C802.20-03/56

Criteria for Network Capacity

802.20 meeting #2
March 12-16, 2003
Dallas, TX

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Outline

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.

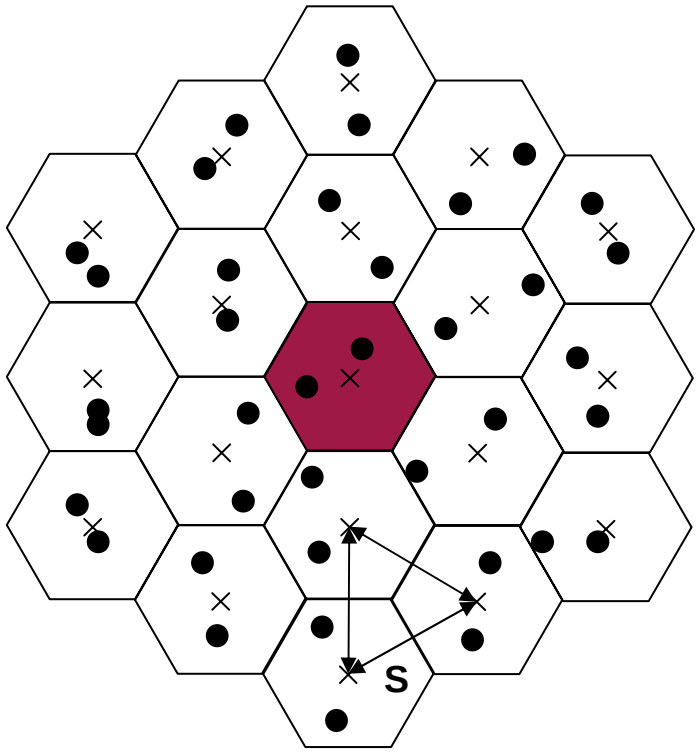
Network-Level Analysis

- **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.

802.20 Network: Network Operating Point (Load/Coverage)



Example:

- **Load (N):**
  - N active users/cell
  - Uniformly distributed across cell area
- **Coverage (S):**
  - S = inter-BS separation
  - Uniform across the entire network
- **Simulation:**
  - Monte-Carlo on placement of all users
  - All users (19 cells)
  - Output statistics
    - Gathered from interior cell only
    - Sampled separately in UL, DL directions.

The network capacity is evaluated for a fixed load/coverage operating point with statistics gathered from the interior cell.

802.20 Network: Network Operating Point (Load/Coverage)

- **Two tiers of interfering users to fully stress the system**

Tiers surrounding the center cell	Total Cells	Interior Cells for collecting statistics
2	19	1
3	37	7

- **Other parameters: fixed and stochastic parameters**
  - Fixed: Base station heights, TX power, RX noise figure, etc.
  - Stochastic: propagation model, etc.

