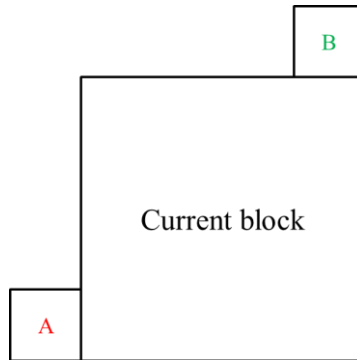


Simplification of MPM derivation

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Introduction

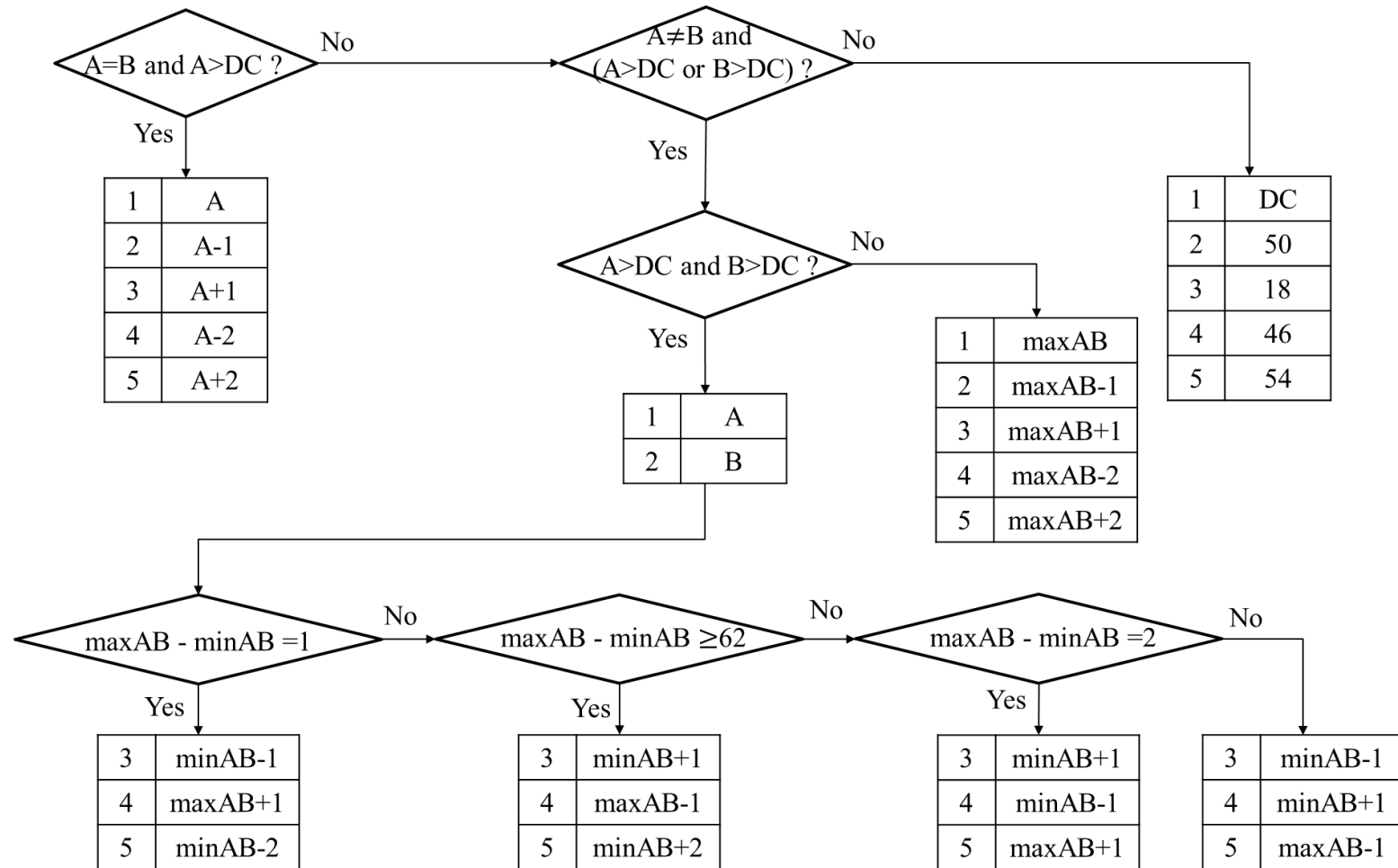
- In current VVC WD 6, 7 categories of MPM lists are used
 - The number of categories increased from 5 categories of VVC WD 5 to 7 categories of VVC WD 6



