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# ***On secondary transforms for inter prediction residual JCTVC-G632***

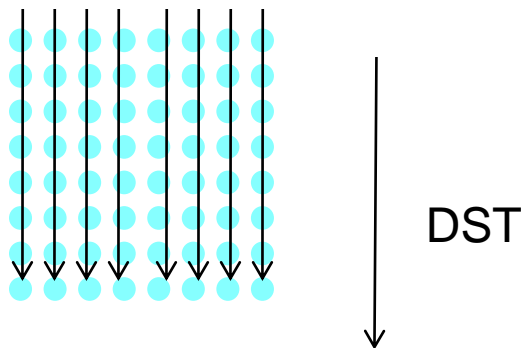
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# Overview

- ❑ Boundary-Dependent DCT/DST technique proposed in JCTVC-G281 for **inter** prediction residues.
- ❑ This proposal builds on top of JCTVC-G281
  - ❑ At size 4 DCT/DST used for coding inter residue.
  - ❑ At size 8 DCT/proposed transform used for coding inter residue.
  - ❑ At sizes 16 and 32 DCT is retained – No change to HM.
- ❑ Gains upto 0.4 % obtained for Low-delay Low-Complexity settings.
  - ❑ Further gains possible if the scheme is applied to 16x16 TU as well.

# Motivation for **Secondary Transforms** for Inter prediction residues

- ❑ Consider Vertical Transform, when energy in prediction residual increases as we go down.
- ❑ DST better adapted to this kind of residue as compared to DCT.
- ❑ At size 8x8 and larger, secondary transforms are being investigated for coding Intra residues in CE 7.
- ❑ Similar to intra coding, we propose to use secondary transform following DCT at sizes 8x8 and larger for Inter residues.




# *Symmetry property of DCT*

□  $C(i,j) = (-1)^{(j-1)} * C(N+1-i, j)$

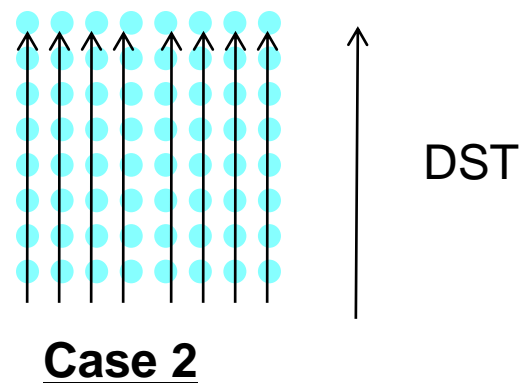
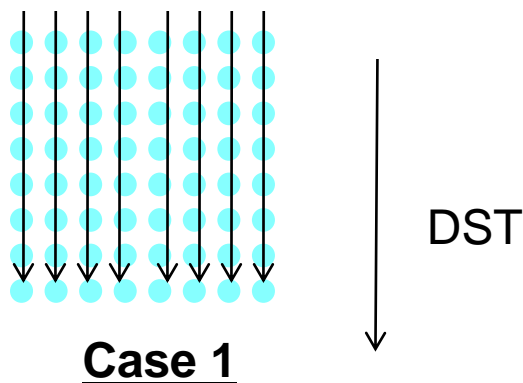
- 8x8 DCT Example: Even basis vectors are symmetric.  
Odd basis vectors are symmetric with a sign change.

[	64	89	84	75	64	50	35	18
	64	75	35	-18	-64	-89	-84	-50
	64	50	-35	-89	-64	18	84	75
	64	18	-84	-50	64	75	-35	-89
	64	-18	-84	50	64	-75	-35	89
	64	-50	-35	89	-64	-18	84	-75
	64	-75	35	18	-64	89	-84	50
	64	-89	84	-75	64	-50	35	-18
								]



