TSG-RAN Working Group 1 meeting #15 **TSGR1#15(00)1029**
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Agenda item: Release 2000 issues / AH22
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Title: Clarification of UE battery life calculations
Document for: Discussion & Decision

1. Introduction

In our last contribution on DPCCH gating, R1-00-0856, we showed UE battery life improvement calculations. Questions were received from the WG1 group, what was the exact model on which the calculations were based on .
We clarify here the assumptions and models that were used in the battery life calculations.

2. Assumptions and models used in battery life calculations

2.1 Packet model

The same packet model was used as described in our contribution R1-00-0686. The figure 1 shows the structure of the packet session, where:

Tp = average duration of one packet call.
Tcr_dch = connection release time for DCH only case.
Tcr_dsch = connection release time for DSCH+DCH case.

One interesting point here is that Tcr_dsch can be quite large, larger than Tcr_dch, which means that it can be so long the connection does not have to be released between each packet call. This is because DCH associated with DSCH could use quite high spreading factor, e.g. SF=256. However, it does not make any difference to the battery life calculations. Meaning , that if the simplified assumption is that gap between two packet calls is equal or larger than Tcr_dch or Tcr_dsch, then following model, explained below can be used in the battery life calculations.

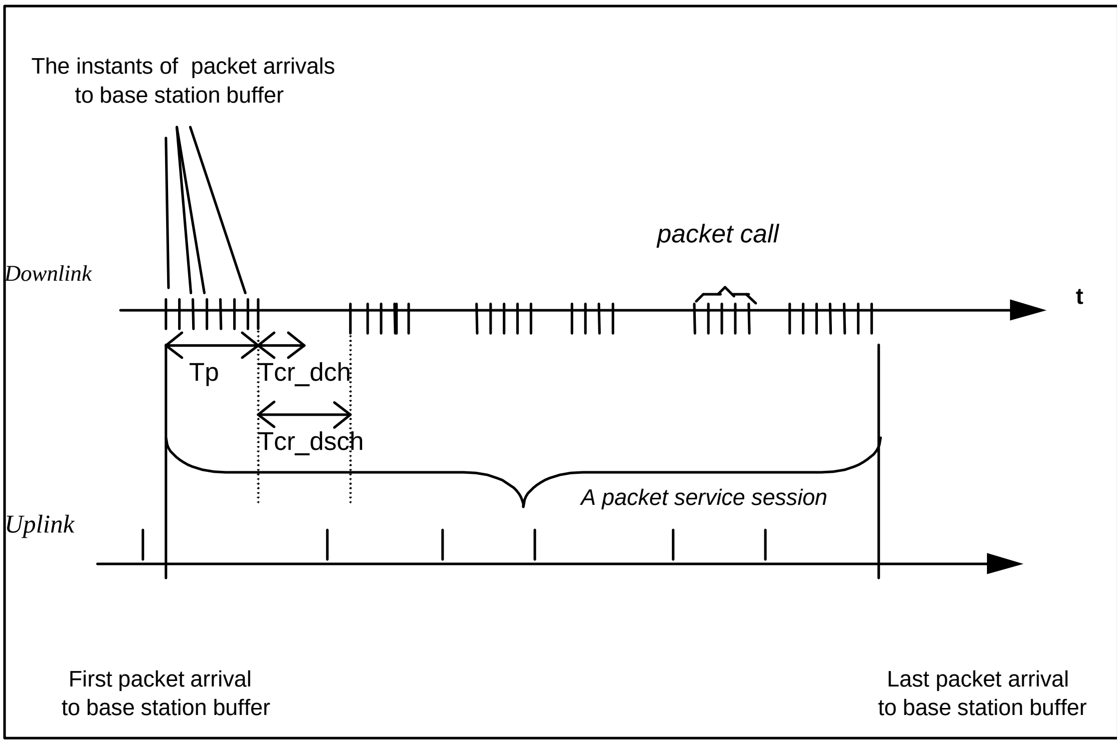

Figure 1. Packet model

Figure 2 shows the timing model, how the gating is assumed to be turned on in the battery calculations. Here Tgat_on is the time after the last packet when the gating is turned on . Note that Tgat_on should be larger than the time interval between individual packet bursts within Tp. Thus the percentage of time that the gating is on during the whole connection is