Categories		MPM list
Both angular and they are the same		{ Left, Left-1, Left+1, Left-2, Left+2 }
Both angular and they are different	$Max - Min = 1$	{ Left, Above, Min-1, Max+1, Min-2 }
	$Max - Min \geq 62$	{ Left, Above, Min+1, Max-1, Min+2 }
	$Max - Min = 2$	{ Left, Above, Min+1, Min-1, Max+1 }
	<i>Otherwise</i>	{ Left, Above, Min-1, Min+1, Max-1 }
One is angular, the other is non-angular		{ Max, Max-1, Max+1, Max-2, Max+2 }
Both Left and Above are non-angular		{ DC, VER, HOR, VER-4, VER+4 }

Introduction

- VVC WD 6 checks 6 conditions at the worst case



Problems

- Problem 1

- Two categories generate identical MPM lists.

- ✓ In the first category, the Left and Above are the same.
- ✓ Thus, the Max is also the same to the left and above.

Categories		MPM list
Both angular and they are the same		{Left, Left-1, Left+1, Left-2, Left+2}
Both angular and they are different	$Max - Min = 1$	{Left, Above, Min-1, Max+1, Min-2}
	$Max - Min \geq 62$	{Left, Above, Min+1, Max-1, Min+2}
	$Max - Min = 2$	{Left, Above, Min+1, Min-1, Max+1}
	Otherwise	{Left, Above, Min-1, Min+1, Max-1}
One is angular, the other is non-angular		{Max, Max-1, Max+1, Max-2, Max+2}
Both Left and Above are non-angular		{DC, VER, HOR, VER-4, VER+4}



Categories		MPM list
Both angular and they are the same		{Max, Max-1, Max+1, Max-2, Max+2}
Both angular and they are different	$Max - Min = 1$	{Left, Above, Min-1, Max+1, Min-2}
	$Max - Min \geq 62$	{Left, Above, Min+1, Max-1, Min+2}
	$Max - Min = 2$	{Left, Above, Min+1, Min-1, Max+1}
	Otherwise	{Left, Above, Min-1, Min+1, Max-1}
One is angular, the other is non-angular		{Max, Max-1, Max+1, Max-2, Max+2}
Both Left and Above are non-angular		{DC, VER, HOR, VER-4, VER+4}