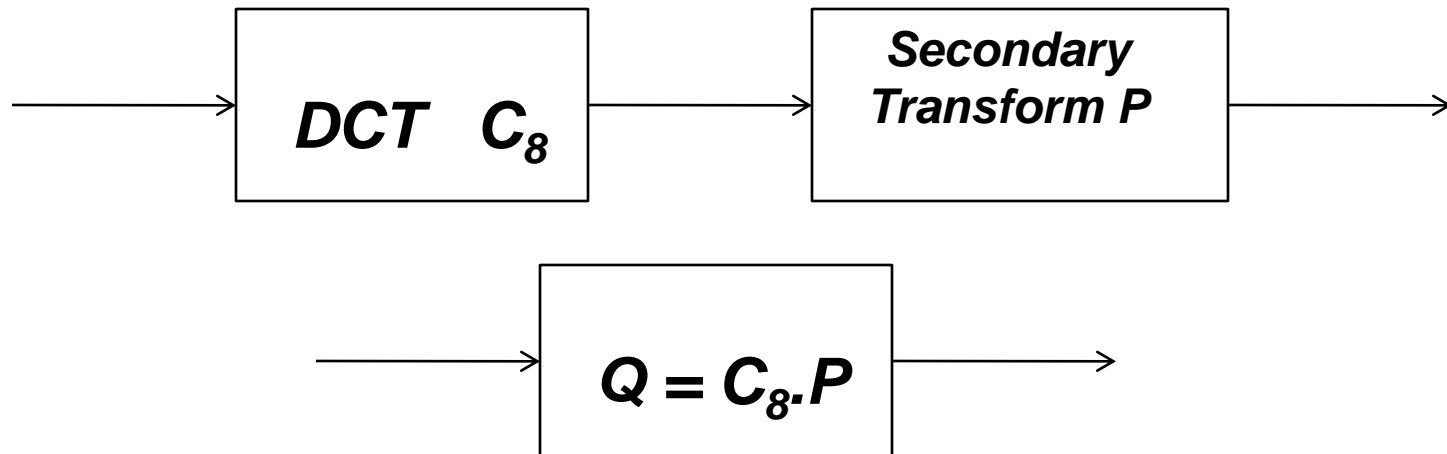
# Proposed **Secondary Transform** Techniques for Inter prediction residues

- **Case 1** : When energy increases as we go down, transform order is:
  - DCT ; Secondary Transform ; Inverse Secondary Transform, Inverse DCT.
- **Case 2**: When energy increases as we go **up**:
  - Option 1: **Flip Data**; DCT; Secondary Transform; Inverse Secondary Transform ; Inverse DCT; **Flip Data**.
  - Option 2 : DCT, Secondary transform  $(-1)^{(i-1)} * S(j,k)$  instead of  $S(j,k)$  ; Inverse Secondary Transform  $(-1)^{i-1} * P(l,i)$  instead of  $P(l,i)$ ; Inverse DCT



# Experiment

- ❑ Intra Coding – Same as HM.
- ❑ Inter Coding
  - ❑ Size 4 DCT/DST scheme from JCTVC-G281 is retained.
  - ❑ Size 8 DCT or matrix  $\mathbf{Q}$  defined below is used.
  - ❑ Size 16 and 32: Same as HM.
- ❑  $\mathbf{Q} = \mathbf{C}_8 \cdot \mathbf{P}$ , where  $\mathbf{C}_8$  is 8x8 DCT and  $\mathbf{P}$  is 8x8 secondary transform presented in JCTVC-G108.



# Results: Proposed Scheme vs. HM 4.0

	Random Access HE			Random Access LC		
	Y	U	V	Y	U	V
Class A	-0.2%	-0.3%	-0.2%	-0.3%	0.0%	-0.2%
Class B	-0.2%	0.1%	0.1%	-0.3%	0.1%	0.2%
Class C	-0.2%	-0.1%	0.0%	-0.2%	0.1%	0.0%
Class D	-0.2%	0.0%	0.0%	-0.3%	-0.1%	0.1%
Class E						
Class F						
<b>Overall</b>	-0.2%	-0.1%	0.0%	-0.3%	0.0%	0.0%
	-0.2%	-0.1%	0.0%	-0.3%	0.0%	0.0%
Enc Time[%]	101%			101%		
Dec Time[%]	101%			100%		

	Low delay B HE			Low delay B LC		
	Y	U	V	Y	U	V
Class A						
Class B	-0.3%	0.0%	0.1%	-0.4%	0.3%	0.3%
Class C	-0.4%	-0.2%	-0.1%	-0.4%	0.1%	-0.2%
Class D	-0.3%	0.2%	0.5%	-0.4%	0.3%	0.0%
Class E	-0.3%	0.5%	0.8%	-0.5%	0.8%	0.3%
Class F						
<b>Overall</b>	-0.3%	0.1%	0.3%	-0.4%	0.3%	0.1%
	-0.3%	0.1%	0.2%	-0.4%	0.3%	0.1%
Enc Time[%]	101%			100%		
Dec Time[%]	101%			99%		

# Summary

- ❑ Proposal builds on top of JCTVC-G281, a transform scheme for Inter prediction residues
- ❑ No R-D search; No signaling.
- ❑ Gains of 0.4 % are obtained at negligible run time increase by applying an alternate transform scheme at sizes 4 and 8 only.
  - ❑ Further gains possible when scheme is extended to 16x16 TU.
  - ❑ Current results indicate upto 0.6-0.7 % gain when secondary transforms are used for both Intra and Inter residues.
- ❑ Recommend to test the proposal in a Core Experiment on Additional Transforms.