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| Project | **IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16> |
| Title | **A Methodology for Fudge Factor Estimation** |
| Date Submitted | **2007-09-17** |
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| Re: | Simulation methodology for P802.16m Advanced Air Interface |
| Abstract | A quantization of the SCM urban macro environment adopted by 3GPP2 Evaluation Methodology that allows the pre-computation of channel coefficients but most importantly various imperfection (fudge) factors that have channel model dependence is proposed. |
| Purpose | Inclusion of the Tables in the Evaluation Methodology Document as an appendix for the ray-based channel modeling option of the urban macro environment. |
| Notice |  |
| Release |  |
| Patent Policy |  |

## 1. Introduction

The development of 802.16m radio interface involves PHY algorithms that assume certain channel estimation quality. An extensive set of work resulted in extensive channel models, SCM, WINNER, etc. but a methodology that captures accurately the receiver imperfections leaves lot to be desired. In this contribution we attempt to solve two problems:

1. The expensive simulation runs with SCM that result when the number of users exceed 400 VoIP calls per 10 MHz TDD as expected by 802.16m
2. The explicit account of non-ideal estimation and other imperfections in the evaluation methodology something that is quite important for all non-linear algorithms such as OFDMA interference cancellation (IC), MIMO detection, etc.

## 2. Basis-64 Methodology

For the ray based method of SCM an infinite permutation of channel parameters is allowed. This is because the channel parameters are extracted out of distribution draws. This fact imposes a severe limitation in capturing fudge factors that are needed for realistic system level simulation. We propose to quantize the number of allowed permutations to a finite number and we have verified that such quantization does not entail information loss in system simulations. The suggested basis for quantizing the set of allowed channel parameters is tabulated in the next section. The methodology for capturing the set of fudge factors needed at the system level is as follows:

1. Simulate the actual link level for each of the 64 cases and Doppler spreads of interest. Extract from each of the 64 cases the fudge factors of interest e.g. reduction in true SINR due to imperfect cancellation factors. From our experience this is a step that can be very quickly capture realistic imperfection factors since all link simulations can be run in parallel in a computing cluster.
2. Use the fudge factors in the system simulation. Each MS will instantiate one of the 64 channels tabulated in the next section. The fudge factors that were extracted from link simulations are going to be directly applicable for each MS station channel instantiation.

## 3. Quantization Tables of the SCM Urban Macro Environment

The 3GPP2/3GPP2 SCM channel model for the urban macro environment will be used for generating the link to system mapping and fudge factors. The values of Tables 1 to Table 5 represent 64 realizations of the SCM urban macro environment for the case of 15 degree composite azimuth spread at the base station. The MS is at boresite of the base station with $\Omega_{MS}$ = 90 deg and $\theta_{BS}$ = 0 deg, LOS path to AT is $\Omega_{MS}$ = 90 deg.

