Application Report
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OMAP3 H.264 Encoder Quality Analysis and Benchmarking

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ABSTRACT

This application report is a summary of video quality experiments and analysis done for the OMAP3 H.264 encoder.

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1 Platform Used

The experiments are conducted for OMAP3 H.264 baseline profile encoder. H.264 encoder is available for the following OMAP3 platforms: OMAP3430, OMAP3530, OMAP3630 and OMAP3730. The term *OMAP3 H.264 baseline profile encoder* or just *OMAP3 encoder* indicates the encoder on all these platforms. The base source code used for all these platforms is the same and there are only minor differences between the H.264 encoders on these platforms, especially the tools that are turned on by default can be different in these platforms.

The MHz available on these platforms are vastly different; therefore, it is assumed that the user's of these codecs will make an informed judgment about some of the important tools to use and the corresponding MHz implications.

2 Sequences and Settings

The data set for video encoder quality benchmarking consisted of 60 different video files, listed below, at quarter common intermediate format (QCIF)/common intermediate format (CIF)/video graphics array (VGA)/D1 resolutions. The data base consists of a variety of mostly publically available sequences. Most of them are progressive scanned streams.

akiyo_p176x144_30fps_420pl_300fr	coastguard_i640x480_30fps_420pl_300fr
carphone_p176x144_30fps_420pl_382fr	crew_p704x576_25fps_420pl_300fr
coastguard_p176x144_30fps_420pl_300f	fire_p720x480_30fps_420pl_99fr
container_p176x144_30fps_420pl_300fr	football_p704x480_30fps_420pl_150fr
flower_p176x144_30fps_420pl_250fr	foreman_i640x480_30fps_420pl_300fr
football_p176x144_30fps_420pl_260fr	harbour_p704x576_25fps_420pl_300fr
foreman_p176x144_30fps_420pl_300fr	harryPotter_p720x480_30fps_420pl_152fr
ice_p176x144_30fps_420pl_240fr	ice_p704x576_25fps_420pl_240fr
kidsoccer_p176x144_30fps_420pl_450fr	mobcal_p720x480_25fps_420pl_252fr
news_p176x144_30fps_420pl_300fr	mobile_p704x480_30fps_420pl_150fr
suzie_p176x144_30fps_420pl_150fr	parkrun_p720x480_25fps_420pl_252fr
traffic_p176x144_30fps_420pl_501fr	shields_p720x480_25fps_420pl_252fr
vectra_p176x144_30fps_420pl_142fr	soccer_p704x576_25fps_420pl_300fr
walk_p176x144_30fps_420pl_376fr	starwars_p720x480_30fps_420pl_100fr
	tennis_p704x480_30fps_420pl_150fr
akiyo_p352x288_30fps_420pl_300fr	crowdrun_p720x480_25fps_420pl_250fr
bus_p352x288_30fps_420pl_150fr	parkjoy_p720x480_25fps_420pl_250fr
coastguard_p352x288_30fps_420pl_300fr	duckstakeoff_p720x480_25fps_420pl_250fr
container_p352x288_30fps_420pl_300fr	intotree_p720x480_25fps_420pl_250fr
crew_p352x288_30fps_420pl_300fr	oldtowncross_p720x480_25fps_420pl_250fr
football_p352x288_30fps_420pl_260fr	station2_p720x480_24fps_420pl_300fr
foreman_p352x288_30fps_420pl_300fr	tractor_p720x480_30fps_420pl_300fr
harbour_p352x288_30fps_420pl_300fr	pedestrian_p720x480_24fps_420pl_300fr
ice_p352x288_30fps_420pl_240fr	vipertraffic_p720x480_24fps_420pl_250fr
mobile_p352x288_30fps_420pl_300fr	vipertakeoff_p720x480_24fps_420pl_296fr
news_p352x288_30fps_420pl_300fr	cheer_i704x480_30fps_420pl_150fr
silent_p352x288_30fps_420pl_300fr	bicycle_i704x480_30fps_420pl_150fr
soccer_p352x288_30fps_420pl_300fr	sfire_p720x480_24fps_420pl_60fr
traffic_p352x288_30fps_420pl_501fr	sfish_p720x480_24fps_420pl_60fr
walk_p352x288_30fps_420pl_376fr	sfoolsgold_p720x480_24fps_420pl_60fr
	snoreservations_p720x480_24fps_420pl_59fr

NOTE: The file naming convention is: seqname_p/iWxH_Ffps_420pl_Nfr.yuv

Where

- W = Width
- H = Height
- F = Frame-rate in fps
- N = Number of frames
- Format is YUV 420 planar
- p/i = p → progressively scanned sequence, i → interlaced scanned sequence

Both fixed-QP ranges, i.e., without use of rate control, and also rate-control experiments were conducted. Although fixed-QP experiments are not useful in real life, it is a very good tool to compare the basic encoding performance of various encoders/encoding modes. This is especially true since the rate control used in the joint model (JM) encoder, which is the reference encoder for H.264, is not very good and gives poor results for some sequences.