Problems

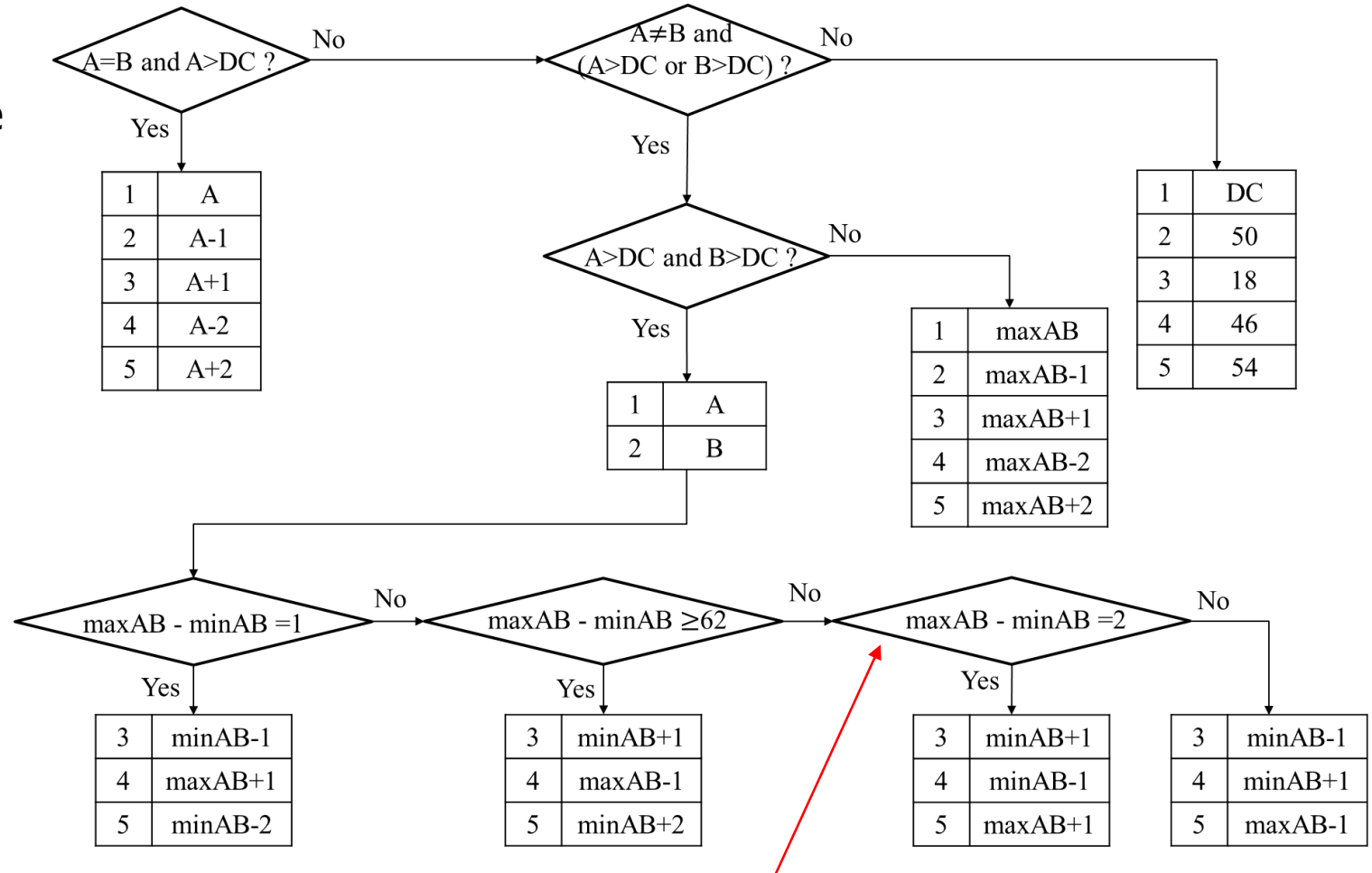
- Problem 2
 - The number of categories increased from 5 to 7 with minor gain
 - ✓ There are many branches when “Both angular and they are different”

Categories		MPM list
Both angular and they are the same		{Left, Left-1, Left+1, Left-2, Left+2}
Both angular and they are different	$Max - Min = 1$	{Left, Above, Min-1, Max+1, Min-2}
	$Max - Min \geq 62$	{Left, Above, Min+1, Max-1, Min+2}
	$Max - Min = 2$	{Left, Above, Min+1, Min-1, Max+1}
	Otherwise	{Left, Above, Min-1, Min+1, Max-1}
One is angular, the other is non-angular		{Max, Max-1, Max+1, Max-2, Max+2}
Both Left and Above are non-angular		{DC, VER, HOR, VER-4, VER+4}

Problems

- Problem 2

- At the worst case, 6 conditions are checked instead of 4 conditions to derive the MPM list.



The worst case

The proposed methods

- Method I unifies two categories that generate identical MPMs.
 - No any BD-rate changes
- Method II reduces the number of categories from 7 to 5
 - 0.02%/0.05%/0.03% BD-rate under AI
- Method III harmonizes the method I and method II.