Table 1: Power Levels for 64 realizations of the SCM's 6 paths

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 1 | 0.4699878393 | 0.1121509871 | 0.1538803462 | 0.1302980517 | 0.1291785545 | 0.0045042212 |
| 2 | 0.3323039087 | 0.2030574613 | 0.2527225796 | 0.0380961519 | 0.0965994171 | 0.0772204813 |
| 3 | 0.1320271351 | 0.4005296115 | 0.3575193246 | 0.0173951555 | 0.0278855467 | 0.0646432266 |
| 4 | 0.2541653729 | 0.2348525244 | 0.3301762407 | 0.0792536764 | 0.0874842826 | 0.0140679030 |
| 5 | 0.1389882893 | 0.3641602983 | 0.2486146336 | 0.1313183277 | 0.0874310541 | 0.0294873970 |
| 6 | 0.1260841128 | 0.2340698514 | 0.1075228014 | 0.1290675514 | 0.3630905126 | 0.0401651705 |
| 7 | 0.2180883814 | 0.4066938186 | 0.0669638060 | 0.1220162399 | 0.1769989583 | 0.0092387957 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 8 | 0.1113137373 | 0.3546804407 | 0.2474272259 | 0.2108931409 | 0.0429986434 | 0.0326868118 |
| 9 | 0.4803898832 | 0.1150346947 | 0.0919443311 | 0.0752311247 | 0.1612569706 | 0.0761429957 |
| 10 | 0.0299914621 | 0.2706598030 | 0.1580067293 | 0.2745978541 | 0.2047917913 | 0.0619523602 |
| 11 | 0.0786295301 | 0.4743348887 | 0.1391244947 | 0.0801981832 | 0.1146195919 | 0.1130933114 |
| 12 | 0.2781128277 | 0.1789618641 | 0.3533711116 | 0.1177163082 | 0.0553485686 | 0.0164893198 |
| 13 | 0.1808616156 | 0.2205919938 | 0.2416364183 | 0.0956476464 | 0.1369247286 | 0.1243375974 |
| 14 | 0.5398597542 | 0.1240807422 | 0.1445597984 | 0.1000019498 | 0.0404075561 | 0.0510901992 |
| 15 | 0.2278397659 | 0.0696610121 | 0.3702863534 | 0.0512376086 | 0.2045980663 | 0.0763771937 |
| 16 | 0.2207573561 | 0.1518646524 | 0.3117512926 | 0.1306937351 | 0.1116928733 | 0.0732400905 |
| 17 | 0.1578243498 | 0.4513858641 | 0.0403248128 | 0.0475677131 | 0.1934390128 | 0.1094582475 |
| 18 | 0.2444859425 | 0.0518628069 | 0.3717194291 | 0.0916399827 | 0.1712611511 | 0.0690306877 |
| 19 | 0.1708738735 | 0.1279988592 | 0.1841019586 | 0.1436358658 | 0.1265456752 | 0.2468437678 |
| 20 | 0.1695011752 | 0.1170682816 | 0.3322744493 | 0.2710598577 | 0.0596005880 | 0.0504956482 |
| 21 | 0.1303277711 | 0.2307857363 | 0.2211942399 | 0.2460706913 | 0.0449247776 | 0.1266967838 |
| 22 | 0.5678822123 | 0.1888138054 | 0.1035607216 | 0.0138684238 | 0.0887054580 | 0.0371693789 |
| 23 | 0.3362129120 | 0.1815273748 | 0.1295062398 | 0.2571952939 | 0.0730172965 | 0.0225408830 |
| 24 | 0.7987915877 | 0.0217713806 | 0.0979083852 | 0.0462386742 | 0.0233335263 | 0.0119564459 |
| 25 | 0.4274814933 | 0.2999245485 | 0.0837345141 | 0.0634718962 | 0.0876607267 | 0.0377268212 |
| 26 | 0.1954590044 | 0.2203344918 | 0.1814986578 | 0.2654536302 | 0.0404080181 | 0.0968461977 |
| 27 | 0.2048115231 | 0.0430998122 | 0.0988432889 | 0.4097896125 | 0.0802230063 | 0.1632327569 |
| 28 | 0.2156311208 | 0.2677454738 | 0.0649408004 | 0.2853025224 | 0.0920073834 | 0.0743726993 |
| 29 | 0.1864403424 | 0.2169027956 | 0.1427526067 | 0.1014908742 | 0.1728783101 | 0.1795350711 |
| 30 | 0.1693889850 | 0.1556035730 | 0.4191075325 | 0.1176533117 | 0.0271592715 | 0.1110873263 |
| 31 | 0.0964569121 | 0.3606993837 | 0.0608504242 | 0.0645721355 | 0.3567869571 | 0.0606341873 |
| 32 | 0.0566926099 | 0.3823313949 | 0.1556308684 | 0.0491070460 | 0.2360863182 | 0.1201517625 |
| 33 | 0.3402930235 | 0.1665251835 | 0.2879666665 | 0.1215627367 | 0.0303086264 | 0.0533437634 |
| 34 | 0.3465119981 | 0.0908137109 | 0.0747397299 | 0.1508297682 | 0.2246673339 | 0.1124374590 |
| 35 | 0.2927359858 | 0.2227908417 | 0.1307435678 | 0.1269410256 | 0.2137136788 | 0.0130749004 |
| 36 | 0.1197822243 | 0.3609509946 | 0.0869320584 | 0.1696966235 | 0.2106724461 | 0.0519656531 |
| 37 | 0.4763027366 | 0.1353219023 | 0.0569147466 | 0.2621767156 | 0.0560982015 | 0.0131856975 |
| 38 | 0.2967955438 | 0.0912677526 | 0.2712679935 | 0.1839757642 | 0.0854665824 | 0.0712263636 |
| 39 | 0.2477459317 | 0.1862119010 | 0.4395913476 | 0.0580210991 | 0.0235355844 | 0.0448941363 |
| 40 | 0.1480668939 | 0.1288990076 | 0.3904258770 | 0.1143654613 | 0.1728561307 | 0.0453866295 |
| 41 | 0.1210382157 | 0.5016352485 | 0.1443486988 | 0.1528457526 | 0.0424814583 | 0.0376506262 |
| 42 | 0.2870481626 | 0.3709873998 | 0.1943672517 | 0.0928203063 | 0.0397846891 | 0.0149921906 |
| 43 | 0.2133615682 | 0.1350368455 | 0.4366058542 | 0.0633918664 | 0.0360348950 | 0.1155689707 |
| 44 | 0.2680853143 | 0.0822559506 | 0.1626629320 | 0.3588937513 | 0.0851988520 | 0.0429031998 |
| 45 | 0.4470116440 | 0.0709692323 | 0.1656082643 | 0.0392227074 | 0.0836007375 | 0.1935874145 |
| 46 | 0.2708413518 | 0.3383716076 | 0.0518980861 | 0.1988818315 | 0.0511576998 | 0.0888494233 |
| 47 | 0.1241486025 | 0.3520581625 | 0.1884504166 | 0.0366455197 | 0.0720766161 | 0.2266206826 |
| 48 | 0.4354902948 | 0.0985662839 | 0.2791192387 | 0.0496850302 | 0.1168705438 | 0.0202686087 |
| 49 | 0.1683573476 | 0.2693203809 | 0.0344124950 | 0.0774356537 | 0.4500409069 | 0.0004332159 |
| 50 | 0.1809038379 | 0.1210333637 | 0.1453947318 | 0.3477919701 | 0.1086934116 | 0.0961826849 |
| 51 | 0.3170777077 | 0.1653350352 | 0.3410680596 | 0.0707487716 | 0.0337340528 | 0.0720363730 |
| 52 | 0.2866223958 | 0.1555833656 | 0.2546130487 | 0.1375081140 | 0.0240877320 | 0.1415853438 |
| 53 | 0.2812320145 | 0.2182422300 | 0.0941003415 | 0.0700237282 | 0.1365316827 | 0.1998700031 |
| 54 | 0.0461019662 | 0.1786750223 | 0.0473745037 | 0.5200044498 | 0.0818971459 | 0.1259469121 |
| 55 | 0.4045866497 | 0.2496335144 | 0.0747677304 | 0.1448685579 | 0.0920867612 | 0.0340567864 |