2.1 Bit Rate and QP Ranges for Experiments

For rate control experiments, a set of four bit rates were used as input for the rate controller to encode a stream. The achieved bit rate and peak signal-to-noise ratio (PSNR) were noted for each encoding. These four sets of values were used to plot a graph or to measure the average PSNR deviation between two encoders or encoder settings.

Resolution	Bit Rate Range (bps) for Experiment
QCIF	48000, 64000, 96000, 128000
CIF	192000, 256000, 384000, 512000
VGA/D1	512000, 1000000, 1500000, 2000000

NOTE: These bit rate ranges are quite low values. These values are being used for benchmarking and analysis because the video quality problems, if any, will become apparent in these low bit-rate ranges. For actual encoding, it is recommended to use higher bit-rate values than these, if possible. For more information on recommended bit rate ranges, see Section 9.

For fixed-QP experiments a set of four QP values were selected such that the encoded bit rate falls approximately within the above bit rate range; the achieved bit rate and PSNR were noted for each encoding. The average delta PSNR between two encoders or encoder settings were measured using the BD-PSNR method ([1], [2]). If the absolute value of delta PSNR is smaller than 0.25, it can be considered as negligible. If the absolute value of delta PSNR is smaller than 0.5, it can be considered as small and the quality difference may not be visually perceptible, but still it is desirable to investigate/analyze if the quality can be improved in that case. However, if the absolute PSNR difference is larger than 0.5, analysis may be required to identify the root cause of the difference.

3 Encoding Parameters

3.1 Basic Configuration for Generic Use-Cases

This section explains the parameters that can be used in a wide variety of use cases, see Table 1. These set of parameters provide reasonable quality and MHz. Most of the benchmarking and analysis done in this document uses these parameters. Parameters for higher quality for specialized use cases is explained in other sections.

Table 1. Parameters for Wide Variety of Use Cases

Sr No	XDM Data Structure	XDM Parameter	Value	Description
1	IVIDENC1_Params	encodingPreset	XDM_USER_DEFINED	This configuration allows specifying additional parameters.
2	-do-	rateControlPreset	IVIDEO_LOW_DELAY	IVIDEO_LOW_DELAY: Fast reacting CBR configuration. IVIDEO_STORAGE: Slow reacting VBR Configuration IVIDEO_NONE: Fixed QP encoding
3	-do-	maxHeight	NS [1]	
4	-do-	maxWidth	NS [1]	
5	-do-	maxFrameRate	NS [1]	
6	-do-	maxBitRate	NS [1]	
7	-do-	dataEndianness	1	
8	-do-	maxInterFrameInterval	0	
9	-do-	inputChromaFormat	1	
10	-do-	inputContentType	0	
11	IVIDENC1_DynamicParams	inputHeight	NS [1]	
12	-do-	inputWidth	NS [1]	
13	-do-	refFrameRate	NS [1]	
14	-do-	targetFrameRate	NS [1]	
15	-do-	targetBitRate	NS [1]	Target bit rate value for encoding.
16	-do-	intraFrameInterval	30 [2]	Typically set as a multiple of frame rate in common use cases.
17	-do-	generateHeader	0	
18	-do-	captureWidth	0	
19	-do-	forceFrame	0	
20	-do-	interFrameInterval	interFrameInterval	
21	-do-	mbDataFlag	mbDataFlag	
22	IH264VENC_Params	profileIdc	66	
23	-do-	levelIdc	30	
24	-do-	rcAlgo	0	Not needed - used only if rateControlPreset == IVIDEO_USER_DEFINED.
25	-do-	searchRange	48	
26	IH264VENC_DynamicParams	qpIntra	28	
27	-do-	qpInter	28	
28	-do-	qpMax	51	
29	-do-	qpMin	10	Can use 0, but 10 is found to be better to handle various kind of situations.
30	-do-	lfDisableIdc	0	
31	-do-	quartPelDisable	0	

[1] NS = Not specified, depends on actual application.
[2] You might want to use something different than the recommended value.

Table 1. Parameters for Wide Variety of Use Cases (continued)

Sr No	XDM Data Structure	XDM Parameter	Value	Description
32	-do-	airMbPeriod	0	
33	-do-	maxMBsPerSlice	0	
34	-do-	maxBytesPerSlice	0	
35	-do-	sliceRefreshRowStartNumber	0	
36	-do-	sliceRefreshRowNumber	0	
37	-do-	filterOffsetA	0	
38	-do-	filterOffsetB	0	
39	-do-	log2MaxFNumMinus4	0	
40	-do-	chromaQPIndexOffset	0	
41	-do-	constrainedIntraPredEnable	0	
42	-do-	picOrderCountType	IH264_POC_ TYPE_0	
43	-do-	maxMVperMB	1	1: Enable only 16x16 partitions 4: Enable smaller partitions
44	-do-	intra4x4EnableIdc	INTRA4x4_NONE	0: Enable only Intra16x16 mode 1 or 2: Enable smaller partitions for Intra
45	-do-	mvDataEnable	0	
46	-do-	hierCodingEnable	0	0: IPP coding without non-reference frames 2: Use non-reference frames alternatively for improved quality and lower DDR bandwidth 1: Use non-reference frames if it benefits video quality
47	-do-	streamFormat	IH264_BYTE_ STREAM	
48	-do-	intraRefreshMethod	IH264_ INTRAREFRESH_ NONE	
49	-do-	perceptualQuant	0	Quantization parameter usage for better visual quality
50	-do-	sceneChangeDet	0	Use scene change detection for better encoding
51	-do-	pfNalUnitCallBack	NULL	
52	-do-	numSliceASO	0	
53	-do-	asoSliceOrder[MAXNUMSLCGPS]	[0,0,0,0,0,0,0,0]	
54	-do-	numSliceGroups	0	
55	-do-	sliceGroupMapType	0	
56	-do-	sliceGroupChangeDirectionFlag	0	
57	-do-	sliceGroupChangeRate	0	
58	-do-	sliceGroupChangeCycle	0	
59	-do-	sliceGroupParams[MAXNUMSLCGPS]	[0,0,0,0,0,0,0,0]	