Proposal

Method I

- Method I unifies two categories of MPM derivation process that generate identical MPM lists.
- The number of angular modes is used to classify categories.
- MPM lists constructed by the method I are the same to VVC WD 6

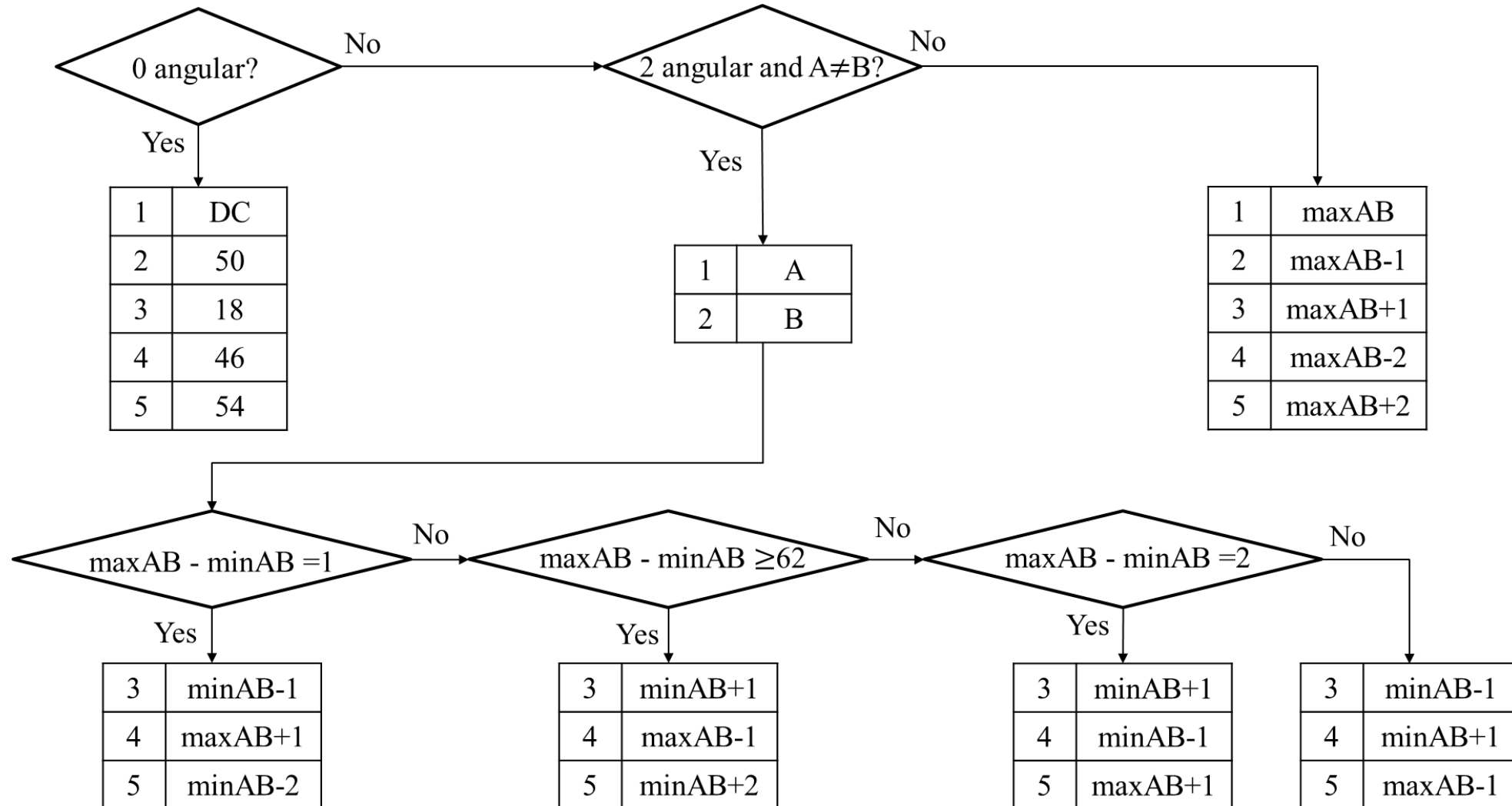
Categories		MPM list
Both angular and they are the same		{Left, Left-1, Left+1, Left-2, Left+2}
Both angular and they are different	$Max - Min = 1$	{Left, Above, Min-1, Max+1, Min-2}
	$Max - Min \geq 62$	{Left, Above, Min+1, Max-1, Min+2}
	$Max - Min = 2$	{Left, Above, Min+1, Min-1, Max+1}
	Otherwise	{Left, Above, Min-1, Min+1, Max-1}
One is angular, the other is non-angular		{Max, Max-1, Max+1, Max-2, Max+2}
Both Left and Above are non-angular		{DC, VER, HOR, VER-4, VER+4}