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|---|---|---|---|---|---|---|
| 56 | 0.2259569449 | 0.2847681920 | 0.1019630418 | 0.1277708999 | 0.1187752102 | 0.1407657113 |
| 57 | 0.1315633896 | 0.4193298292 | 0.0641866629 | 0.1614136137 | 0.2203497388 | 0.0031567658 |
| 58 | 0.5154432475 | 0.0786847679 | 0.0590088122 | 0.1057410873 | 0.2157936588 | 0.0253284263 |
| 59 | 0.1660378899 | 0.1511954089 | 0.3152619699 | 0.1786887923 | 0.0565884408 | 0.1322274982 |
| 60 | 0.3143491951 | 0.2337164259 | 0.2008582947 | 0.0685404156 | 0.1283614759 | 0.0541741928 |
| 61 | 0.2684282612 | 0.1991882420 | 0.1567112662 | 0.1115467494 | 0.0568304690 | 0.2072950122 |
| 62 | 0.2406470499 | 0.3147909629 | 0.1813148911 | 0.1778623879 | 0.0823385949 | 0.0030461134 |
| 63 | 0.3699285620 | 0.3338681556 | 0.1048521281 | 0.0871040030 | 0.0671645882 | 0.0370825632 |
| 64 | 0.0586134713 | 0.0749042496 | 0.3099683574 | 0.1302599674 | 0.1288477895 | 0.2974061648 |