For DCH only case: $$DPCCH\_gating\_\% = \frac{Tcr\_dch - Tgat\_on}{Tp + Tcr\_dch}$$

For DCH+DSCH case: $$DPCCH\_gating\_\% = \frac{Tcr\_dsch - Tgat\_on}{Tp + Tcr\_dsch}$$

In Tdoc 686 it was roughly calculated with these equations, that the percentage of time the DPCCH gating could be on, on average:

For DCH only case: DPCCH_gating_% = 0.30
For DCH+DSCH case: DPCCH_gating_% = 0.66

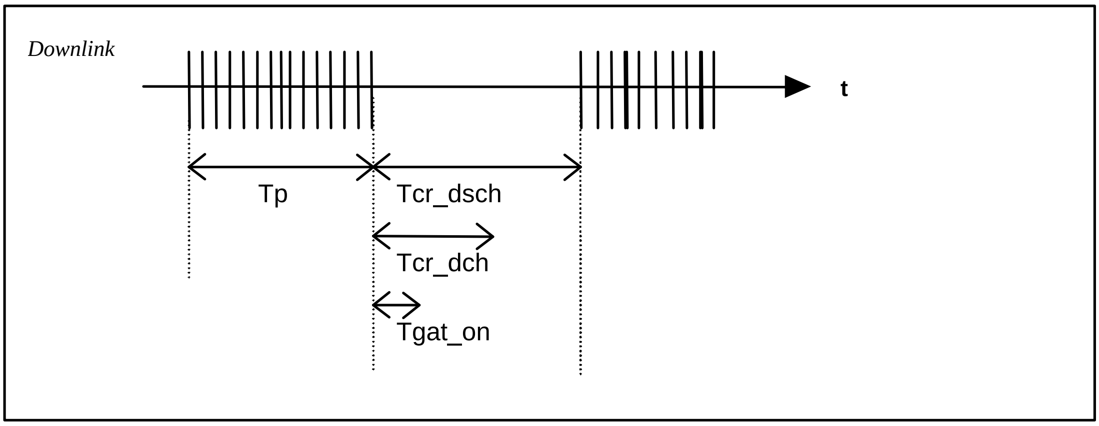

Figure 2. Timing for turning the gating on.

2.2 Assumptions in UE battery life calculations

Following assumptions were used in the simplified UE battery life calculations in our previous contribution , tdoc R1-00-0856.

1) First it was assumed what is the percentage of battery consumption of tx side and rx side, respectively, for certain tx power level, when gating is not used. Let's say that with tx power level , txpwr, this results in :

    - tx side consumes N1 mA @ txpwr
    - rx side consumes N2 mA @ txpwr

    No specific data rates were assumed here either in uplink or downlink, for simplification. This is because data rate change in downlink was assumed not to affect the battery consumption so much. The continuous decoding is needed anyway in downlink, since the packet transmission can assumed to restart in any frame and handover measurements are running continuously. If continuous decoding in every frame could be avoided, then we could assume clearly a different figure for rx side battery consumption during gating state, but until then, the same value N2, is assumed for rx side throughout the whole connection.

2) Then it was calculated , what is the tx side battery consumption , if tx gating is used. Separate values were calculated for 1/3 gating and 1/5 gating, with the same corresponding tx power level tx pwr. This resulted in following value:

    - tx side consumes N1_gating mA, during gating @ txpwr

3) Finally it was calculated what is the overall battery life improvement:

$$Battery\_life\_improvement = \frac{N1 + N2}{(1 - DPCCH\_gating\_\%) \cdot N1 + DPCCH\_gating\_\% \cdot N1\_gating + N2}$$

3. UE battery life improvement calculations

The battery life improvement calculations from [R1-00-0856] are repeated here once more , for clarification.
Table 1 and 2 show UE battery lifetime improvements for DCH and DCH+DSCH case, for medium range tx pwr level and high tx power level, respectively.

Thus the only difference in calculating DCH case and DCH+DSCH case, is the value used for DPCCH_gating_% value.