Categories		MPM list
Both Left and Above are non-angular (The # of distinct angular modes = 0)		{DC, VER, HOR, VER-4, VER+4}
Both angular and they are different (The # of distinct angular modes = 2)	$Max - Min = 1$	{Left, Above, Min-1, Max+1, Min-2}
	$Max - Min \geq 62$	{Left, Above, Min+1, Max-1, Min+2}
	$Max - Min = 2$	{Left, Above, Min+1, Min-1, Max+1}
	Otherwise	{Left, Above, Min-1, Min+1, Max-1}
'One angular and the other non-angular' or 'Both angular and they are the same' (The # of distinct angular modes = 1)		{Max, Max-1, Max+1, Max-2, Max+2}

※ Distinct angular modes are angular modes that are different each other

Method I Flowchart



Proposal

Method II

- In VVC WD 6, there are four kinds of MPM lists when “Both angular and they are different”.
- The proposed method II reduces the number of categories from 4 to 2 when “Both angular and they are different”.

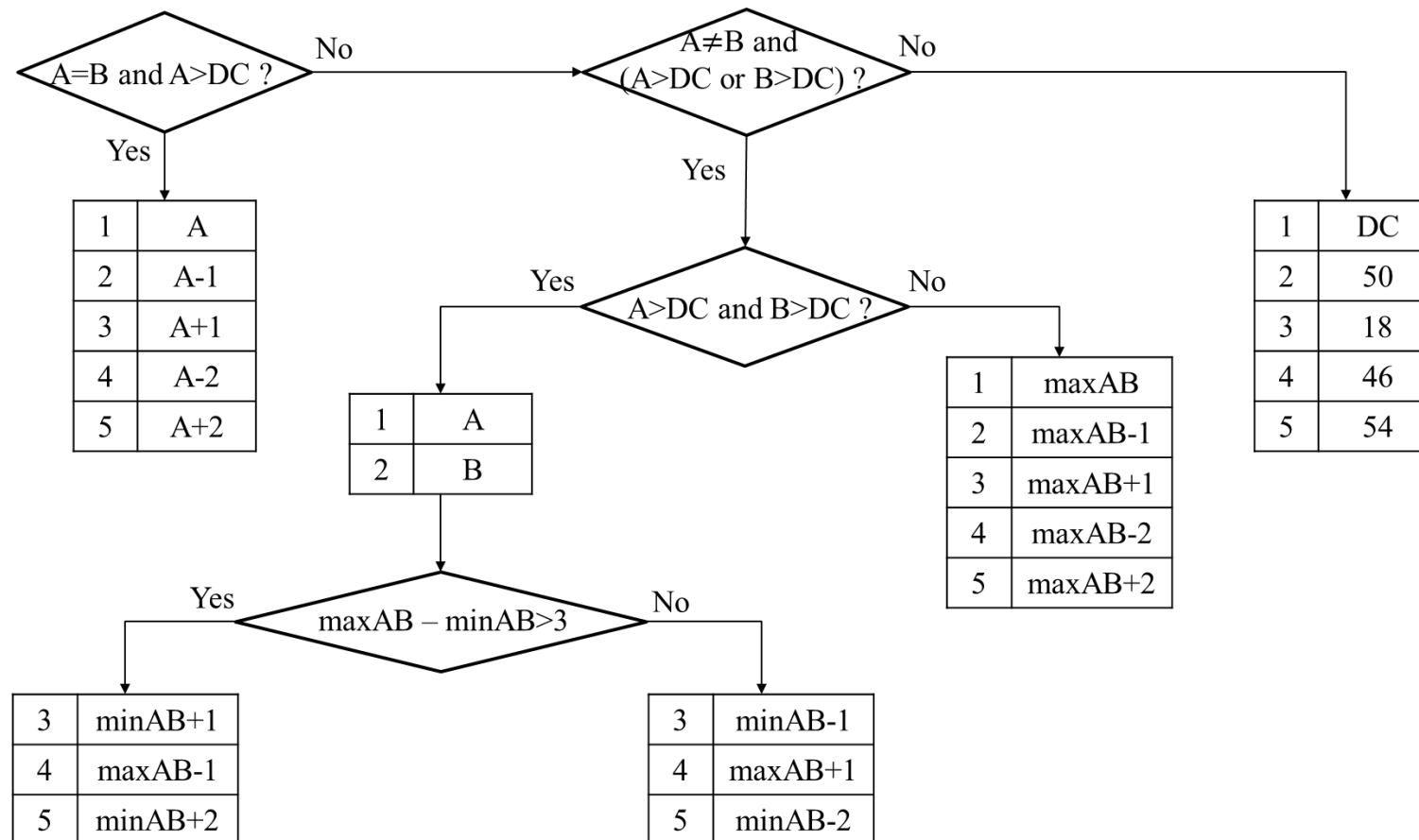
Categories		MPM list
Both angular and they are the same		{Left, Left-1, Left+1, Left-2, Left+2}
Both angular and they are different	$Max - Min = 1$	{Left, Above, Min-1, Max+1, Min-2}
	$Max - Min \geq 62$	{Left, Above, Min+1, Max-1, Min+2}
	$Max - Min = 2$	{Left, Above, Min+1, Min-1, Max+1}
	Otherwise	{Left, Above, Min-1, Min+1, Max-1}
One is angular, the other is non-angular		{Max, Max-1, Max+1, Max-2, Max+2}
Both Left and Above are non-angular		{DC, VER, HOR, VER-4, VER+4}