Table 2: Delays for 64 realizations of the SCM's 6 paths

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 1 | 0.000E+00 | 5.696E-07 | 7.272E-07 | 1.224E-06 | 1.452E-06 | 1.999E-06 |
| 2 | 0.000E+00 | 2.062E-07 | 6.871E-07 | 8.734E-07 | 1.649E-06 | 1.908E-06 |
| 3 | 0.000E+00 | 2.425E-07 | 2.941E-07 | 2.118E-06 | 2.188E-06 | 2.199E-06 |
| 4 | 0.000E+00 | 6.865E-08 | 8.949E-08 | 2.320E-06 | 2.423E-06 | 2.939E-06 |
| 5 | 0.000E+00 | 1.623E-07 | 3.201E-07 | 5.896E-07 | 6.031E-07 | 1.311E-06 |
| 6 | 0.000E+00 | 5.624E-07 | 6.857E-07 | 1.101E-06 | 1.376E-06 | 3.052E-06 |
| 7 | 0.000E+00 | 3.380E-07 | 7.101E-07 | 9.606E-07 | 9.837E-07 | 3.862E-06 |
| 8 | 0.000E+00 | 9.124E-07 | 1.168E-06 | 1.218E-06 | 1.987E-06 | 3.078E-06 |
| 9 | 0.000E+00 | 1.447E-06 | 1.781E-06 | 1.855E-06 | 2.093E-06 | 2.576E-06 |
| 10 | 0.000E+00 | 1.121E-07 | 2.015E-07 | 6.737E-07 | 1.133E-06 | 1.618E-06 |
| 11 | 0.000E+00 | 1.890E-07 | 1.999E-07 | 1.166E-06 | 1.757E-06 | 1.851E-06 |
| 12 | 0.000E+00 | 1.311E-07 | 5.342E-07 | 1.166E-06 | 2.458E-06 | 4.832E-06 |
| 13 | 0.000E+00 | 2.232E-08 | 1.931E-07 | 9.588E-07 | 1.922E-06 | 2.540E-06 |
| 14 | 0.000E+00 | 7.063E-09 | 4.403E-08 | 6.363E-07 | 1.375E-06 | 2.282E-06 |
| 15 | 0.000E+00 | 2.770E-07 | 5.326E-07 | 8.379E-07 | 1.106E-06 | 3.327E-06 |
| 16 | 0.000E+00 | 6.622E-08 | 2.448E-07 | 2.725E-07 | 4.861E-07 | 2.141E-06 |
| 17 | 0.000E+00 | 4.773E-07 | 5.291E-07 | 6.904E-07 | 1.331E-06 | 1.759E-06 |
| 18 | 0.000E+00 | 4.821E-07 | 5.694E-07 | 5.779E-07 | 5.999E-07 | 3.449E-06 |
| 19 | 0.000E+00 | 1.444E-07 | 2.971E-07 | 3.315E-07 | 4.505E-07 | 6.295E-07 |
| 20 | 0.000E+00 | 4.516E-08 | 1.782E-07 | 2.008E-07 | 4.133E-07 | 1.698E-06 |
| 21 | 0.000E+00 | 1.742E-07 | 2.150E-07 | 4.342E-07 | 1.451E-06 | 1.986E-06 |
| 22 | 0.000E+00 | 2.106E-07 | 4.404E-07 | 1.221E-06 | 1.251E-06 | 1.773E-06 |
| 23 | 0.000E+00 | 1.894E-07 | 3.340E-07 | 8.583E-07 | 1.300E-06 | 1.488E-06 |
| 24 | 0.000E+00 | 5.779E-08 | 4.064E-07 | 7.493E-07 | 1.113E-06 | 1.845E-06 |
| 25 | 0.000E+00 | 1.218E-07 | 8.781E-07 | 1.368E-06 | 1.999E-06 | 2.426E-06 |
| 26 | 0.000E+00 | 1.454E-06 | 1.976E-06 | 2.144E-06 | 3.265E-06 | 5.520E-06 |
| 27 | 0.000E+00 | 5.039E-07 | 5.141E-07 | 8.520E-07 | 1.153E-06 | 2.121E-06 |
| 28 | 0.000E+00 | 3.135E-07 | 1.079E-06 | 1.179E-06 | 1.878E-06 | 4.332E-06 |
| 29 | 0.000E+00 | 3.079E-08 | 1.161E-07 | 1.868E-07 | 2.015E-07 | 2.513E-07 |
| 30 | 0.000E+00 | 5.792E-08 | 3.746E-07 | 5.723E-07 | 9.468E-07 | 1.099E-06 |
| 31 | 0.000E+00 | 3.248E-08 | 1.842E-07 | 7.783E-07 | 1.052E-06 | 2.058E-06 |
| 32 | 0.000E+00 | 4.904E-07 | 6.154E-07 | 6.194E-07 | 8.056E-07 | 2.735E-06 |

