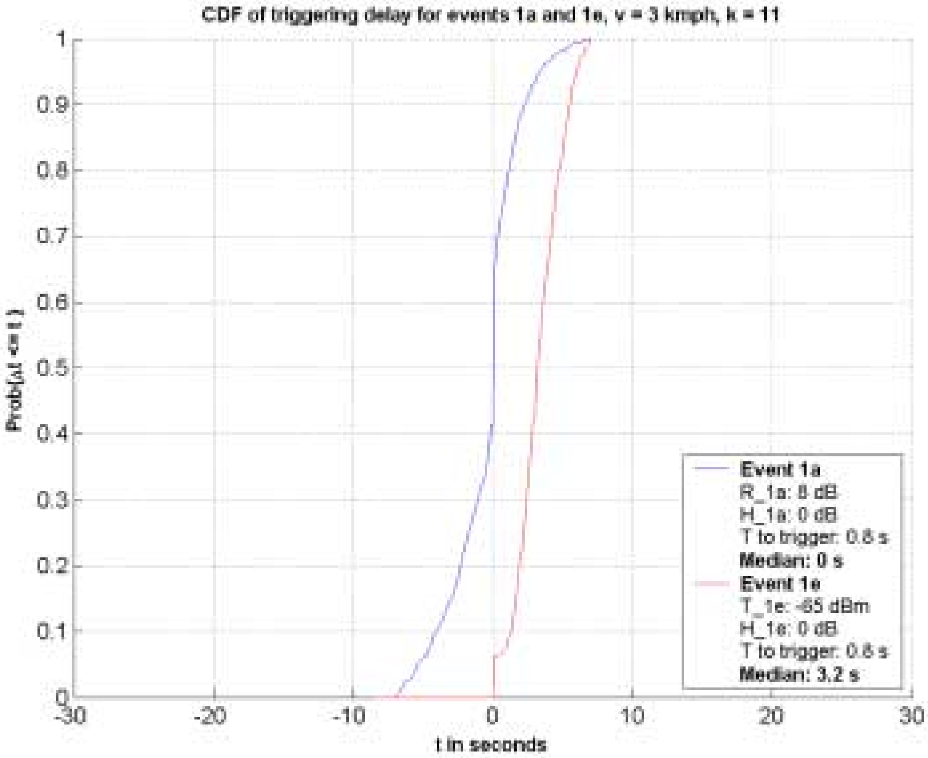

Figure 8 CDFs of triggering delays, v = 3 kmph, k = 11

In general, for low speeds like 3 kmph and lower there seems not to be any significant difference in event 1a triggering for linear versus logarithmic L3 filtering. Just the event 1e triggering was working faster with linear L3 filtering for a given L3 parameter k.

4.2 Speed 30 kmph

In this section we summarize similar simulation results as in the previous section, just for the case of 30 kmph and some different settings for the L3 filtering parameter k. Further comments on the results:.

- Delays for triggering event 1a in depicted examples (Figure 8) are rather small
- Delays for triggering event 1e in depicted examples (Figure 8) are rather large
- Average over dBm values in Figure 10, k = 7, match reasonably well with results in right side of Figure 1 in [5]. The hypothetical delay for event 1a driven would seem to be –1 second.
- From average over mW values in Figure 11, k = 7, the hypothetical delay for event 1a would be 0 seconds.
- Average over mW values indicates that linear L3 filtering follows much better the actual mean L1 power levels.
- From triggering delay CDFs in Figure 12, the median delay for event 1a is –0.4 seconds (for k=10 and k=7). The median delay for triggering event 1e is 3.6 seconds or 30 m (k=10) or 1.2 seconds or 10 m (k=7)
- It seems not to be possible to derive the triggering delay that could be expected just from the average over dBm or average over mW results.
- The only way to find out what the triggering delay looks like is to investigate the actual statistics of the triggering time differences.

Again, the differences for linear versus logarithmic L3 filtering in triggering event 1a seem to be rather small, whereas the differences for triggering event 1e remain larger.