Categories		MPM list
Both angular and they are the same		{Left, Left-1, Left+1, Left-2, Left+2}
Both angular and they are different	$Max - Min \geq 3$	{Left, Above, Min+1, Max-1, Min+2}
	Otherwise	{Left, Above, Min-1, Max+1, Min-2}
One is angular, the other is non-angular		{Max, Max-1, Max+1, Max-2, Max+2}
Both Left and Above are non-angular		{DC, VER, HOR, VER-4, VER+4}

Method II Flowchart

- The proposed method II checks 4 conditions at the worst case, whereas VVC WD 6 checks 6 conditions.



Proposal

Method III

- The method III harmonizes the method I and method II.
 - Method I unifies two categories that generate identical MPM lists.
 - Method II reduces 2 categories when “Both angular and they are different”.

Categories		MPM list
Both angular and they are the same		{Left, Left-1, Left+1, Left-2, Left+2}
Both angular and they are different	$Max - Min = 1$	{Left, Above, Min-1, Max+1, Min-2}
	$Max - Min \geq 62$	{Left, Above, Min+1, Max-1, Min+2}
	$Max - Min = 2$	{Left, Above, Min+1, Min-1, Max+1}
	Otherwise	{Left, Above, Min-1, Min+1, Max-1}
One is angular, the other is non-angular		{Max, Max-1, Max+1, Max-2, Max+2}
Both Left and Above are non-angular		{DC, VER, HOR, VER-4, VER+4}