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|---|---|---|---|---|---|---|
| 33 | 0.000E+00 | 1.682E-07 | 5.573E-07 | 1.539E-06 | 2.295E-06 | 3.478E-06 |
| 34 | 0.000E+00 | 4.718E-08 | 9.490E-08 | 1.270E-07 | 5.428E-07 | 6.485E-07 |
| 35 | 0.000E+00 | 9.609E-08 | 2.845E-07 | 3.913E-07 | 4.445E-07 | 1.278E-06 |
| 36 | 0.000E+00 | 1.092E-07 | 1.726E-07 | 1.546E-06 | 2.375E-06 | 2.440E-06 |
| 37 | 0.000E+00 | 4.112E-08 | 9.695E-07 | 4.009E-06 | 5.784E-06 | 9.494E-06 |
| 38 | 0.000E+00 | 6.088E-07 | 7.400E-07 | 1.272E-06 | 2.731E-06 | 3.026E-06 |
| 39 | 0.000E+00 | 5.990E-07 | 1.088E-06 | 1.724E-06 | 1.802E-06 | 1.904E-06 |
| 40 | 0.000E+00 | 3.719E-09 | 2.289E-08 | 4.605E-07 | 5.572E-07 | 9.645E-07 |
| 41 | 0.000E+00 | 2.704E-07 | 3.348E-07 | 5.912E-07 | 7.780E-07 | 2.721E-06 |
| 42 | 0.000E+00 | 2.979E-07 | 5.382E-07 | 5.860E-07 | 1.113E-06 | 5.813E-06 |
| 43 | 0.000E+00 | 1.147E-08 | 1.247E-07 | 2.062E-06 | 2.400E-06 | 2.433E-06 |
| 44 | 0.000E+00 | 3.395E-08 | 4.771E-08 | 9.985E-08 | 3.100E-07 | 1.016E-06 |
| 45 | 0.000E+00 | 2.104E-07 | 2.194E-07 | 2.953E-07 | 6.775E-07 | 1.082E-06 |
| 46 | 0.000E+00 | 2.125E-07 | 1.909E-06 | 2.439E-06 | 2.813E-06 | 3.052E-06 |
| 47 | 0.000E+00 | 6.272E-09 | 4.048E-07 | 9.895E-07 | 1.110E-06 | 1.379E-06 |
| 48 | 0.000E+00 | 4.056E-07 | 5.293E-07 | 1.050E-06 | 1.055E-06 | 3.910E-06 |
| 49 | 0.000E+00 | 1.155E-07 | 3.271E-07 | 3.815E-07 | 4.867E-07 | 2.192E-06 |
| 50 | 0.000E+00 | 1.778E-07 | 5.887E-07 | 6.751E-07 | 8.898E-07 | 1.396E-06 |
| 51 | 0.000E+00 | 4.178E-08 | 6.851E-08 | 6.329E-07 | 6.466E-07 | 2.882E-06 |
| 52 | 0.000E+00 | 4.094E-07 | 8.066E-07 | 1.582E-06 | 1.959E-06 | 2.780E-06 |
| 53 | 0.000E+00 | 7.852E-08 | 1.885E-07 | 5.617E-07 | 6.155E-07 | 7.129E-07 |
| 54 | 0.000E+00 | 3.333E-07 | 4.673E-07 | 5.069E-07 | 2.225E-06 | 2.834E-06 |
| 55 | 0.000E+00 | 2.803E-07 | 6.344E-07 | 9.027E-07 | 9.208E-07 | 3.131E-06 |
| 56 | 0.000E+00 | 3.057E-07 | 6.091E-07 | 7.369E-07 | 9.518E-07 | 1.318E-06 |
| 57 | 0.000E+00 | 4.799E-08 | 2.462E-07 | 3.365E-07 | 5.288E-07 | 3.063E-06 |
| 58 | 0.000E+00 | 6.872E-07 | 7.733E-07 | 1.048E-06 | 1.151E-06 | 3.666E-06 |
| 59 | 0.000E+00 | 1.383E-07 | 4.949E-07 | 5.170E-07 | 5.746E-07 | 6.565E-07 |
| 60 | 0.000E+00 | 1.149E-08 | 9.584E-08 | 4.884E-07 | 8.514E-07 | 2.028E-06 |
| 61 | 0.000E+00 | 5.433E-08 | 5.519E-08 | 2.315E-07 | 2.773E-07 | 2.981E-07 |
| 62 | 0.000E+00 | 6.553E-07 | 8.700E-07 | 1.925E-06 | 3.667E-06 | 9.838E-06 |
| 63 | 0.000E+00 | 1.515E-08 | 8.346E-07 | 3.711E-06 | 4.371E-06 | 7.680E-06 |
| 64 | 0.000E+00 | 3.473E-07 | 4.626E-07 | 6.514E-07 | 8.998E-07 | 1.320E-06 |

