Proposal for IEEE 802.16m Uplink Power Control

Document Number: IEEE C802.16m-08/613r1

Date Submitted: 2008-07-15

Source:

Sophie Vrzic, Mo-Han Fong, Jun Yuan, Robert Novak, Dongsheng Yu, Hosein Nikopourdeilami, Sang-Youb Kim, Kathiravetpillai Sivanesan

Nortel Networks E-mail: svrzic@nortel.com, mhfong@nortel.com

*<http://standards.ieee.org/faqs/affiliationFAQ.html>

Re: IEEE 802.16m-08/024 – Call for Contributions on Project 802.16m System Description Document (SDD), on the topic of "UL Power Control"

Purpose: Adopt the proposal into the IEEE 802.16m System Description Document

Scope

- This contribution proposes a uplink power control scheme for IEEE 802.16m.
- The new scheme is an IoT based power control method, which can be combined with FFR to further improve coverage.

IEEE 802.16m System Requirements

- The TGm SRD (IEEE 802.16m-07/002r4) specifies the following requirements:
  - Provide support for FFR (A.2.2)
  - Section 7.1.1 Relative Performance
    - DL cell edge throughput should be greater than 2 times the reference system
- The proposed scheme is an IoT based power control scheme that can make use of UL FFR zones to improve coverage and overall performance.

Overview of Uplink Power Control

- In IEEE.16e, there is both open loop and closed loop power control.
- However, in both cases, the MS power is determined without considering the amount of interference that is caused to neighbouring sectors.
- In order to reduce the amount of interference caused by interfering cell edge mobiles, base stations can use parameters related to loading such as the interference over thermal (IoT) to either increase or decrease the loading in other cells.
- This method of IoT control can be combined with zone based interference management or FFR to further improve cell edge coverage.
  - With interference management, the bandwidth can be divided into zones where the loading is unrestricted on one of the zones and restricted on the remaining.
  - A coverage gain is obtained when different sectors define a different zone for unrestricted IoT loading.
- This IoT based power control method can be used with either closed loop or open loop power control.

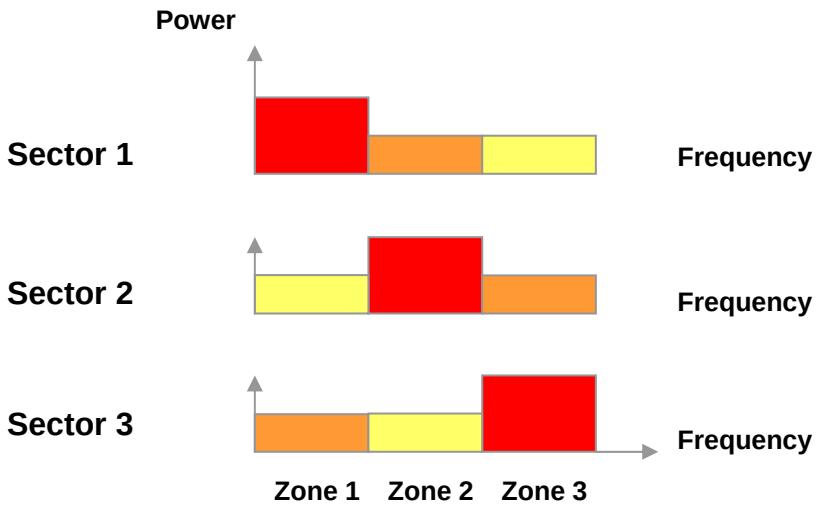
Uplink Power Control (1/2)

- Open loop power control is used when the MS does not have a dedicated UL feedback channel (e.g. Fast feedback control channel)
- In open loop power control, the MS determines its transmit power based on an equation that includes both MS and sector specific parameters.
  - The equation is given by $P_{TX} = L_s + (N+I) + CINR_{data} + \Delta_{BS} + \Delta_{MS}$
  - The value L_s is the path loss to the serving sector, N+I is the noise plus interference term that is broadcast by the BS, $CINR_{data}$ is the target CINR and Δ_{BS} and Δ_{MS} are BS and MS specific offsets.
- In closed loop power control, the UL fast feedback control channel for each MS is power controlled to achieve a target SINR.
  - The MS adjusts its transmit power based on the power control commands that it receives from its serving sector.
  - The MS calculates its power headroom based on the transmit power used for the fast feedback control channel and based on a maximum transmit power.
  - The maximum transmit power can be different for different FFR zones.
  - Both and inner loop and an outer loop can be used to target the mobile's SINR.

Uplink Power Control (2/2)

- In both open and closed loop power control, the MS reports its power headroom via the UL control channel. The power headroom is given by the equation $P_{HR} = P_{max} – P_{TX}$ (dB).
  - Pmax is the maximum power that the MS is allowed to transmit. The value is different for different MS and can be different for different FFR zones.
- The BS uses the mobile's power headroom and the received SINR on the UL control channel to assign an MCS.
  - In open loop power control, the SINR is measured on the bandwidth request channel.
  - In closed loop power control, the SINR is measured on the UL fast feedback control channel.
  - The received SINR on the control channel, $SINR_{control}$, can be the instantaneous SINR or an average SINR measured by the BS.
- The mobile's power headroom is used to calculate the target SINR for data.
  - The target SINR is given by $SINR_{data} = SINR_{control} + P_{HR}$ (dB)
- The assigned MCS is determined using the target SINR for data.