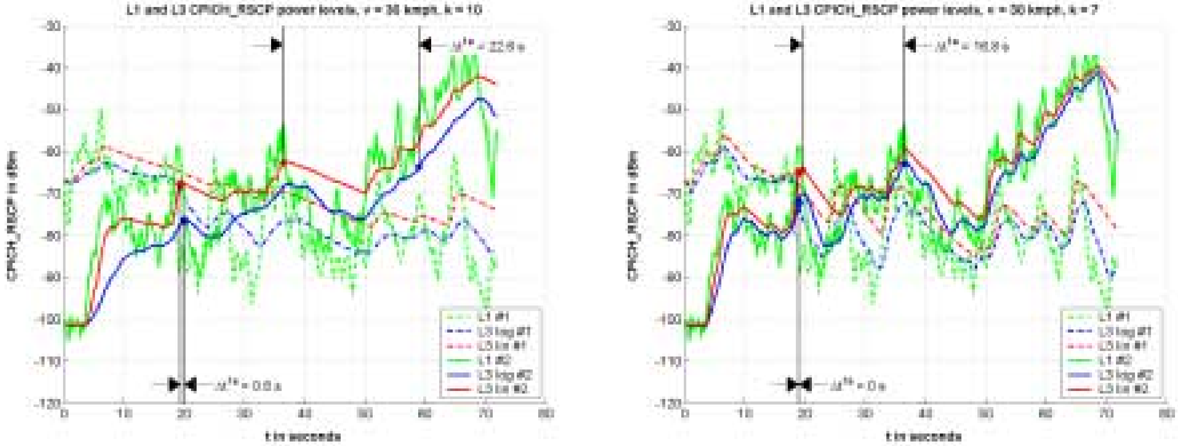

Figure 9 Example of simulation run for 30 kmph, k=10 and k=7

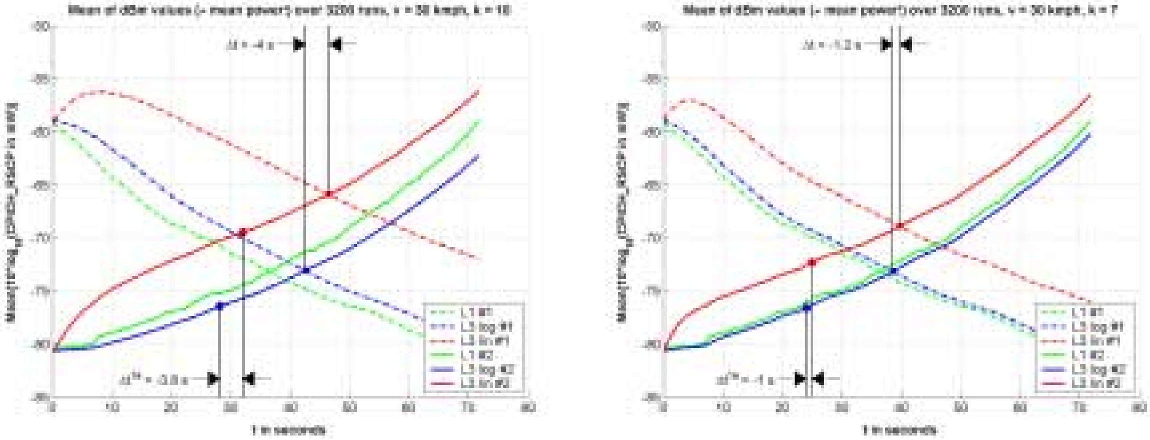

Figure 10 Averaging of dBm values over all simulation runs

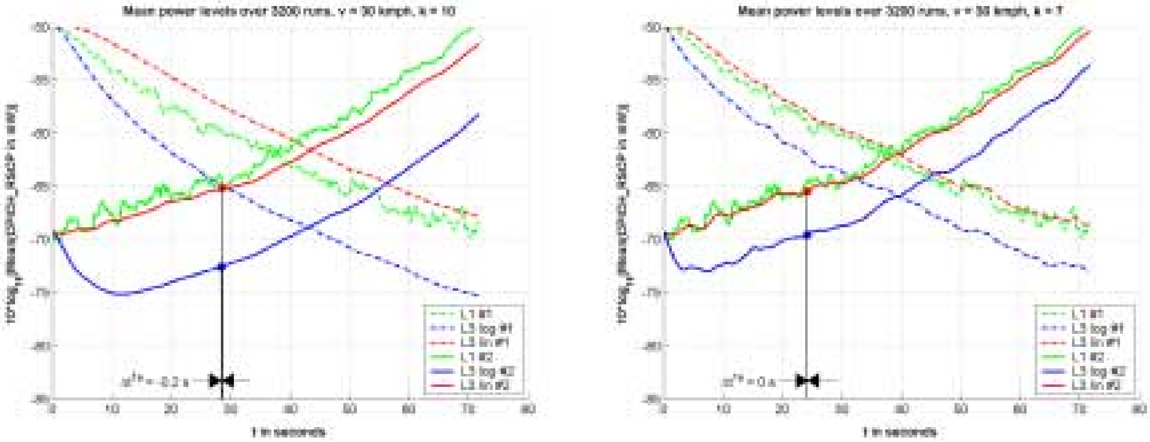

Figure 11 Averaging of mW values over all simulation runs

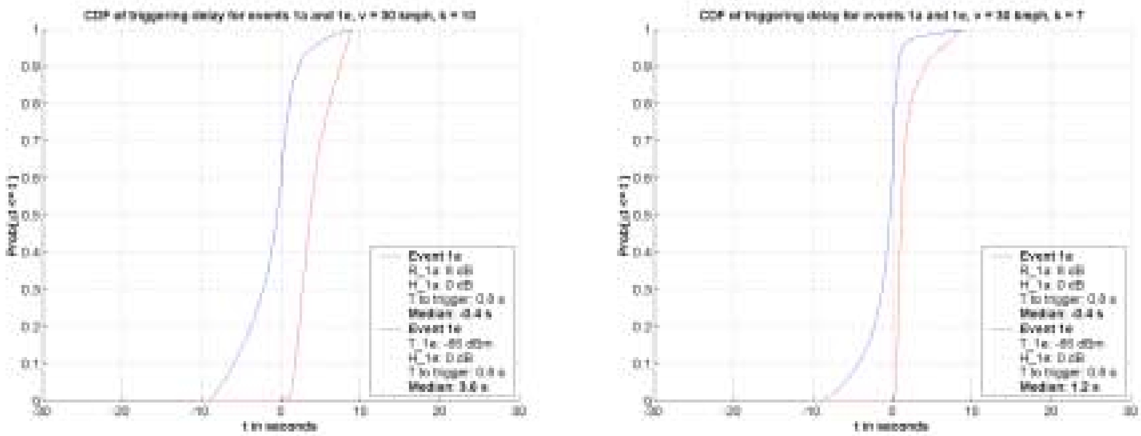

Figure 12 CDFs of triggering delays, v = 30 kmph, k=10 and k=7

4.3 Speed 60 kmph

All comments on results at 30 kmph also apply to this section, respectively.

Again, it becomes quite obvious that deriving an estimate for a triggering delay from averaged results seems not to be possible. The differences for linear versus logarithmic L3 filtering in triggering event 1a seem to be still reasonably small for 60 kmph, whereas the differences for triggering event 1e remain larger.