Table 3: AoD for 64 realizations of the SCM's 6 paths

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 1 | 6.19 | -9.84 | -14.34 | 18.63 | 32.76 | -41.09 |
| 2 | 4.91 | -5.75 | -11.40 | -18.60 | 20.97 | 31.11 |
| 3 | 0.06 | 6.17 | 12.56 | -15.44 | -19.10 | -51.91 |
| 4 | -5.35 | 8.29 | 11.28 | 17.66 | 18.67 | 23.25 |
| 5 | -1.64 | -2.54 | 4.24 | -5.36 | 17.18 | -21.33 |
| 6 | -7.65 | -12.97 | -13.59 | -21.76 | -36.45 | -54.38 |
| 7 | -4.10 | 4.74 | -6.89 | -18.34 | 20.46 | 34.09 |
| 8 | 2.64 | -16.43 | -29.83 | -29.99 | -44.48 | -54.91 |
| 9 | -0.26 | -2.16 | -5.05 | 5.64 | -8.25 | -18.01 |
| 10 | 4.49 | -8.25 | 14.86 | 29.90 | -37.75 | 57.13 |
| 11 | -0.09 | 5.36 | 14.04 | 15.83 | -18.45 | -23.77 |
| 12 | -4.32 | -11.63 | -12.03 | -13.37 | -13.81 | 17.13 |
| 13 | -12.96 | 13.52 | 14.45 | -21.82 | 34.71 | -39.94 |
| 14 | -0.45 | -3.10 | 7.33 | -11.17 | -13.95 | 26.65 |
| 15 | -0.48 | -1.69 | -8.66 | -8.86 | -18.20 | 27.94 |
| 16 | 0.67 | 25.44 | -28.61 | -44.64 | 66.44 | -70.12 |
| 17 | -1.80 | -12.89 | 19.94 | -25.72 | 32.69 | 45.11 |
| 18 | 4.90 | -8.22 | -8.58 | 16.92 | -21.33 | -31.56 |
| 19 | -0.50 | -6.05 | 9.72 | 11.59 | -13.27 | -17.70 |
| 20 | 3.93 | -5.37 | -9.00 | -12.59 | 15.94 | 38.14 |
| 21 | -8.45 | -12.70 | -34.00 | -39.79 | 54.76 | 73.91 |
| 22 | 2.42 | 11.96 | -17.40 | -20.55 | 25.58 | 29.18 |
| 23 | -0.23 | 8.02 | -8.22 | -17.57 | 26.11 | -64.32 |
| 24 | -4.08 | -8.47 | -14.59 | -18.61 | -26.33 | -30.66 |
| 25 | 7.27 | -12.31 | -15.01 | 19.40 | 19.70 | -44.79 |
| 26 | -1.07 | 6.09 | 7.61 | -12.41 | 17.00 | -28.18 |
| 27 | -7.79 | 9.35 | 10.11 | 10.11 | -11.37 | 16.91 |
| 28 | -4.81 | -8.60 | 15.30 | 21.42 | -21.55 | -41.41 |
| 29 | -0.06 | -0.86 | -4.41 | -5.09 | 10.20 | 19.42 |
| 30 | -1.33 | -1.46 | 12.21 | 13.31 | 16.37 | 16.56 |
| 31 | -5.04 | 6.18 | -13.44 | 16.21 | -21.60 | 33.99 |
| 32 | 1.61 | -5.27 | -6.82 | -12.47 | -12.56 | 17.90 |
| 33 | -2.35 | -18.18 | 27.92 | -29.45 | 34.97 | 60.69 |
| 34 | -21.43 | 22.07 | -26.60 | 31.05 | 32.26 | -41.47 |
| 35 | 2.01 | -5.07 | -5.78 | -6.41 | 8.94 | -12.11 |
| 36 | 6.94 | 7.50 | 9.51 | -10.66 | -15.04 | -19.19 |
| 37 | 1.29 | 2.49 | -3.71 | -12.09 | 22.66 | -35.28 |
| 38 | 1.04 | 7.69 | -21.19 | -23.87 | -29.64 | -120.95 |
| 39 | -3.01 | -7.70 | -11.89 | 12.22 | -15.90 | -36.00 |
| 40 | 3.58 | -5.79 | 10.76 | -26.41 | -30.77 | -71.23 |
| 41 | -2.74 | 9.77 | -12.94 | 19.90 | -25.48 | -39.48 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 42 | 2.05 | 8.45 | 8.53 | -9.19 | -20.19 | -29.66 |
| 43 | 7.30 | -11.30 | -26.94 | -38.78 | 44.27 | -50.27 |
| 44 | 3.88 | -5.20 | -8.35 | 23.99 | -29.13 | -45.78 |
| 45 | 1.51 | 4.60 | -8.18 | -15.77 | -20.76 | -21.87 |
| 46 | 4.53 | -7.01 | 9.72 | 11.03 | 19.96 | -49.49 |
| 47 | 2.64 | 13.88 | 18.59 | -25.51 | -30.00 | -35.12 |
| 48 | -4.46 | -4.52 | 6.86 | -8.57 | 17.15 | -41.03 |
| 49 | 3.42 | -11.49 | -15.88 | -18.12 | -27.50 | 49.88 |
| 50 | -10.76 | 23.29 | 38.41 | 42.29 | -72.44 | -93.11 |
| 51 | 4.23 | -6.14 | 12.52 | -19.05 | -23.00 | 23.16 |
| 52 | 7.02 | -8.15 | 10.74 | -18.19 | 24.02 | -27.88 |
| 53 | -12.84 | 13.09 | -24.32 | 28.74 | 29.01 | -39.62 |
| 54 | 0.40 | 17.78 | 27.93 | -33.15 | 40.15 | -62.98 |
| 55 | 1.35 | -7.78 | 10.73 | -13.58 | -16.05 | 33.73 |
| 56 | 12.17 | -13.17 | -17.25 | -18.61 | -37.33 | -51.22 |
| 57 | -1.72 | -3.51 | -4.24 | -4.95 | -9.96 | 17.34 |
| 58 | -4.25 | 6.43 | -12.94 | 14.66 | -20.33 | 22.33 |
| 59 | -7.01 | -11.12 | 15.20 | -15.93 | 17.70 | 44.60 |
| 60 | 3.55 | 7.26 | -8.96 | -41.75 | 43.35 | 51.47 |
| 61 | 2.34 | 15.46 | -15.79 | -17.47 | -26.57 | 34.67 |
| 62 | -1.92 | 8.82 | -9.49 | 9.68 | -14.11 | 28.79 |
| 63 | 21.07 | 28.75 | 44.15 | 47.60 | -83.31 | -85.54 |
| 64 | 5.37 | 8.90 | 10.31 | -14.47 | 16.29 | 25.97 |

