



Non-CE11: Extending MDCS to 16x16 and 32x32 TUs

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Overall Summary

- In this contribution, MDCS is applied to larger TU sizes including 16x16 and 32x32
- Two scan patterns for horizontal and vertical scanning are proposed
- The first scan pattern can achieve 0.1% and 0.4% coding efficiency gains for HE-AI and LC-AI, respectively
- The second scan pattern can achieve 0.1% and 0.5% coding efficiency gains for HE-AI and LC-AI, respectively
- Run times are unchanged on average

Introduction

- In HM-4.0, MDCS is only used for TU sizes of 4x4 and 8x8
- Three scan patterns are selected by intra modes
 - For CABAC, they are diagonal, horizontal, and vertical scans
 - For CAVLC, they are zigzag, horizontal, and vertical scans
- In this contribution, MDCS is extended to TU sizes of 16x16 and 32x32
 - Two kinds of scan patterns are proposed for horizontal and vertical scans

Proposed Method

- Scan patterns selections for TU sizes of 16x16 and 32x32
 - 0, 1, and 2 stand for diagonal/zigzag, horizontal, and vertical scans, respectively

Intra Mode TU size	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
32x32	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	2	2	0	0	0
16x16	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	2	2	0	0	0
8x8	0	1	2	0	0	1	1	0	2	2	0	0	1	1	0	0	2	2	0	0	0	1	1	1	1	0	0	0	0	2	2	2	2	0	0
4x4	0	1	2	0	0	1	1	0	2	2	0	0	1	1	0	0	2	2	0	0	0	1	1	1	1	0	0	0	0	2	2	2	2	0	0

- Two alternative scan patterns for horizontal and vertical scans are proposed

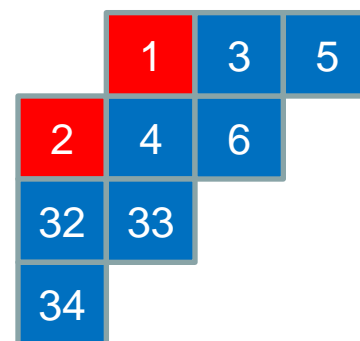
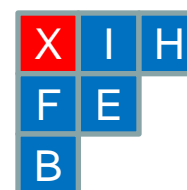
First Scan Pattern

- Scan positions are grouped into pairs except the first position and the last position
- For CABAC, the context formation for one significant flag is independent of the other significant flag in one pair

First horizontal scan pattern for TU size of 16x16

0	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29
2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	31
32	33	35	37	39	41	43	45	47	49	51	53	55	57	59	61
34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	63
64	65	67	69	71	73	75	77	79	81	83	85	87	89	91	93
66	68	70	72	74	76	78	80	82	84	86	88	90	92	94	95
96	97	99	101	103	105	107	109	111	113	115	117	119	121	123	125
98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	127
128	129	131	133	135	137	139	141	143	145	147	149	151	153	155	157
130	132	134	136	138	140	142	144	146	148	150	152	154	156	158	159
160	161	163	165	167	169	171	173	175	177	179	181	183	185	187	189
162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	191
192	193	195	197	199	201	203	205	207	209	211	213	215	217	219	221
194	196	198	200	202	204	206	208	210	212	214	216	218	220	222	223
224	225	227	229	231	233	235	237	239	241	243	245	247	249	251	253
226	228	230	232	234	236	238	240	242	244	246	248	250	252	254	255

Context formation for significant flag



Different colors indicate pairs for parallel processing

Second Scan Pattern

- From F124, first eight positions in the first row have the highest variances for horizontal scan
 - The eight positions should be scanned first to get better coding efficiency
- Other scan positions are grouped into pairs

