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| *Title:* | **CE1: Nokia’s results on intra transform mode dependency simplifications** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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| *Source:* | Nokia | | |

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# Abstract

This contribution presents the CE1 results by Nokia on intra transform mode dependency simplifications. In this core experiment, two simplifications were tested. Simplification 1 uses DST for all intra prediction modes of 4x4 luma TU’s. Simplification 2 uses DST for all intra prediction modes of 4x4 luma TU’s except the DC mode is coded with DCT. Both simplifications show coding efficiency loss ranging between 0.0%-0.1%.

# Introduction

JCTVC-I0582 proposed two simplifications for the mode-mapping for using DCT or DST as the transform for 4x4 Intra Luma TU’s, which were tested in CE1:

**Simplification 1:** DST is used for both horizontal and vertical directions for all intra prediction modes of luma intra 4x4 TUs.

**Simplification 2:** For Intra\_DC mode of luma intra 4x4 TUs, DCT is used for both horizontal and vertical directions. For all other prediction modes of luma intra 4x4 TUs, DST is used for both horizontal and vertical directions. These two simplifications were tested with three different test conditions:

**Test 1 Configuration:**

* **Main, All-Intra, Common Conditions QP Range:**

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| **Simplification 1** | **Simplification 2** |
| |  |  |  |  | | --- | --- | --- | --- | |  | **All Intra Main** | | | |  | Y | U | V | | Class A | -0.1% | -0.1% | -0.2% | | Class B | 0.0% | -0.2% | -0.2% | | Class C | 0.2% | -0.2% | -0.2% | | Class D | 0.2% | -0.1% | -0.2% | | Class E | 0.0% | -0.2% | -0.2% | | **Overall** | 0.1% | -0.2% | -0.2% | |  | 0.1% | -0.2% | -0.2% | | Class F | 0.5% | 0.1% | 0.1% | | Enc Time[%] | 99% | | | | Dec Time[%] | 100% | | | | |  |  |  |  | | --- | --- | --- | --- | |  | **All Intra Main** | | | |  | Y | U | V | | Class A | -0.1% | -0.1% | -0.1% | | Class B | 0.0% | -0.1% | -0.1% | | Class C | 0.1% | -0.1% | -0.1% | | Class D | 0.1% | 0.0% | -0.1% | | Class E | 0.0% | -0.1% | -0.2% | | **Overall** | 0.0% | -0.1% | -0.1% | |  | 0.0% | -0.1% | -0.1% | | Class F | 0.3% | 0.1% | 0.1% | | Enc Time[%] | 101% | | | | Dec Time[%] | 99% | | | |

**Test 2 Configuration:**

* **Main, All Intra, Low QP Range: 2, 7, 12, 17:**

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| **Simplification 1** | **Simplification 2** |
| |  |  |  |  | | --- | --- | --- | --- | |  | **All Intra Main** | | | |  | Y | U | V | | Class A | 0.1% | -0.1% | -0.1% | | Class B | 0.1% | 0.0% | 0.0% | | Class C | 0.1% | 0.0% | 0.0% | | Class D | 0.2% | 0.0% | 0.0% | | Class E | 0.1% | -0.1% | -0.1% | | **Overall** | 0.1% | 0.0% | 0.0% | |  | 0.1% | 0.0% | 0.0% | | Class F | 0.8% | 0.1% | 0.1% | | Enc Time[%] | 99% | | | | Dec Time[%] | 100% | | | | |  |  |  |  | | --- | --- | --- | --- | |  | **All Intra Main** | | | |  | Y | U | V | | Class A | 0.1% | 0.0% | 0.0% | | Class B | 0.0% | 0.0% | 0.0% | | Class C | 0.1% | 0.0% | 0.0% | | Class D | 0.2% | 0.0% | 0.0% | | Class E | 0.1% | -0.1% | -0.1% | | **Overall** | 0.1% | 0.0% | 0.0% | |  | 0.1% | 0.0% | 0.0% | | Class F | 0.5% | 0.1% | 0.1% | | Enc Time[%] | 99% | | | | Dec Time[%] | 100% | | | |

**Test 3 Configuration :**

* **Main, All Intra, Common Conditions QP Range, Transform Skipping ON: The anchor for these tests was HM7.0 + Transform Skipping.**