Table 4: AoA for 64 realizations of the SCM's 6 paths

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 1 | -35.19 | 34.83 | -72.51 | -13.41 | 98.08 | -77.68 |
| 2 | 60.88 | 4.97 | -10.22 | -128.09 | -106.43 | 54.46 |
| 3 | 46.04 | -11.96 | 6.44 | 9.49 | 104.50 | 45.00 |
| 4 | -125.44 | -97.48 | -40.51 | 36.89 | -53.70 | 142.51 |
| 5 | -81.58 | 3.03 | 14.63 | 58.32 | 7.32 | 123.45 |
| 6 | -135.22 | -15.28 | -122.17 | -40.91 | 18.92 | 45.19 |
| 7 | 37.29 | 39.16 | 75.55 | -126.32 | -26.01 | 14.39 |
| 8 | 27.55 | -38.45 | 80.34 | -55.07 | 139.24 | 90.05 |
| 9 | -50.85 | 12.99 | 10.91 | 23.17 | -89.10 | -259.47 |
| 10 | 66.13 | -78.10 | 109.38 | 21.86 | 30.82 | 87.56 |
| 11 | -53.37 | -100.16 | -69.75 | -160.30 | -139.60 | -35.37 |
| 12 | -3.51 | -53.26 | -92.57 | 1.94 | -12.88 | -149.70 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 13 | 3.03 | 113.50 | 85.32 | -74.88 | -21.08 | 2.99 |
| 14 | -129.30 | -7.20 | 8.32 | -113.43 | -81.16 | -37.28 |
| 15 | -42.95 | -37.94 | -43.63 | 7.01 | 99.59 | -165.09 |
| 16 | 12.48 | -68.66 | 71.70 | 36.19 | -87.37 | 3.27 |
| 17 | -120.02 | 35.23 | -79.61 | 29.68 | -19.29 | -132.29 |
| 18 | -89.28 | -104.36 | 22.89 | 95.26 | -53.65 | -31.35 |
| 19 | 71.56 | 46.31 | 144.12 | -55.42 | 47.69 | -94.22 |
| 20 | 125.67 | -6.18 | -66.94 | 113.51 | -38.17 | -109.41 |
| 21 | -41.61 | -53.32 | 74.00 | 21.06 | 28.39 | 137.68 |
| 22 | 11.24 | 15.76 | 28.01 | -112.03 | 49.05 | 97.91 |
| 23 | 69.08 | -54.16 | -47.40 | 142.40 | -92.60 | 42.62 |
| 24 | -57.84 | -43.51 | -15.27 | -24.08 | -88.05 | 24.14 |
| 25 | 78.77 | 61.53 | 159.88 | -146.03 | -160.58 | -9.04 |
| 26 | -54.56 | -98.20 | 31.38 | -84.78 | -134.71 | -48.86 |
| 27 | 55.62 | -201.85 | -32.51 | -13.95 | -84.31 | -48.48 |
| 28 | -21.58 | -69.87 | 131.48 | 36.09 | 24.27 | -122.91 |
| 29 | -32.84 | -80.67 | 41.24 | 48.75 | 192.37 | -98.79 |
| 30 | 87.25 | -15.22 | -15.29 | 116.45 | 177.17 | 44.18 |
| 31 | 45.65 | -154.17 | 31.56 | 68.75 | 125.64 | 96.25 |
| 32 | 187.97 | 11.98 | 133.04 | -97.97 | -52.72 | -44.79 |
| 33 | 126.29 | 36.22 | -66.73 | -2.14 | -98.80 | 31.30 |
| 34 | 1.22 | 103.14 | 27.44 | 57.81 | 7.51 | 76.79 |
| 35 | -46.74 | 85.55 | 87.33 | 41.95 | 9.92 | 26.88 |
| 36 | 9.91 | -18.20 | 20.92 | 96.67 | -31.67 | 55.27 |
| 37 | -51.55 | -71.46 | -128.75 | -114.61 | 53.94 | 24.05 |
| 38 | -88.62 | 13.56 | 163.59 | -65.86 | 113.03 | 75.93 |
| 39 | -54.28 | 79.78 | -16.24 | -40.62 | -175.52 | 73.06 |
| 40 | 51.37 | 56.91 | 67.19 | 299.97 | 58.22 | -74.30 |
| 41 | -34.96 | 61.66 | 9.51 | 59.72 | -36.18 | 185.55 |
| 42 | -2.05 | -28.56 | 91.88 | -19.41 | 35.35 | 0.78 |
| 43 | -33.72 | -39.01 | -127.20 | 105.00 | 96.27 | -77.82 |
| 44 | 4.21 | -242.17 | -61.89 | 75.28 | -18.86 | 133.00 |
| 45 | 3.62 | -47.60 | -60.50 | -58.47 | 86.79 | 29.37 |
| 46 | 35.47 | -5.51 | 47.67 | 78.42 | 84.49 | -26.38 |
| 47 | 50.02 | 28.72 | -92.57 | -28.70 | 93.80 | 100.58 |
| 48 | 17.81 | -46.60 | -6.18 | 72.14 | -142.77 | 60.97 |
| 49 | -79.00 | 51.38 | 142.28 | 68.65 | 40.38 | -90.21 |
| 50 | 2.89 | -46.65 | 90.98 | 105.31 | 32.51 | 112.18 |
| 51 | 32.63 | -154.85 | 18.13 | -51.03 | -84.96 | 135.21 |
| 52 | -88.84 | 55.11 | -39.94 | -83.47 | 59.04 | -6.38 |
| 53 | -90.46 | 1.00 | 18.78 | 56.81 | 16.65 | 29.44 |
| 54 | -70.05 | 21.67 | 165.06 | 15.54 | 81.19 | 21.88 |
| 55 | 2.79 | -17.34 | -29.92 | 53.15 | -85.90 | -103.63 |
| 56 | 161.00 | -54.54 | 2.17 | 3.72 | 76.00 | -150.85 |
| 57 | 173.68 | -132.87 | 115.33 | 39.29 | -44.00 | 91.70 |
| 58 | -59.69 | 79.77 | -10.45 | 175.78 | -83.13 | -46.71 |
| 59 | -41.11 | 16.21 | -6.04 | -3.13 | -233.21 | -56.99 |
| 60 | 5.01 | -49.92 | -46.36 | -33.07 | 71.02 | 13.40 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 61 | -18.76 | 76.95 | -46.01 | 144.10 | -28.36 | -65.31 |
| 62 | -122.52 | -74.05 | -6.62 | 126.60 | -135.19 | 54.53 |
| 63 | -12.09 | 97.94 | -6.13 | 18.53 | 30.03 | -25.93 |
| 64 | -44.05 | -210.36 | -18.58 | -140.39 | 45.94 | -13.19 |