Uplink Power Control with FFR



- In the above figure, each sector in a cell has an IoT unrestricted zone and two restricted IoT zones.
- The zones represent logical tones, which are contiguous in the case of an AMC channel and are spread out over the entire bandwidth in the case of a diversity channel.
- In order to achieve a coverage gain, each sector in a cell uses a different zone for the unrestricted IoT region.
- Cell edge users can be scheduled in the serving sector's unrestricted IoT zone. Since the neighbouring interfering sectors schedule cell centre users in this zone, the channel condition improves for the cell edge users.

Operation of IoT Based Power Control (1/2)

- Each sector periodically broadcasts the loading threshold for each IoT zone.
  - There can be one or more IoT controlled zones (FFR zones).
  - The loading threshold can be adapted to target a specific interference over thermal (IoT) value.
- A mobile reports its power headroom on each zone by taking into account the other sector's loading threshold.
- The power headroom is given by the equation

$$P_{HR} = P_{\max} - P_{TX}$$

- The value P_{max} is determined from the loading threshold of non-serving sectors.
- The value P_{TX} is the mobile's transmit power when transmitting either the fast feedback control channel or a bandwidth request.

Operation of IoT Based Power Control (2/2)

- The mobile periodically measures the path loss to the other sectors in its active list. The estimated received power to the interfering sector is given by

$$P_{RX,i} = P_{\max} - L_i$$

- If an interfering sector reports a loading threshold of $I_{thresh,k}$ for zone *k* then the following condition must be satisfied

$$I_{thresh,k} > P_{RX,i}$$

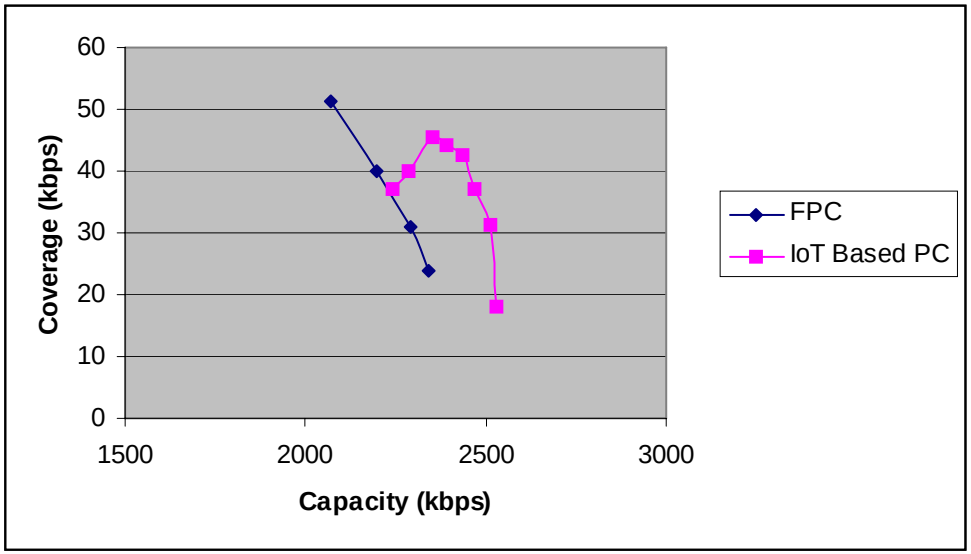
- If the above condition is violated then the mobile adjusts its reported power headroom on zone *k* using the following equations.

$$\Delta_k = P_{RX,i} - I_{thresh,k}$$

$$P_{\max,k} = P_{\max} - \Delta_k$$

$$P_{HR,k} = P_{\max,k} - P_{TX}$$

Performance Comparison



- The IoT based power control method achieves a higher capacity and improved coverage compared with the fractional power control method (FPC).
- The improved performance is due to a smaller IoT variance compared with the FPC method.
  - For FPC the variance is between 1.6 and 3.6 dB
  - For IoT based PC the variance < 1 dB

Summary

- The proposed uplink power control scheme can be used with either closed loop or open loop power control.
- Closed loop power control is used with the mobile has been assigned an UL fast feedback control channel.
- Open loop power control is used when the mobile does not have a dedicated UL control channel.
- The new scheme controls the amount of interference generated to neighbouring BS and can be used with or without FFR.
- The IoT based method significantly improves both capacity and coverage compared with the FPC method.

Proposed Text for SDD

- Section 11.x UL Power Control
  - [*Add content of slide 5 to this section*]
- Section 11.x.1 UL Power Control with IoT Load Control
  - [*Add content of slides 6, 7 to this section*]
- Section 11.x.2 UL Power Control and FFR
  - [*Add content of slide 8 to this section*]
- Section 11.x.3 Operation of IoT Based Power Control
  - [*Add content of slides 9 and 10 to this section*]