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| **Simplification 1** | **Simplification 2** |
| |  |  |  |  | | --- | --- | --- | --- | |  | **All Intra Main** | | | |  | Y | U | V | | Class A | -0.1% | -0.2% | -0.1% | | Class B | 0.0% | -0.2% | -0.2% | | Class C | 0.1% | -0.2% | -0.2% | | Class D | 0.2% | -0.1% | -0.1% | | Class E | 0.0% | -0.1% | -0.2% | | **Overall** | 0.0% | -0.2% | -0.2% | |  | 0.0% | -0.2% | -0.2% | | Class F | 0.5% | 0.2% | 0.2% | | Enc Time[%] | 99% | | | | Dec Time[%] | 101% | | | | |  |  |  |  | | --- | --- | --- | --- | |  | **All Intra Main** | | | |  | Y | U | V | | Class A | -0.1% | -0.1% | -0.1% | | Class B | 0.0% | -0.1% | -0.1% | | Class C | 0.0% | -0.1% | -0.1% | | Class D | 0.1% | -0.1% | -0.1% | | Class E | -0.1% | -0.1% | -0.2% | | **Overall** | 0.0% | -0.1% | -0.1% | |  | 0.0% | -0.1% | -0.1% | | Class F | 0.2% | 0.0% | 0.0% | | Enc Time[%] | 99% | | | | Dec Time[%] | 101% | | | |

# Conclusion

It is proposed to adopt simplification 1, as it represents a more simplified design and removes the dependency between intra prediction mode and transform type completely.

# Specification text

**Simplification 1**

Depending on PredMode, the following applies:

– If PredMode is equal to MODE\_INTRA, Log2(nW\*nH) is equal to 4, and cIdx is equal to 0, the variable trType is set equal to 0.

– Otherwise, the variable trType is set equal to 0.







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* Otherwise (transSkipFlag is equal to 0), the following applies.

1. Each (horizontal) row of scaled transform coefficients dij (i=0..nW−1, j=0..nH−1) is transformed to eij (i=0..nW−1, j=0..nH−1) by invoking the one-dimensional transformation process as specified in subclause 8.6.4.1 according to the width of the transform unit nW, with the (nW)x(nH) array d and the transform type variable trType as the inputs and the output is the (nW)x(nH) array e.
2. The intermediate sample values gij (i=0..nW−1, j=0..nH−1) are derived by

gij = Clip3( −32768, 32767, ( eij + 64 ) >> 7 ) (8‑253)

1. Each (vertical) column of the resulting matrix gij (i=0..nW−1, j=0..nH−1) is transformed to fij (i=0..nW−1, j=0..nH−1) by invoking the one-dimensional transformation process as specified in subclause 8.6.4.1 according to the height of the transform unit nH, with the (nW)x(nH) array e and the transform type variable trType as the inputs and the output is the (nW)x(nH) array f.

**Simplification 2**

Depending on PredMode and IntraPredMode, the following applies:

– If PredMode is equal to MODE\_INTRA, Log2(nW\*nH) is equal to 4, and cIdx is equal to 0, and IntraPredMode is not equal to INTRA\_DC, the variable trType is set equal to 1.

– Otherwise, the variable trType is set equal to 0.







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* Otherwise (transSkipFlag is equal to 0), the following applies.

1. Each (horizontal) row of scaled transform coefficients dij (i=0..nW−1, j=0..nH−1) is transformed to eij (i=0..nW−1, j=0..nH−1) by invoking the one-dimensional transformation process as specified in subclause 8.6.4.1 according to the width of the transform unit nW, with the (nW)x(nH) array d and the transform type variable trType as the inputs and the output is the (nW)x(nH) array e.
2. The intermediate sample values gij (i=0..nW−1, j=0..nH−1) are derived by

gij = Clip3( −32768, 32767, ( eij + 64 ) >> 7 ) (8‑253)

1. Each (vertical) column of the resulting matrix gij (i=0..nW−1, j=0..nH−1) is transformed to fij (i=0..nW−1, j=0..nH−1) by invoking the one-dimensional transformation process as specified in subclause 8.6.4.1 according to the height of the transform unit nH, with the (nW)x(nH) array e and the transform type variable trType as the inputs and the output is the (nW)x(nH) array f.

# Patent rights declaration(s)

**Nokia may have current or pending patent rights relating to the technology described in this contribution and, conditioned on reciprocity, is prepared to grant licenses under reasonable and non-discriminatory terms as necessary for implementation of the resulting ITU-T Recommendation | ISO/IEC International Standard (per box 2 of the ITU-T/ITU-R/ISO/IEC patent statement and licensing declaration form).**