Table 5: AT orientation and complex velocity vector angle

| | **Array Orientation Broadside from the LOS direction (deg)** | **Direction of Travel measured from the Array Broadside (deg)** |
|---|---|---|
| 1 | 342.92 | 42.30 |
| 2 | 266.72 | 126.78 |
| 3 | 155.31 | 223.90 |
| 4 | 153.00 | 270.90 |
| 5 | 242.12 | 295.02 |
| 6 | 210.88 | 316.32 |
| 7 | 356.88 | 190.00 |
| 8 | 16.31 | 174.74 |
| 9 | 289.67 | 204.97 |
| 10 | 122.74 | 250.75 |
| 11 | 4.92 | 117.33 |
| 12 | 259.16 | 272.43 |
| 13 | 66.53 | 314.21 |
| 14 | 55.49 | 186.70 |
| 15 | 355.49 | 182.52 |
| 16 | 56.02 | 254.54 |
| 17 | 10.49 | 184.92 |
| 18 | 308.95 | 60.19 |
| 19 | 182.83 | 20.75 |
| 20 | 186.48 | 260.27 |
| 21 | 247.54 | 134.43 |
| 22 | 25.55 | 166.19 |
| 23 | 310.07 | 280.61 |
| 24 | 274.31 | 355.58 |
| 25 | 141.33 | 274.73 |
| 26 | 312.72 | 149.95 |
| 27 | 257.12 | 141.04 |
| 28 | 231.14 | 98.05 |
| 29 | 171.04 | 37.27 |
| 30 | 351.89 | 244.64 |
| 31 | 5.03 | 67.67 |
| 32 | 40.33 | 284.89 |
| 33 | 262.51 | 320.57 |
| 34 | 211.07 | 16.88 |
| 35 | 24.57 | 106.37 |

| | | |
|---|---|---|
| 36 | 330.67 | 176.47 |
| 37 | 269.84 | 44.25 |
| 38 | 286.25 | 137.25 |
| 39 | 302.66 | 261.72 |
| 40 | 49.52 | 137.32 |
| 41 | 342.90 | 125.68 |
| 42 | 212.03 | 334.80 |
| 43 | 9.28 | 146.66 |
| 44 | 295.92 | 171.86 |
| 45 | 268.87 | 34.11 |
| 46 | 256.97 | 123.21 |
| 47 | 168.06 | 191.82 |
| 48 | 332.39 | 149.42 |
| 49 | 80.25 | 197.42 |
| 50 | 299.22 | 312.74 |
| 51 | 214.60 | 121.01 |
| 52 | 305.58 | 353.68 |
| 53 | 52.52 | 262.73 |
| 54 | 119.05 | 71.58 |
| 55 | 164.64 | 206.67 |
| 56 | 68.56 | 149.90 |
| 57 | 185.60 | 145.88 |
| 58 | 233.82 | 144.43 |
| 59 | 248.23 | 355.88 |
| 60 | 272.48 | 108.78 |
| 61 | 2.41 | 171.30 |
| 62 | 358.49 | 337.43 |
| 63 | 354.20 | 242.04 |
| 64 | 148.74 | 144.94 |

The methodology was adopted by 3GPP2 and together with the adoption of drop files resulted in reducing substantially the simulation time as well as improving the accuracy of fudge factors that for specific receivers makes all the difference between right and wrong capacity results.