Uplink Interference Coordination/Control for 802.16m

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Re:
TGm Call for comments on SDD, IEEE 802.16m-07/040

Abstract:
Discussed the functional of uplink interference coordination and control for 802.16m

Purpose:
Discussion and adoption of functional area into SDD outline

UL Interference Coordination/Control

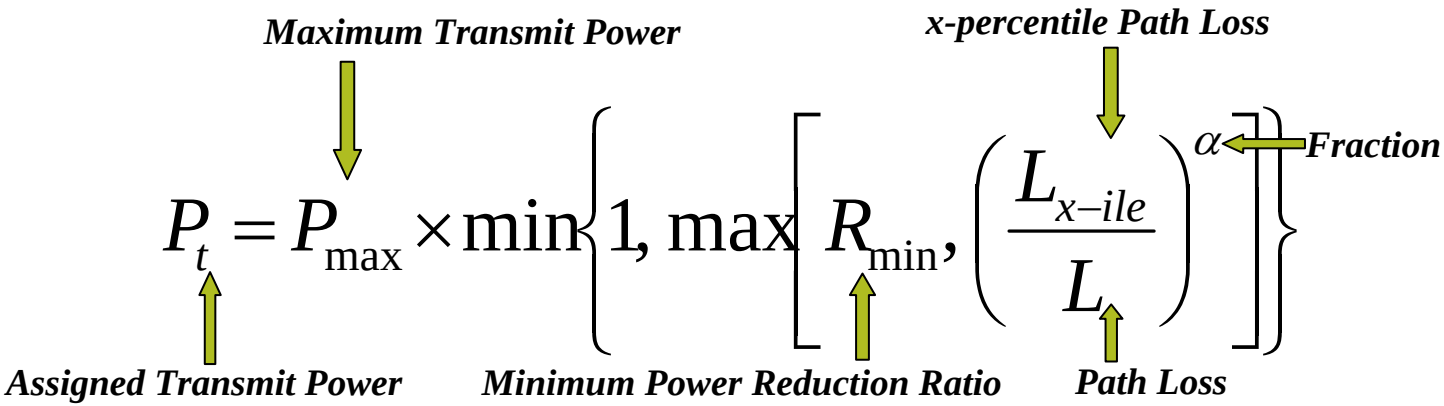
- IoT control is critical for 802.16m
  - **MS battery life**
  - **Cell edge coverage/performance**

- Fractional power control (FPC) compensates a fraction of the path loss and shadowing
  - **Tradeoff between cell edge performance and overall sector SE**

- To tightly control IoT, neighbor APs need to share uplink performance metric e.g. IoT, UL quality etc.
  - **Through Backhaul message**
  - **AP then adapts the parameters of FPC formula and broadcast them to the UE's**

- UL interference control can be done through
  - **Each AP sends slow updates to power control UL transmission.**
    - **E.g. using UL grant message**
  - **Alternatively, each MS can derive its own transmission power and MCS according to the path loss measurement from downlink pilot.**

Fractional Power Control Scheme



- $1>\alpha>0$ is the PC fraction for MSs with bad channel and MSs with good channel.
  - $\alpha=0 \Rightarrow$ All MSs transmit at full power: high interference level and poor edge performance.
  - $\alpha=1 \Rightarrow$ Traditional slow power control: all MSs received at the same power with poor spectral efficiency.
- α can be adjusted based on e.g. IoT, UL performance etc. of neighbor cells for good edge coverage performance and high spectral efficiency.
  - MSs with good channel condition transmit at relatively low power level to reduce interference level.
  - At the same time, MSs with good channel condition are received at relatively high power level to achieve high spectral efficiency.

System Simulation (an example)

- 3 reference simulation cases

Simulation Cases	ISD (m)	PLoss (dB)	Speed (km/h)	Traffic Type Used
1	500	20	3	Full-buffer
2	500	10	30	Full-buffer
3	1732	20	3	Full-buffer

- 10 MHz system bandwidth
- 10 mobiles per sector with 8 maximum scheduled per 0.5ms sub-frame

Parameter		Assumption
Cellular Layout		Hexagonal grid, 19 cell sites, 3 sectors per site
Inter-site distance (ISD)		500m, 1732m
Distance-dependent path loss		$L=I + 37.6\log_{10}(.R)$, R in kilometers I=128.1 – 2GHz
Lognormal Shadowing		Similar to UMTS 30.03, B 1.41.4
Shadowing standard deviation		8 dB
Correlation distance of Shadowing		50 m
Shadowing correlation	Between cells	0.5
	Between sectors	1.0
Penetration Loss		10, 20dB
Carrier Frequency		2.0GHz
Channel model		Typical Urban (TU)
UE speeds of interest		3 & 30 km/h
Total BS TX power		43dBm
UE power class		24dBm
Inter-cell Interference modeling		UL: Explicit modelling (all cells occupied by UEs),
Min distance between UE and cell		>= 35 meters

Comparison of PC Schemes

Case	Sector Throughput (Kbps)			5%-ile User Throughput (Kbps)		
	Fractional PC	Regular PC	Full Power	Fractional PC	Regular PC	Full Power
1	7294	5892	7424	172.5	187.1	92.6
2	7452	6288	7199	209.0	243.1	224.9
3	5859	4638	6505	15.9	15.3	6.70
5	2870	2077	2959	6.41	4.92	2.98

- Fractional power control compared with regular power control and full power transmission:
  - Fractional power control provides the best tradeoff between the spectral efficiency and cell-edge performance.

Conclusions

- Fractional power control scheme can be applied for 802.16m UL interference coordination/control
- Inter-cell interference control through backhaul messaging
- Significant gains in term of simultaneous cell edge performance and sector throughput over regular and full power schemes.
- Tightly control of IoT is achievable through fractional power control

Proposal to 802.16m SDD

- **Include the following components in the SDD ToC**
  - Uplink interference coordination and control