

# Uplink Interference Coordination/Control for 802.16m

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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

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# 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

$$P_t = P_{\max} \times \min \left\{ 1, \max \left[ R_{\min}, \left( \frac{L_{x-ile}}{L} \right)^\alpha \right] \right\}$$

*Maximum Transmit Power* (points to  $P_{\max}$ )  
*Assigned Transmit Power* (points to  $P_t$ )  
*Minimum Power Reduction Ratio* (points to  $R_{\min}$ )  
*x-percentile Path Loss* (points to  $L_{x-ile}$ )  
*Path Loss* (points to  $L$ )  
*Fraction* (points to  $\alpha$ )

- $1 > \alpha > 0$  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.
- $\alpha$  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 $I=128.1 - 2\text{GHz}$
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		$\geq 35$ 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