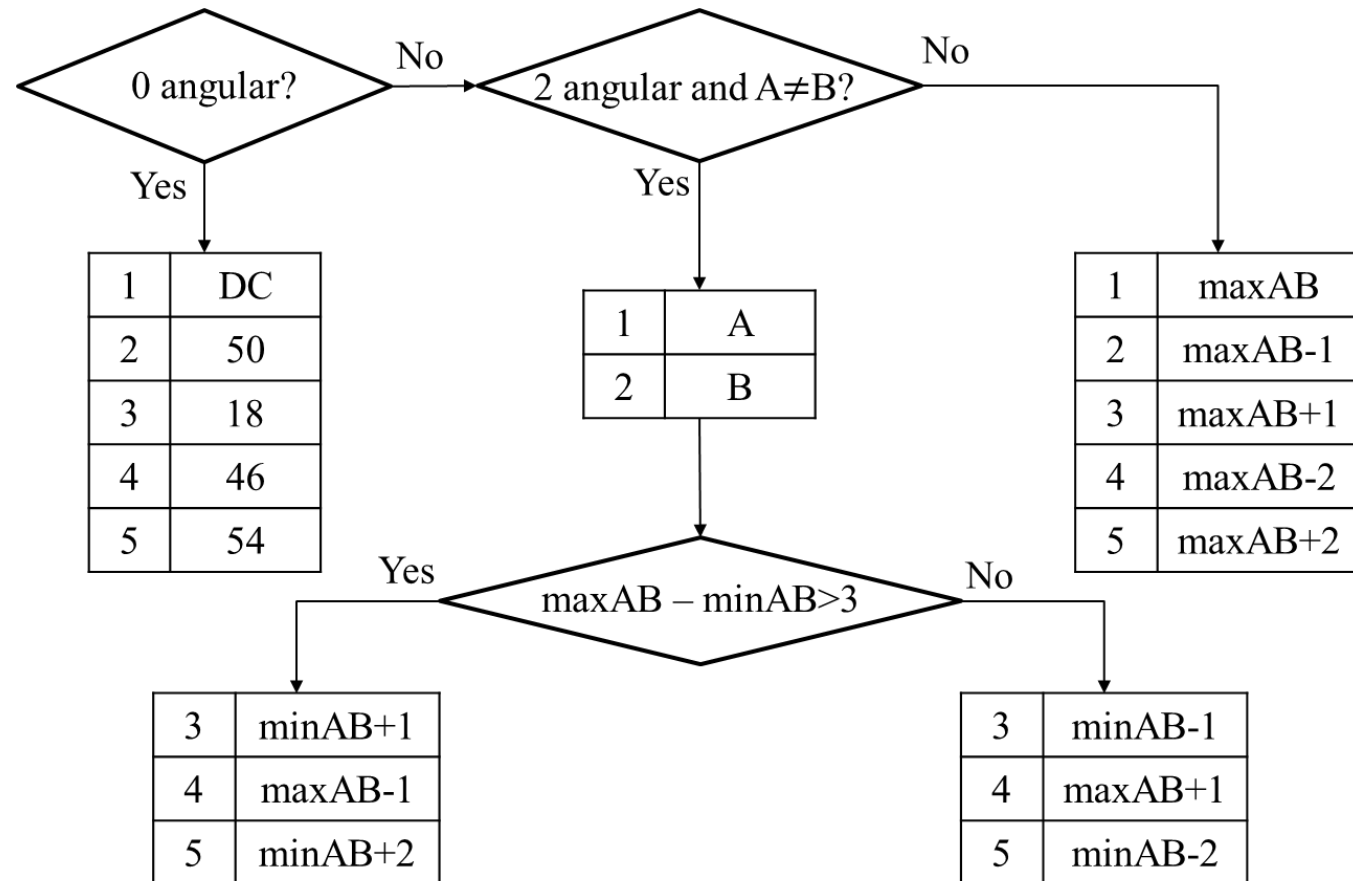


Categories		MPM list
Both Left and Above are non-angular (The # of distinct angular modes = 0)		{DC, VER, HOR, VER-4, VER+4}
Both angular and they are different (The # of distinct angular modes = 2)	$Max - Min > 3$	{Left, Above, Min+1, Max-1, Min+2}
	$Otherwise$	{Left, Above, Min-1, Max+1, Min-2}
‘One angular and the other non-angular’ or ‘Both angular and they are the same’ (The # of distinct angular modes = 1)		{Max, Max-1, Max+1, Max-2, Max+2}

※ Distinct angular modes are angular modes that are different each other

Method III Flowchart

- The method III has a very simple flowchart.



