Criteria for Network Capacity

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This contribution proposes criteria for network-level evaluation of 802.20 air interfaces.

• Comments on single-cell Link-Level analysis

• A setting for network-level evaluation
  • A simple topology with realistic levels of inter-cell interference.
  • A proposed parameterization for “loading” the network

• Proposed statistics for evaluation
  • Minimum service level
  • Aggregate throughput
  • Spectral efficiency
Link-Level Analysis

• One (or more) users, single-cell.

• Useful for understanding many aspects of the air interface. Examples:
  • Maximum data rate, peak spectral efficiency
  • Maximum number of co-channel users
  • Noise-limited range

• Limitation: not easily generalized to a network-level setting.

It is essential to understand how 802.20 systems behave in a network setting if the goal of ubiquitous coverage is to be achieved.
Network-Level Analysis

- **Topology:** Hexagonal tessellation of cells
- **Parameterization by the *Load/Coverage Operating Point***
  - Network Load: number of active users/cell
    - Stresses the system under interference
  - Coverage: Inter-basestation separation
    - Stresses the system due to pathloss, propagation, etc

- **An active user is defined as:**
  - a terminal that is registered with a cell
  - and is using or seeking to use airlink resources to receive and transmit data within the simulation interval.

*The goal is to evaluate the ability of the air interface to serve information to its active users at a given load/coverage operating point.*
The network capacity is evaluated for a fixed load/coverage operating point with statistics gathered from the interior cell.
Two tiers of interfering users to fully stress the system

<table>
<thead>
<tr>
<th>Tiers surrounding the center cell</th>
<th>Total Cells</th>
<th>Interior Cells for collecting statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>19</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>37</td>
<td>7</td>
</tr>
</tbody>
</table>

Other parameters: fixed and stochastic parameters
- Fixed: Base station heights, TX power, RX noise figure, etc.
- Stochastic: propagation model, etc.
Monte-Carlo simulation for fixed load/coverage (N,S)

Collected Statistics:

- Per-user throughput: $T(N,S)$:
  Definition: number of correctly received information bits divided by the simulation time-interval.

- Aggregate throughput: $A(N,S)$:
  Definition: sum of the throughputs to all the users in the cell.

Cumulative Result:

- A *service distribution* on the ensemble of stochastic parameters.
The minimum service level $T(N,S)$ is the throughput guaranteed for a specified fraction of the cell users.
• The *service distribution* characterizes performance for a *fixed* load/coverage operating point (N,S).

• Contours of constant value for a statistic of interest can effectively visualize results on the (N,S) space.

  Examples:
  • Minimum Service Level
  • Aggregate Throughput
Performance under varying Load/Coverage (2)

Example: contours of constant minimum service level.
Spectral Efficiency

- **Spectral efficiency** is defined as the expected value of aggregate throughput ($A_{DL}$) divided by the effective bandwidth ($BW_{DL}$):

\[
\eta_{DL} = \frac{A_{DL}}{BW_{DL}} \text{ bits/sec/Hz/Cell}
\]

- The **effective bandwidth** is the fraction of the total bandwidth allocated to UL, DL.

- Total spectral efficiency is similarly defined:

\[
\eta_T = \frac{A_{UL} + A_{DL}}{BW_{UL} + BW_{DL}} \text{ bits/sec/Hz/Cell}
\]
Conclusions

• **Network-level and Link-level results:**
  • Enumeration of input parameters and assumptions is required for proper interpretation
  • Parameterization as load/coverage operating point

• **Proposed statistics for network-level evaluation:**
  • Service distribution
  • Minimum service level
  • Aggregate Throughput

• **Spectral efficiency:**
  • Well-defined in terms of aggregate throughput
  • Most meaningful in the setting of a loaded network
  • Can be parameterized by the load/coverage operating point