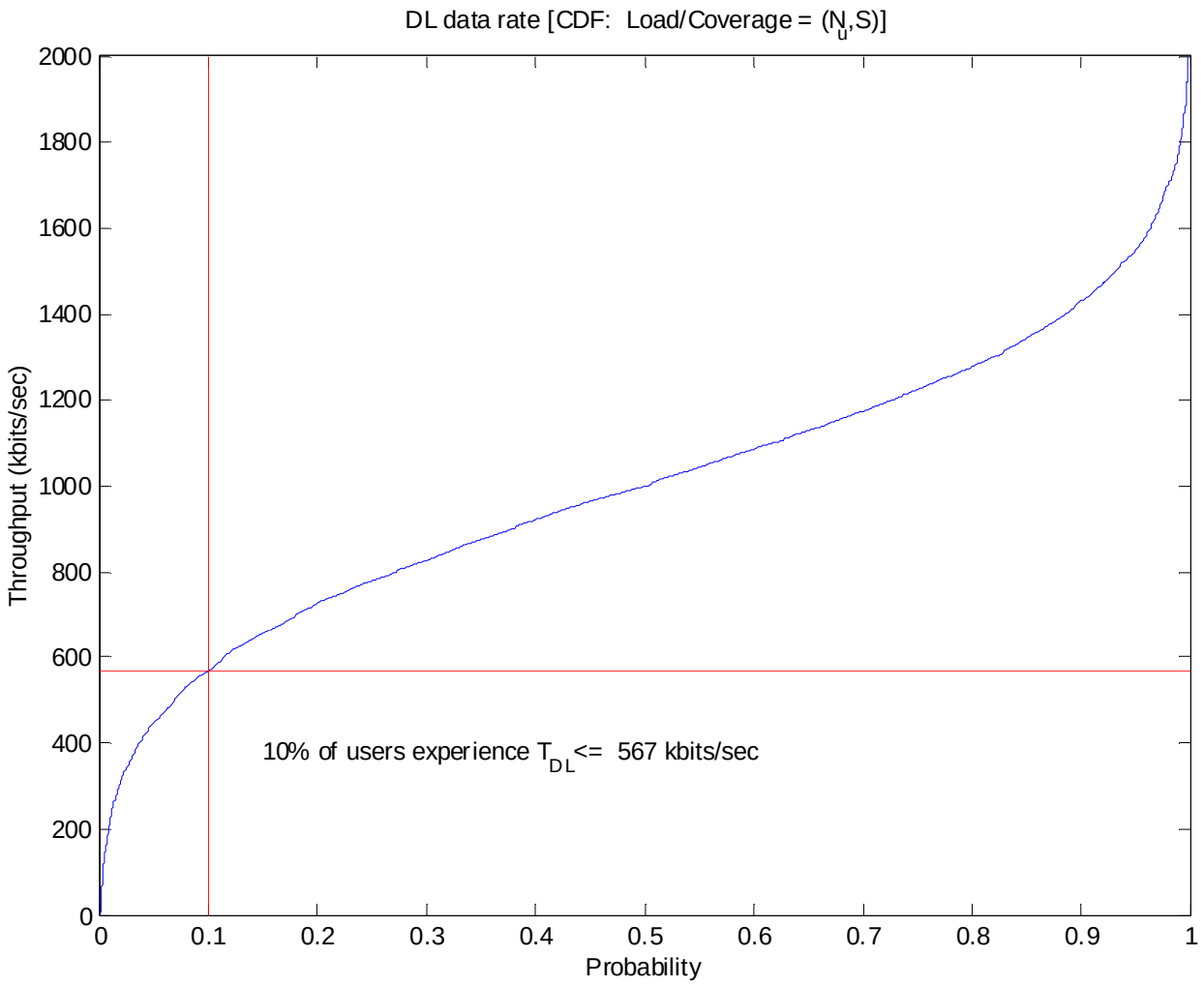
Statistical Measures

- **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.

Statistical Measure: Minimum Service Level



The *minimum service level* T(N,S) is the throughput guaranteed for a specified fraction of the cell users.

Performance under varying Load/Coverage

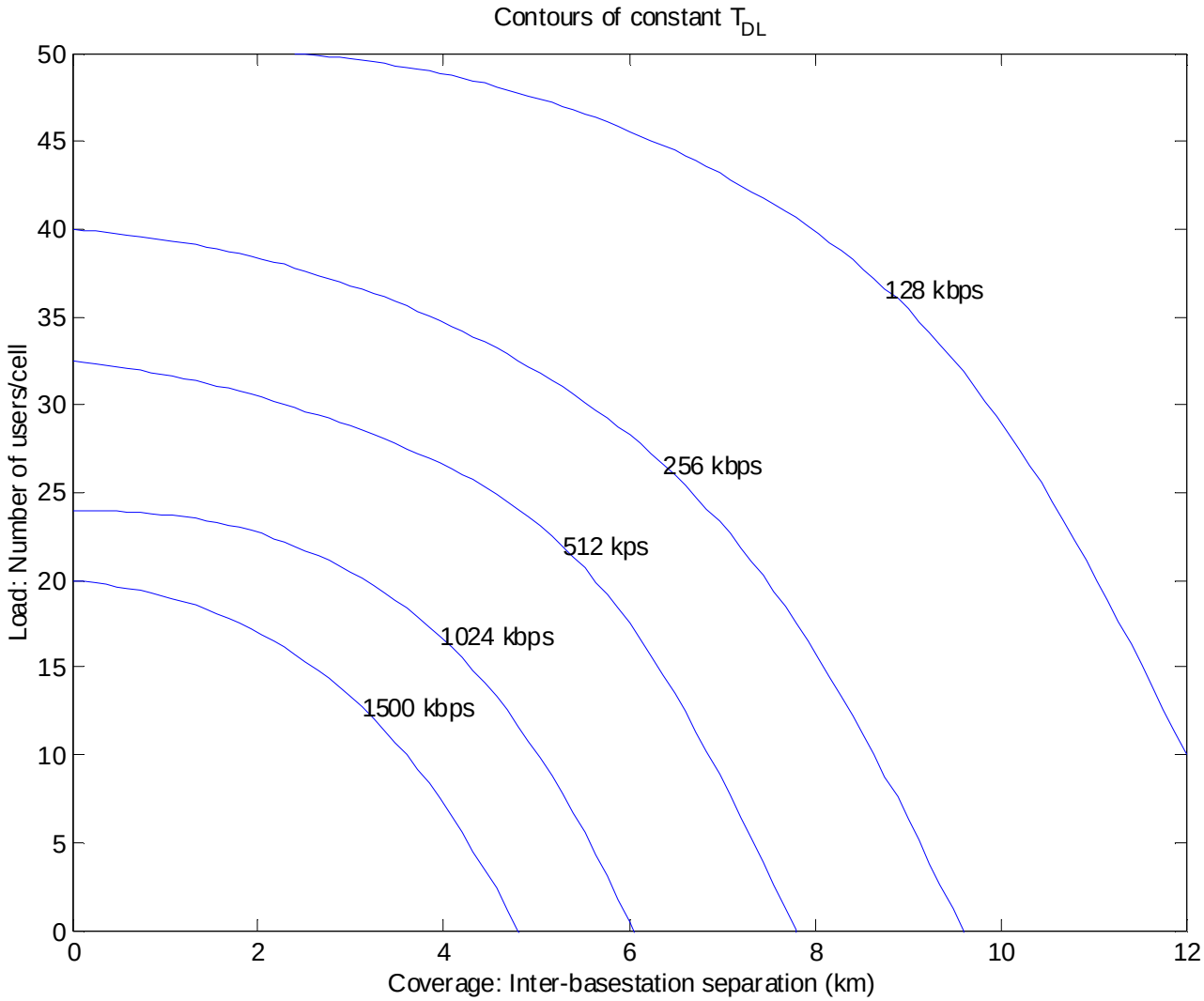
- **The *service distribution* characterizes performance for a *fixed* load/coverage operating point (N,S).**

- **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}):**

$$\eta_{\mathrm{DL}} = \frac{A_{\mathrm{DL}}}{BW_{\mathrm{DL}}} bits/\mathrm{sec}/Hz/\mathrm{Cell}$$

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

- **Total spectral efficiency is similarly defined:**

$$\eta_T = \frac{A_{UL} + A_{DL}}{BW_{UL} + BW_{DL}} bits/\mathrm{sec}/\mathrm{Hz}/\mathrm{Cell}$$

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