Optimal channel allocation for wireless cities

Keith Briggs & Martin Tijmes

Complexity Research Group
BT Innovate

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Wireless cities
Branch-and-bound
Channel optimization
802.11b spectral characteristics

- a *channel assignment* is a vector $x \in \mathbb{Z}^n$, meaning that $x_i$ is the channel used by node $i$
802.11b spectral characteristics

- a *channel assignment* is a vector \( x \in \mathbb{Z}^n \), meaning that \( x_i \) is the channel used by node \( i \)
- vector of overlap factors:
  \[
  [0, -2.767, -11.329, -28.525, -45.296, -61.560, -74.686, \ldots]
  \]
802.11b interference

- the interference at node $j$ caused by node $i$ is

$$I_{ij} = r_{ij} + c(|x_i - x_j|)$$

where

$$r_{ij} = T_j - \left(P_{\text{ref}} + 10m \log_{10}(d_{ij})\right) \text{dBm}$$

is the received power at node $i$ from node $j$. 

- $d_{ij}$ is the distance from node $i$ to node $j$.
- $T_j$ is the transmit power, typically 20dBm (100mW).
- $P_{\text{ref}}$ is the reference loss at 1m, typically 40.2dB.
- $m$ is the path loss exponent, typically about 2.86.
802.11b interference

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  $$w_i = \log_{10} \max_{j=1, \ldots, n, j \neq i} \exp(I_{ij} \log(10))$$

- the *objective function* is $w(x) = \max_i w_i(x)$; that is, the worst maximum interference at any AP
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Local best-first search

- Branch-and-bound
  - Exact and enumerative method
- Combination depth-first and best-first
  - Depth-first: find feasible solution fast
  - Best-first: find best solution fast
Speed-up tricks [1]

- Complementary solutions
  - Symmetric channels
  - Omit similar assignments
- Channel spacing
  - Reduce channel overlap and number of channels
  - Reduce complexity
- Pre-ordering
  - Critical access points first
Speed-up tricks [2]

- Initial random solution
  - Find a good upper bound for pruning
- Incremental objectives
  - Reduce time complexity
  - Only applicable on certain objectives
- Symmetric AP distance matrix
  - If measuring point is at AP
  - Transmit power is left out
Results [1]

Comparison of the throughput area

Modulation schemes: 11Mbps, 5.5Mbps, 2Mbps, 1Mbps

(a) 20 APs using the same power level and channel
(b) 20 APs with randomly assigned channels
(c) 20 APs using the same power level, but with an optimized channel allocation (13 channels)
Results [2]

Comparison of two objectives

Channel spacings: 1 (red), 2 (green), 3 (blue), 4 (magenta), 5 (cyan), 6 (dotted red)

Minimizing the average interference

Minimizing the maximum interference