

# 8.6.4 Power Control

As far as SEAMCAT is concerned, the actual CDMA power control algorithm looks merely like a black box that maps link quality to channel power. However, the mapping is not simply one-to-one. Depending on the conditions of the mobile user, the same link quality can map to different channel power requirements. A key parameter that determines the condition of a user is called the “geometry”. The higher the geometry, the more favorable the UE’s condition is. The geometry is defined as:

$$G = \frac{P_{active}}{N_0 + P_{other} + I_{ext}} \quad (Eq. 35)$$

with the following definitions:

- $P_{active}$  is the total power received from BS’s in the active set;
- $N_0$  is the thermal noise;
- $P_{other}$  is the total power received from BS’s not in the active set;
- $I_{ext}$  is the external Interference (out of system).

The fractional power levels found in the link level data are defined for each user (channel) as:

$$\frac{E_c}{I_{or}} = \frac{P_{traff\_active}/W}{P_{total\_active}/W} = \frac{P_{traff\_active}}{P_{total\_active}} \quad (Eq. 36)$$

with the following definitions:

- $P_{traff\_active}$  is the total received traffic channel power from BS’s in the active set
- $P_{total\_active}$  is the total power received from BS’s in the active set

$P_{total\_active}$  is the sum of the total received power from the BS’s in the active set including their pilot, overhead and all traffic channels. Whereas  $P_{traff\_active}$  includes only the traffic channel power that is received from the BS’s in the active for the particular user. In other words, a user’s  $E_c/I_{or}$

shows the fraction of the total received power that is used for voice communication with that user. Based on this definition, the amount of traffic channel power received from a BS for a particular user can be derived from the  $E_c/I_{or}$  requirements reported in the link level data.

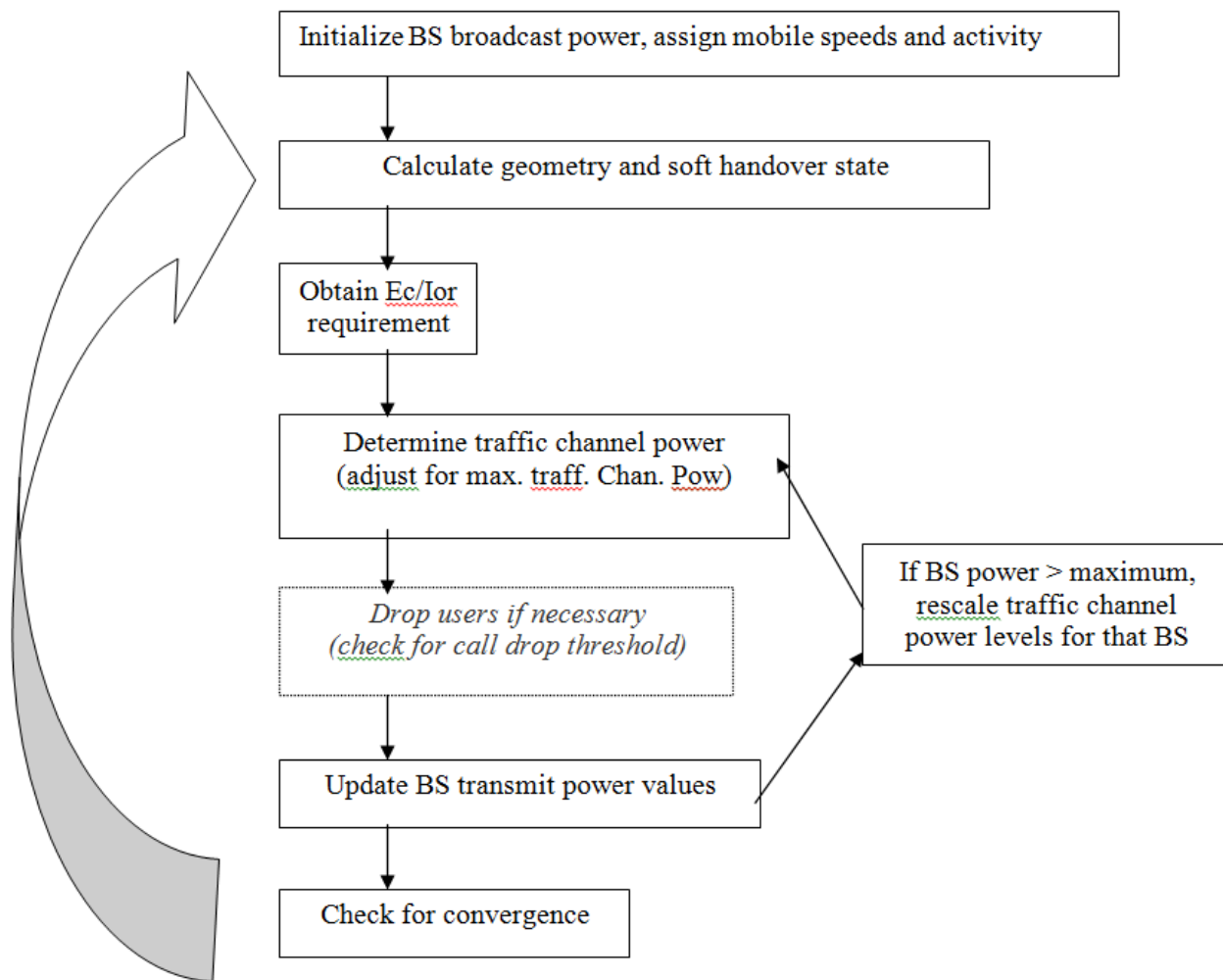
If user has only 1 BS in the active set (simplex), the power received from the BS is:

$$P_{traff} = P_{total\_active} \times E_c/I_{or} \quad (Eq. 37)$$

If user has 2 BS's in the active set (2-way soft handover), power received from one of the BS's is then:

$$P_{traff} = (P_{total\_active} \times E_c/I_{or})/2 \quad (Eq. 38)$$

Note that symmetry between the two soft handover legs (links with BS's in the active set) is assumed. Therefore, when a user is connected to two BS's, it receives equal power from each link. The determination of the traffic channel power levels for each user cannot be done in a single step. The inherent assumption in equations 37 and 38 is that  $P_{total\_active}$  is known. However,  $P_{total\_active}$  itself is the sum of the pilot, overhead and all traffic channel power levels received from the BS's in the active set. Therefore, an iterative process is required to determine the individual traffic channel received power levels.



**Figure 196: Power Control Loop**

Figure 196 shows how the power control loop operates. The initial step is to initialize each BS in the cell layout (figure 1) by assigning total broadcast power levels. A figure around 70% of maximum BS power is appropriate. Note that for the simulated BS's, the total BS power will be updated at each iteration by the power control loop. After enough iterations, the power levels will converge to the correct values.

Once the initialization is complete, geometry and soft handover state for each user can be calculated based on the initial values of the BS broadcast levels. Then the  $E_c/I_{or}$  requirement for each active user can be obtained from the link level data using its mobile speed assignment, calculated geometry and soft handover state. Equations 37 and 38 can then be used to get the received traffic channel power levels for each user. Path loss information can then be used to determine the corresponding transmit channel power levels. However, the calculated transmit traffic channel power levels should be checked against the maximum allowable traffic channel power and transmit/receive levels should be adjusted if necessary. As a result of such an adjustment, a user may not meet its  $E_c/I_{or}$  requirement. Based on a "call drop threshold", such a user may be removed from the system if it meets the following criterion:

$$Achieved E_c/I_{or} < E_c/I_{or\text{requirement}} - Call\text{drop}\text{threshold}(dB) \quad (Eq. 39)$$

The call drop threshold is set such that dropping a call is limited to extreme circumstances (thresholds less than 2dB are not recommended) and kept mostly as a safety measure to avoid a single user hogging the BS resources. In an actual system, calls are not dropped at the instant they fail to meet their link quality target. The system will tolerate quality degradation up to certain durations and at the same time avoid a single user to sacrifice the overall system performance by consuming all the BS resources (max. traff. chan. pow. setting). In fact, for systems that employ sufficient control of maximum traffic channel power, call drops may be avoided completely within the power control loop. Eventually, users not meeting their  $E_c/I_{or}$  target will be evaluated when the success rate of the system is calculated.

Once the transmit traffic channel levels are calculated, the broadcast power of each BS should accordingly be updated. If the total broadcast power of a BS turns out to be greater than its maximum allowable level, all traffic channels served by that BS should be scaled down so that the maximum BS power constraint is met. The scaling factor that should be applied to the traffic channel power levels can easily be calculated as:

$$Scaling = \frac{P_{max} - (pilot\_frac \times P_{max}) - (overhead\_frac \times P_{max})}{P_{calculated} - (pilot\_frac \times P_{max}) - (overhead\_frac \times P_{max})} \quad (Eq. 40)$$

where:

- $P_{max}$  is the maximum allowable BS power
- $P_{calculated}$  is the actual calculated BS broadcast power (including pilot and overhead).

Scaling is only done if  $P_{calculated} > P_{max}$  and it is done only on the traffic channels; pilot and overhead power levels remain at a constant percentage of the maximum allowable BS power. For channels that go through the scaling, achieved  $E_c/I_{or}$  levels may not match the required  $E_c/I_{or}$  levels. Therefore, call drop criterion (if used) shown in equation 6 should also be checked after the scaling. The process is outlined in Figure 199.

This process describes a single iteration of the power control loop. After all the traffic channel power levels are determined and the BS levels are updated, the process should be repeated (with the new, more accurate BS broadcast levels). Convergence of the traffic channel power levels should be checked at the end of each iteration. The loop can be terminated once the traffic channel power of every simulated user in the network converges to the desired precision.

Signaling and other errors in power control are considered in the link level simulations. System level simulations do not consider additional errors and assume that each user is served with the required power level that is determined from link level data, provided that the BS has enough power to do so and the maximum traffic channel limit is not exceeded.

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