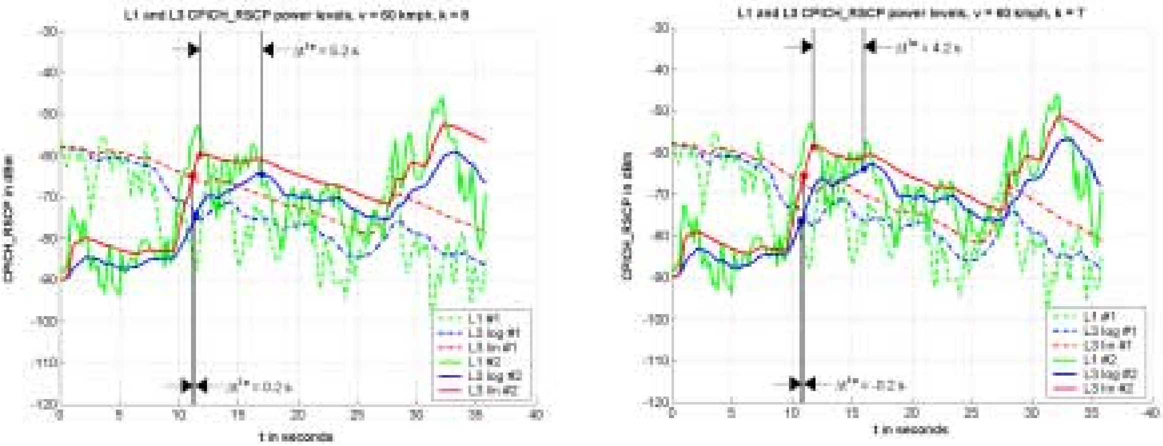

Figure 13 Example of simulation run for 60 kmph, k=8 and k=7

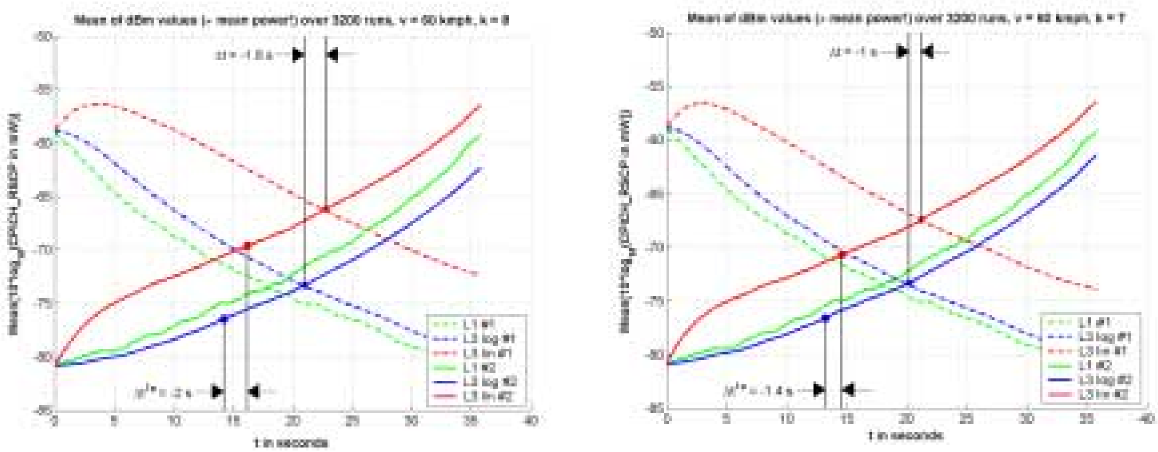

Figure 14 Averaging of dBm values over all simulation runs

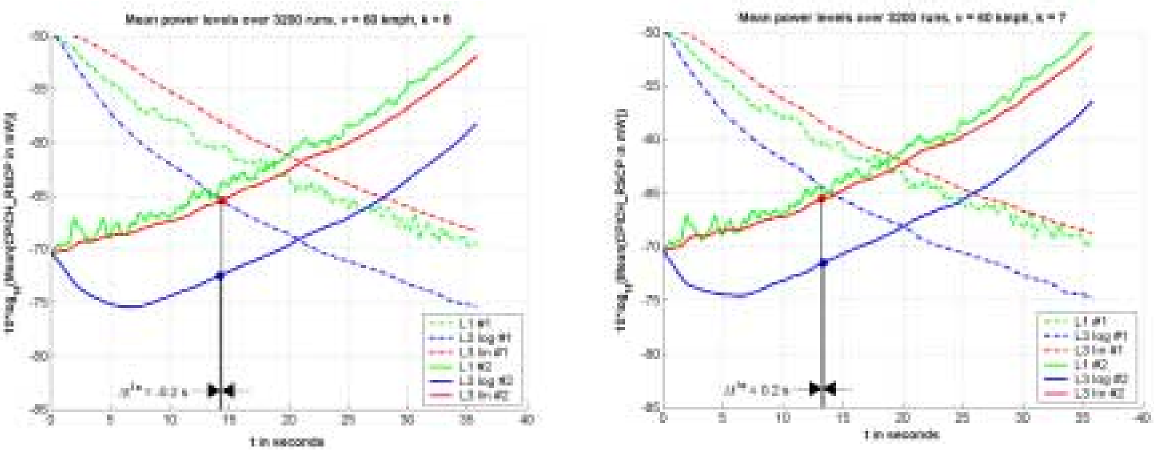

Figure 15 Averaging of mW values over all simulation runs

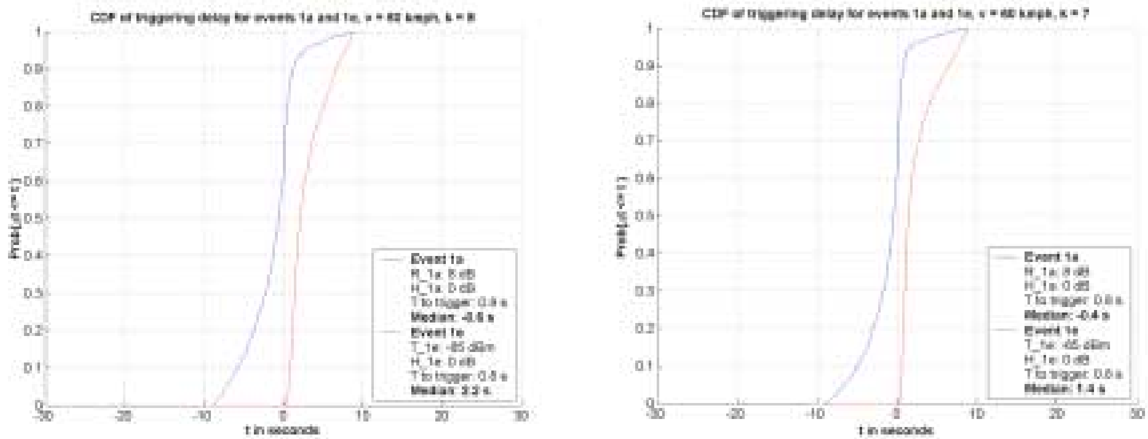

Figure 16 CDFs of triggering delays, v = 60 kmph, k=8 and k=7

4.4 Speed 120 kmph

In this section we present only the resulting CDFs for triggering delays. In addition to the