
INDEX

- 95% likely throughput, 118, 130
- base station assignment, 124
- base station cooperation, 11, 160
- beamforming gain uncertainty, 56, 61, 64–67
- capacity
 - bounds, 36–41
 - ergodic, 39
 - max-min, 187
 - sum, 187
- capacity region, 187
- channel
 - broadcast, 185, 190–194
 - multiple-access, 185, 187–190
 - nullspace, 160
 - point-to-point, 36–41, 176–185
 - scalar, 36–41, 176–182
 - singular values, 142–143, 147
 - stationary, 117
- channel capacity, 36
 - instantaneous, 51
 - instantaneous ergodic, 51
- channel estimation, 45–48, 78
 - error, 47
 - estimation error, 79
 - MMSE, 47, 78
- channel hardening, 11–15, 40, 154
- channel non-orthogonality, 54, 55, 61, 64–67
- channel state information, 6
- circularly symmetric Gaussian, 19, 163–167
 - linear transformation, 166
 - moments, 167
- coherence bandwidth, 21–22, 129, 130
- coherence interval, 15, 22–29, 41, 45
- coherence time, 19–21, 129, 130
- coherent beamforming gain, 52, 55, 56, 62, 63, 81, 85, 90, 92, 96, 146
- contaminating cell, 77
- deterministic equivalent, 157
- dirty-paper coding, 191
- downlink, 200–201
 - multi-cell, 34–35, 85–90
 - single-cell, 32–33, 56–62
- duplexing
 - frequency-division (FDD), 15–16, 159
 - time-division (TDD), 15–16, 24, 159
- effective noise, 39, 50
- energy efficiency, 162
- entropy, 176–185
- fading
 - correlated, 157
 - large-scale, 29–31, 34
 - Rayleigh, 29
 - i.i.d., 146–148, 151
 - independent, 6, 31, 35, 143–148
 - small-scale, 29–31, 34
- favorable propagation, 139–155
 - approximate, 139
 - asymptotic, 140
 - capacity, 140–141
 - linear processing, 141–142
- hardware imperfections, 161

- Hata-COST231 model, 129
 Hata model, 117
 home cell, 16, 77, 123
- I/Q imbalance, 161
- interference
 coherent, 16, 77, 82, 92, 107
 inter-cell, 33
 intra-cell, 53, 57, 60, 62–67, 90, 92
 non-coherent, 77, 81, 85, 92, 133
- isotropic scattering, 6, 143–144, 154
- Jensen's inequality, 41, 175, 178, 195
- keyhole channel, 153
- large-scale fading ratio, 125
- line-of-sight, 6, 10, 11, 145
 uniformly random, 143, 145–151, 154
 urns-and-balls model, 148
- linear processing, 11, 67–69
- linear programming, 100–101
- link budget, 118, 205
- maximum-ratio processing, 14, 53–56, 59–62, 82–85, 88–90, 157, 197–201
- MIMO, 5
 Massive, 10
 cell-free, 159–160
 Multiuser, 8–10, 185–194
 Point-to-Point, 6–7, 183–185
- MMSE processing, 142, 157
- mobile access, 128–135
 dense urban, 128–129
 suburban, 128–130
- multi-cell system, 33–35, 77–96, 122–135
- mutual information, 176–185
- noise
 Gaussian, 179
 non-Gaussian, 179–182
- Nyquist sampling interval, 23–24
- OFDM, 25–29, 129
 cyclic prefix, 25–26
 slot, 26
- phase noise, 161
- pilot assignment, 126
- pilot contamination, 16, 77, 78, 94–95, 158–159
- pilot reuse, 77, 122–123
- pilots
 downlink, 24, 160
 non-synchronous, 94–95
 uplink, 24, 45–48
- power control
 coefficient, 49, 57, 79, 85
 comparison, 134–135
 given SINR targets, 99–101
 max-min, 101–111, 121–122, 127–129
 multi-cell, 100–101, 105–111, 127–129
 pilots, 162
 single-cell, 100–105
- pseudo-covariance matrix, 164
- QAM constellation, 48
- quantization noise, 161
- quasi-linear programming, 101–102, 105–106
- rate, 36
 achievable, 36
 max-min, 186
 sum, 186
- rate region, 186
- reciprocity, 11, 32, 34
 calibration, 161
- rural access, 115–122
- scalability, 11, 15–16
- side information, 40
- single-cell system, 31–33, 45–75, 115–122
- SINR
 effective, 13, 52, 56, 59, 62, 97–99
 target, 100
- SNR, 30, 33
- spectral efficiency, 5, 6, 36

-
- net, 69–72
 - sum, 69–72
 - successive interference cancellation, 189
 - two-path model, 19–22
 - uniformly good service, 11, 48, 112, 117
 - uplink, 195–200
 - multi-cell, 33–34, 79–85
 - single-cell, 31–32, 48–56
 - use and forget CSI, 51–52, 54–56
 - zero-forcing processing, 50–53, 58–59, 80–82, 87–88, 157, 195–197
 - implementation, 160
 - regularized, 157