Second horizontal scan pattern for TU size of 16x16

0	1	2	3	4	5	6	7	8	9	10	12	14	16	18	20	22
11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43
45	47	49	51	53	55	57	59	61	63	65	67	69	71	73	75	77
79	81	83	85	87	89	91	93	95	97	99	101	103	105	107	109	111
113	115	117	119	121	123	125	127	129	131	133	135	137	139	141	143	145
147	149	151	153	155	157	159	161	163	165	167	169	171	173	175	177	179
181	183	185	187	189	191	193	195	197	199	201	203	205	207	209	211	213
215	217	219	221	223	225	227	229	231	233	235	237	239	241	243	245	247
249	251	253	255	257	259	261	263	265	267	269	271	273	275	277	279	281
283	285	287	289	291	293	295	297	299	301	303	305	307	309	311	313	315
317	319	321	323	325	327	329	331	333	335	337	339	341	343	345	347	349
351	353	355	357	359	361	363	365	367	369	371	373	375	377	379	381	383
385	387	389	391	393	395	397	399	401	403	405	407	409	411	413	415	417
419	421	423	425	427	429	431	433	435	437	439	441	443	445	447	449	451
453	455	457	459	461	463	465	467	469	471	473	475	477	479	481	483	485
487	489	491	493	495	497	499	501	503	505	507	509	511	513	515	517	519
521	523	525	527	529	531	533	535	537	539	541	543	545	547	549	551	553
555	557	559	561	563	565	567	569	571	573	575	577	579	581	583	585	587
589	591	593	595	597	599	601	603	605	607	609	611	613	615	617	619	621
623	625	627	629	631	633	635	637	639	641	643	645	647	649	651	653	655
657	659	661	663	665	667	669	671	673	675	677	679	681	683	685	687	689
691	693	695	697	699	701	703	705	707	709	711	713	715	717	719	721	723
725	727	729	731	733	735	737	739	741	743	745	747	749	751	753	755	757
759	761	763	765	767	769	771	773	775	777	779	781	783	785	787	789	791
793	795	797	799	801	803	805	807	809	811	813	815	817	819	821	823	825
827	829	831	833	835	837	839	841	843	845	847	849	851	853	855	857	859
861	863	865	867	869	871	873	875	877	879	881	883	885	887	889	891	893
895	897	899	901	903	905	907	909	911	913	915	917	919	921	923	925	927
929	931	933	935	937	939	941	943	945	947	949	951	953	955	957	959	961
963	965	967	969	971	973	975	977	979	981	983	985	987	989	991	993	995
997	999	1001	1003	1005	1007	1009	1011	1013	1015	1017	1019	1021	1023	1025	1027	1029
1031	1033	1035	1037	1039	1041	1043	1045	1047	1049	1051	1053	1055	1057	1059	1061	1063
1065	1067	1069	1071	1073	1075	1077	1079	1081	1083	1085	1087	1089	1091	1093	1095	1097
1099	1101	1103	1105	1107	1109	1111	1113	1115	1117	1119	1121	1123	1125	1127	1129	1131
1133	1135	1137	1139	1141	1143	1145	1147	1149	1151	1153	1155	1157	1159	1161	1163	1165
1167	1169	1171	1173	1175	1177	1179	1181	1183	1185	1187	1189	1191	1193	1195	1197	1199
1201	1203	1205	1207	1209	1211	1213	1215	1217	1219	1221	1223	1225	1227	1229	1231	1233
1235	1237	1239	1241	1243	1245	1247	1249	1251	1253	1255	1257	1259	1261	1263	1265	1267
1269	1271	1273	1275	1277	1279	1281	1283	1285	1287	1289	1291	1293	1295	1297	1299	1301
1303	1305	1307	1309	1311	1313	1315	1317	1319	1321	1323	1325	1327	1329	1331	1333	1335
1337	1339	1341	1343	1345	1347	1349	1351	1353	1355	1357	1359	1361	1363	1365	1367	1369
1371	1373	1375	1377	1379	1381	1383	1385	1387	1389	1391	1393	1395	1397	1399	1401	1403
1405	1407	1409	1411	1413	1415	1417	1419	1421	1423	1425	1427	1429	1431	1433	1435	1437
1439	1441	1443	1445	1447	1449	1451	1453	1455	1457	1459	1461	1463	1465	1467	1469	1471
1473	1475	1477	1479	1481	1483	1485	1487	1489	1491	1493	1495	1497	1499	1501	1503	1505
1507	1509	1511	1513	1515	1517	1519	1521	1523	1525	1527	1529	1531	1533	1535	1537	1539
1541	1543	1545	1547	1549	1551	1553	1555	1557	1559	1561	1563	1565	1567	1569	1571	1573
1575	1577	1579	1581	1583	1585	1587	1589	1591	1593	1595	1597	1599	1601	1603	1605	1607
1609	1611	1613	1615	1617	1619	1621	1623	1625	1627	1629	1631	1633	1635	1637	1639	1641
1643	1645	1647	1649	1651	1653	1655	1657	1659	1661	1663	1665	1667	1669	1671	1673	1675
1677	1679	1681	1683	1685	1687	1689	1691	1693	1695	1697	1699	1701	1703	1705	1707	1709
1711	1713	1715	1717	1719	1721	1723	1725	1727	1729	1731	1733	1735	1737	1739	1741	1743
1745	1747	1749	1751	1753	1755	1757	1759	1761	1763	1765	1767	1769	1771	1773	1775	1777
1779	1781	1783	1785	1787	1789	1791	1793	1795	1797	1799	1801	1803	1805	1807	1809	1811
1813	1815	1817	1819	1821	1823	1825	1827	1829	1831	1833	1835	1837	1839	1841	1843	1845
1847	1849	1851	1853	1855	1857	1859	1861	1863	1865	1867	1869	1871	1873	1875	1877	1879
1881	1883	1885	1887	1889	1891	1893	1895	1897	1899	1901	1903	1905	1907	1909	1911	1913
1915	1917	1919	1921	1923	1925	1927	1929	1931	1933	1935	1937	1939	1941	1943	1945	1947
1949	1951	1953	1955	1957	1959	1961	1963	1965	1967	1969	1971	1973	1975	1977	1979	1981
1983	1985	1987	1989	1991	1993	1995	1997	1999	2001	2003	2005	2007	2009	2011	2013	2015
2017	2019	2021	2023	2025	2027	2029	2031	2033	2035	2037	2039	2041	2043	2045	2047	2049
2051	2053	2055	2057	2059	2061	2063	2065	2067	2069	2071	2073	2075	2077	2079	2081	2083
2085	2087	2089	2091	2093	2095	2097	2099	2101	2103	2105	2107	2109	2111	2113	2115	2117
2119	2121	2123	2125	2127	2129	2131	2133	2135	2137	2139	2141	2143	2145	2147	2149	2151
2153	2155	2157	2159	2161	2163	2165	2167	2169	2171	2173	2175	2177	2179	2181	2183	2185
2187	2189	2191	2193	2195	2197	2199	2201	2203	2205	2207	2209	2211	2213	2215	2217	2219
2221	2223	2225	2227	2229	2231	2233	2235	2237	2239	2241	2243	2245	2247	2249	2251	2253
2255	2257	2259	2261	2263	2265	2267	2269	2271	2273	2275	2277	2279	2281	2283	2285	2287
2289	2291	2293	2295	2297	2299	2301	2303	2305	2307	2309	2311	2313	2315	2317	2319	2321
2323	2325	2327	2329	2331	2333	2335	2337	2339	2341	2343	2345	2347	2349	2351	2353	2355
2357	2359	2361	2363	2365	2367	2369	2371	2373	2375	2377	2379	2381	2383	2385	2387	2389
2391	2393	2395	2397	2399	2401	2403	2405	2407	2409	2411	2413	2415	2417	2419	2421	2423
2425	2427	2429	2431	2433	2435	2437	2439	2441	2443	2445	2447	2449	2451	2453	2455	2457
2459	2461	2463	2465	2467	2469	2471	2473	2475	2477	2479	2481	2483	2485	2487	2489	2491
2493	2495	2497	2499	2501	2503	2505	2507	2509	2511	2513	2515	2517	2519	2521	2523	2525
2527	2529	2531	2533	2535	2537	2539	2541	2543	2545	2547	2549	2551	2553	2555	2557	2559
2561	2563	2565	2567	2569	2571	2573	2575	2577	2579	2581	2583	2585	2587	2589	2591	2593
2595	2597	2599	2601	2603	2605	2607	2609	2611	2613	2615	2617	2619	2621	2623	2625	2627
2629	2631	2633	2635	2637	2639	2641	2643	2645	2647	2649	2651	2653	2655	2657	2659	2661
2663	2665	2667	2669	2671	2673	2675	2677	2679	2681	2683	2685	2687	2689	2691	2693	2695
2697	2699	2701	2703	2705	2707	2709										