correlation length of 20 m a value of 50 m was also investigated. Also the CDF of the actual trigger times is presented for k=7.

As stated previously, the differences for linear versus logarithmic L3 filtering in triggering event 1a do not become very large (median between –0.4 seconds and 0 seconds), whereas the differences for triggering event 1e remain larger (median between 0.2 and 2 seconds).

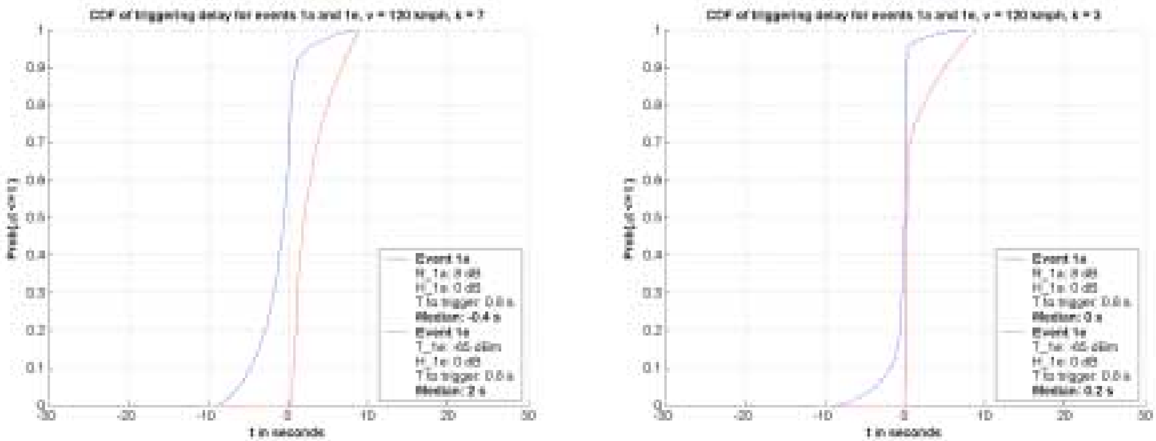

Figure 17 CDFs of triggering delays, v = 120 kmph, k=7 and k=3, correlation length 20 m