	DPCCH_gating_%	Gating rate	UE battery life improvement
DCH	30 %	1/3	8 %
		1/5	13 %
DCH+DSCH	66 %	1/3	21 %
		1/5	34 %

Table 1. UE battery life improvement due to gating, with medium range tx power level.

	DPCCH_gating_%	Gating rate	UE battery life improvement
DCH	30 %	1/3	10 %
		1/5	16 %
DCH+DSCH	66 %	1/3	26 %
		1/5	44 %

Table 2. UE battery life improvement due to gating, with maximum tx power level.

The results show that DPCCH gating means clear UE battery life improvement in DCH+DSCH case. For DCH only case it is maybe not as sensible to utilise it.

4. Some other clarifications

Since there has been some misunderstandings and questions, commented in the reflector, that have we been trying to compare the UE battery consumption between DCH case and DSCH+DCH case, we would like to clarify that issue here. So, no, we have not tried to compare the UE battery consumption between DCH case and DSCH +DCH case. We have only calculated separately for each case that how much UE battery life is improved, if the DPCCH gating feature would be in use.

Thus these calculations should be seen as a case study. We should think about case by case, that in which kind of case what kind of features are sensible. Downlink capacity optimisation always comes first , and only if it comes pretty much for free (=no capacity degradance), then we can allow UE battery savings.

We have had following thinking. Let's make a comparison

- DCH with SF=32 (64 kbit/s in downlink). The sensible connection release time is about 3 seconds. Note it is not specified what kind of connection release times the operator is allowed to use, we are just using an example what might be sensible.

- DCH + DSCH case, where DCH is at SF=256. We have been saying that here we could use 10 second connection release time. So it is about 3 times longer connection release time than with DCH only case. So it would be approximately same as reserving SF=256 with 3 multicodes for 3 seconds which is clearly reserving less capacity than reserving SF=32 for 3 seconds. So clearly, it should be no problem of using somewhat longer connection release times in DCH+DSCH case .

If it does not harm the downlink capacity, if the connection release time is quite long with DSCH+DCH case, of course network operators want to use the long connection release time. There is no restriction of not using it. So, here we come to the question, that if the downlink capacity is not dramatically lost by allowing UEs also to save their batteries at the same time , why not allow them to do that. And what also comes pretty much as a free benefit (=no extra capacity degradance), with this longer connection release time, is that we can avoid using RACH in between, thus we get a fast packet transmission system.

If we think about DCH only case, there it is quite out of the question to use very long connection release time, because then the capacity would be wasted, if we would reserve the small spreading factor (e.g. SF=32) from the code tree for very long time. Thus it is just a fact of life, that for the DCH only case you need to do the connection release quite fast, and use RACH in between. We cannot avoid it if we want to optimise the downlink capacity.

5. Conclusion

With the help of DCH+DSCH concept, several packet calls in one packet session can be transmitted during the same connection without connection release between them, and without unnecessary usage of RACH between every packet call. With the help of DPCCH gating concept together with DCH+DSCH concept, we can offer the end user a very flexible and fast packet service in such way, that we do not sacrify the UE battery life too much.

If DPCCH gating would not be specified, the relative long periods (=end user's reading time) between each packet call, will consume UE batteries unnecessarily, which does not make much sense. However, it should be understood, that if operator wants to use long connection release times, he is allowed to do that, since there are no limitations anyway in the specifications, how long the connection release time can be.

We propose DPCCH gating to be an optional feature for the UE . (Of course it will be optional for the NodeB.) There is no reason why it should be mandatory feature for the UE. We should just define the method for the specification. And then it is up to the UE manufacturers, are they interested to save their batteries during DSCH+DCH connection or not.

So then this would mean that there would be an additional UE capability parameter: Support of DPCCH gating. And we could define , that

- for those UE classes where Support of PDSCH=YES, then Support of DPCCH gating=YES/NO
- for those UE classes where Support of PDSCH=NO then Support of DPCCH gating = NO

Note: we should not discuss in this adhoc, that for which UE classes we define Support of PDSCH=YES. That issue should be discussed in a separate adhoc.