Experimental results

Method I

	All Intra Main10				
	Over VTM-6.0				
	Y	U	V	EncT	
Class A1	0.00%	0.00%	0.00%	102%	100%
Class A2	0.00%	0.00%	0.00%	100%	100%
Class B	0.00%	0.00%	0.00%	100%	100%
Class C	0.00%	0.00%	0.00%	101%	100%
Class E	0.00%	0.00%	0.00%	101%	100%
Overall	0.00%	0.00%	0.00%	101%	100%
Class D	0.00%	0.00%	0.00%	101%	100%
Class F	0.00%	0.00%	0.00%	101%	100%

	Random access Main10				
	Over VTM-6.0				
	Y	U	V	EncT	
Class A1	0.00%	0.00%	0.00%	100%	100%
Class A2	0.00%	0.00%	0.00%	101%	100%
Class B	0.00%	0.00%	0.00%	101%	100%
Class C	0.00%	0.00%	0.00%	100%	100%
Class E					
Overall	0.00%	0.00%	0.00%	101%	100%
Class D	0.00%	0.00%	0.00%	100%	100%
Class F	0.00%	0.00%	0.00%	101%	100%

Experimental results

Method II

	All Intra Main10				
	Over VTM-6.0			EncT	DecT
	Y	U	V		
Class A1	0.00%	0.07%	0.06%	100%	100%
Class A2	0.03%	0.06%	-0.01%	100%	100%
Class B	0.02%	0.05%	0.02%	100%	100%
Class C	0.05%	0.01%	0.06%	100%	100%
Class E	0.00%	0.06%	0.05%	100%	100%
Overall	0.02%	0.05%	0.03%	100%	100%
Class D	-0.01%	0.09%	-0.09%	100%	100%
Class F	0.02%	0.04%	-0.07%	101%	100%

	Random access Main10				
	Over VTM-6.0			EncT	DecT
	Y	U	V		
Class A1	0.00%	-0.07%	-0.04%	100%	100%
Class A2	0.03%	0.01%	0.02%	100%	100%
Class B	0.00%	0.00%	0.10%	100%	100%
Class C	0.00%	0.07%	0.04%	100%	100%
Class E					
Overall	0.01%	0.01%	0.04%	100%	100%
Class D	-0.04%	-0.12%	0.10%	100%	100%
Class F	0.01%	-0.17%	0.04%	100%	100%

Method III

	All Intra Main10				
	Over VTM-6.0			EncT	DecT
	Y	U	V		
Class A1	0.00%	0.07%	0.06%	100%	100%
Class A2	0.03%	0.06%	-0.01%	100%	100%
Class B	0.02%	0.05%	0.02%	100%	100%
Class C	0.05%	0.01%	0.06%	100%	100%
Class E	0.00%	0.06%	0.05%	100%	100%
Overall	0.02%	0.05%	0.03%	100%	100%
Class D	-0.01%	0.09%	-0.09%	100%	100%
Class F	0.02%	0.04%	-0.07%	101%	100%

	Random access Main10				
	Over VTM-6.0			EncT	DecT
	Y	U	V		
Class A1	0.00%	-0.07%	-0.04%	100%	100%
Class A2	0.03%	0.01%	0.02%	100%	100%
Class B	0.00%	0.00%	0.10%	100%	100%
Class C	0.00%	0.07%	0.04%	100%	100%
Class E					
Overall	0.01%	0.01%	0.04%	100%	100%
Class D	-0.04%	-0.12%	0.10%	100%	100%
Class F	0.01%	-0.17%	0.04%	100%	100%

Summary

- We suggest to adopt the proposed simplification method of MPM derivation, because we achieve
 - The number of branches are reduced.
 - The number of condition checking decreases at the worst case
 - One of the same MPM lists is removed.
- Thanks to Samsung for cross-checking! (JVET-P0822)

Thank you!