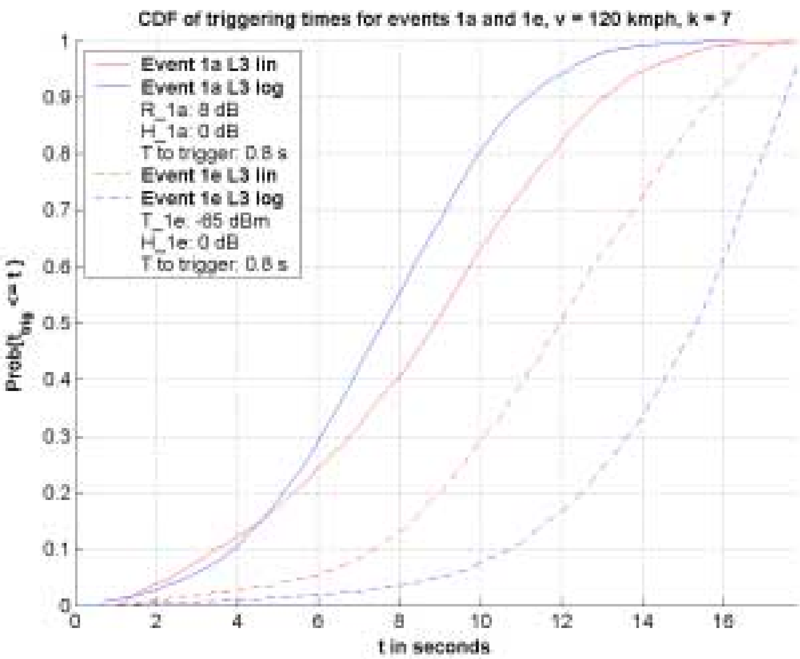

Figure 18 CDF of the absolute trigger times, correlation length 20 m

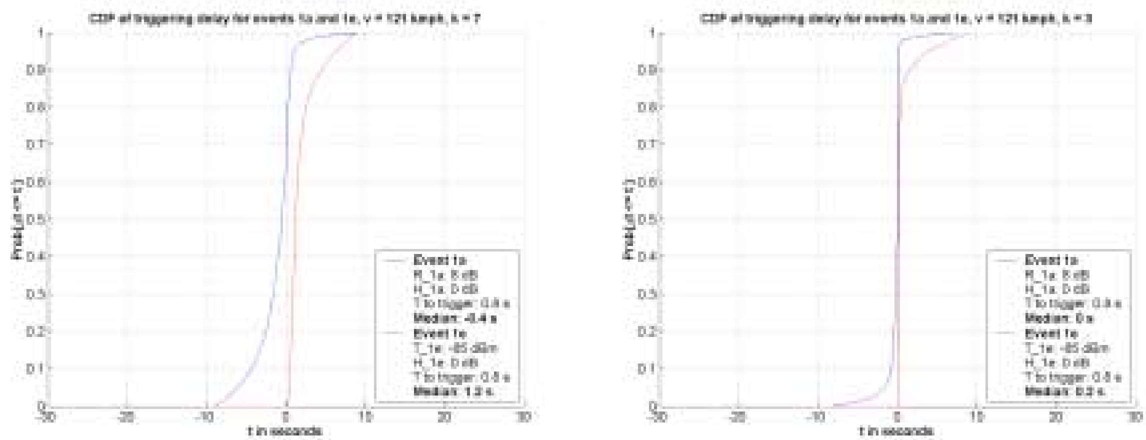

Figure 19 CDFs of triggering delays, v = 121 kmph, k=7 and k=3, correlation length 50 m

5 Conclusion

- It is not possible to estimate triggering delay differences from mean dBm or mean mW values over many simulation runs.
- Statistics of triggering delay differences for many simulation runs have to be collected in order to achieve a good understanding of the actual occurring triggering delays.
- Differences in triggering time for event 1a for linear versus logarithmicL3 filtering are in general quite small and in many cases the median is close to 0 seconds.
- Differences in the triggering time for event 1e can get larger depending on the environment (up to median of 4 seconds)
- For event evaluation (e.g. event 1a), a UE must perform the computation of the triggering criteria based on mW values (for RSCP) or linear ratios (for Ec/io) if the parameter W is not equal to 0. This is very clearly stated in TS 25.331. Therefore, a UE implementation needs to calculate linear values before event evaluation in any case. Therefore, complexity cannot be a reason to do L3 filtering in the logarithmic domain.

Therefore, it is recommended to perform L3 filtering for CPICH_RSCP, CPICH_EcIo and pathloss in the linear domain. UTRA Carrier RSSI and UE Tx Power could be done in logarithmic domain.

References

[1] Nokia: R4-021484 “L3 filtering”, 3GPP RAN WG4 meeting #25, Secaucus, NJ, USA, November 2002.

[2] Motorola: R4-021479 “Unit of layer 3 filtering”, 3GPP RAN WG4 meeting #25, Secaucus, NJ, USA, November 2002.

[3] Qualcomm: R4-021534 “L3 Filtering”, 3GPP RAN WG4 meeting #25, Secaucus, NJ, USA, November 2002.

[4] Ericsson: R4-021446 “Discussion on Linear or Logarithmic L3 Filtering”, 3GPP RAN WG4 meeting #25, Secaucus, NJ, USA, November 2002.

[5] Nokia, NTT-DoCoMo: R4-030113 “Comparison of linear and dB scale L3 filters”, 3GPP RAN WG4 meeting #26, Madrid, Spain, February 2003.