Simulation Results

- Anchor: HM-4.0
- All Intra cases were tested for two scan patterns

First scan pattern

	All Intra HE			All Intra LC		
	Y	U	V	Y	U	V
Class A	0.0%	-0.3%	-0.3%	-0.2%	-0.7%	-0.8%
Class B	-0.1%	-0.7%	-0.7%	-0.7%	-1.4%	-1.3%
Class C	-0.1%	-0.2%	-0.3%	-0.2%	-0.5%	-0.5%
Class D	0.0%	-0.3%	-0.3%	-0.2%	-0.5%	-0.4%
Class E	-0.4%	-0.8%	-0.8%	-0.7%	-1.6%	-1.5%
Overall	-0.1%	-0.5%	-0.5%	-0.4%	-0.9%	-0.9%
	-0.1%	-0.5%	-0.5%	-0.4%	-0.9%	-0.9%
Enc Time[%]	100%			101%		
Dec Time[%]	100%			101%		

Second scan pattern

	All Intra HE			All Intra LC		
	Y	U	V	Y	U	V
Class A	0.0%	-0.3%	-0.3%	-0.2%	-0.8%	-0.8%
Class B	-0.2%	-0.7%	-0.7%	-0.8%	-1.7%	-1.6%
Class C	-0.1%	-0.3%	-0.3%	-0.2%	-0.6%	-0.6%
Class D	-0.1%	-0.3%	-0.3%	-0.3%	-0.5%	-0.4%
Class E	-0.4%	-0.9%	-0.8%	-0.9%	-1.9%	-1.7%
Overall	-0.1%	-0.5%	-0.5%	-0.5%	-1.1%	-1.0%
	-0.1%	-0.5%	-0.5%	-0.5%	-1.1%	-1.0%
Enc Time[%]	101%			100%		
Dec Time[%]	102%			100%		

Conclusions

- In this contribution,
 - MDCS is extended to TUs of 16x16 and 32x32
 - Two scan patterns were proposed
 - 2-parallel processing can be achieved for almost all context formation of the significance map
- The first scan pattern can achieve 0.1% and 0.4% bit rate savings for HE-AI and LC-AI, respectively.
- The second scan pattern can achieve 0.1% and 0.5% bit rate savings for HE-AI and LC-AI, respectively
- No run time change is observed