4 Benchmarking

This section discusses the quality of the OMAP3 encoder against the joint model H.264 encoder. OMAP2430 (previous OMAP version before OMAP3) as well as Davinci (DM6446) H.264 encoders were also compared.

Here are the codec versions used for comparison:

- OMAP3 - OMAP3530 H.264 encoder version: 2.01.013
  - Download the codecs from http://software-dl.ti.com/dsps/dsps_public_sw/codecs/OMAP35xx/index_FDS.html
- Davinci/DM6446 H.264 encoder version: 2.02.00.02
  - Download the codecs from http://software-dl.ti.com/dsps/dsps_public_sw/codecs/C64XPlus_Video/index_FDS.html
- OMAP2430 H.264 encoder version: 1.20.000.05

4.1 Benchmarking Against JM Encoder

The benchmarking was done against the latest version of joint model H.264 encoder (JM17.0). The JM encoder was configured to use similar tools set as the OMAP3 parameters explained above, *Basic configuration for generic use case* or in short *Basic configuration*.

4.1.1 JM Configuration

JM was configured with similar tools set as above. This includes SAD distortion measure, RD-OFF, Inter16x16 partition only, and Intra16x16 partition only.

4.1.2 Results

Table 2 shows the average delta PSNR (BD-PSNR) between the OMAP3 encoder and the JM17.0 encoder. A positive value indicates that the quality of the JM encoder is better and a negative value indicates that the quality of the OMAP3 encoder is better.

Table 2. Delta PSNR Between OMAP3 and JM17.0 Encoders

	PSNR (dB) Change of JM Encoder Over OMAP3 Encoder
Average	0.09
Max	0.51
Min	-0.86
QCIF Average	0.18
QCIF Max	0.50
QCIF Min	-0.06
CIF Average	0.17
CIF Max	0.51
CIF Min	-0.24
D1 Average	0.03
D1 Max	0.33
D1 Min	-0.86

4.1.3 Analysis

OMAP3 encoder loses on some low motion sequences (akiyo, container, news, etc.) and a few other sequences. The maximum PSNR loss for OMAP3 is 0.51 dB and the average PSNR loss is 0.09 dB. (0.5 dB PSNR difference roughly translates to 10% bit rate difference.)

From these results, the OMP3 encoder can be considered marginally poorer or similar in quality compared to the JM17.0 encoder when similar basic encoding tools are enabled.

4.2 Benchmarking Against Previous Platforms

The OMAP3 encoder was compared against the H.264 encoders on prior platforms. They were the OMA2430 H.264 encoder and the DaVinci™ H.264 encoder.

Table 3. Results From OMAP3 Compared Against H.264 Encoders

	PSNR (dB) Change of OMAP2430 Over OMAP3	PSNR (dB) Change of Davinci Over OMAP3
Average	-0.18	-0.19
Max	0.31	0.34
Min	-0.77	-0.68
QCIF Average	-0.20	-0.23
QCIF Max	0.00	0.00
QCIF Min	-0.61	-0.53
CIF Average	-0.18	-0.22
CIF Max	0.07	-0.03
CIF Min	-0.77	-0.60
D1 Average	-0.17	-0.16
D1 Max	0.31	0.34
D1 Min	-0.70	-0.68

4.2.1 Analysis

OMAP2430 and DaVinci encoders have negative average delta PSNR values for several sequences when compared with OMAP3. Therefore, the quality of the OMAP3 encoder is better than the encoders on the previous platforms.

For example, OMAP2430 is worse by 0.18 dB on the average and the DaVinci encoder is worse by 0.19 dB on the average. The worst PSNR losses are 0.77 dB and 0.68 dB, respectively.

5 Analysis of Additional Parameters

The XDM interface of the OMAP3 encoder provides several parameters, as shown in Table 3; each parameter is added for a specific reason. This section analyzes some of the parameters that affect the quality of encoded streams.

5.1 Analysis of Smaller Partition Sizes

This section looks at the use of Inter and Intra partition sizes that are smaller than 16x16. The parameters shown in Table 4 have to be changed to enable these modes.

Table 4. Analysis of Smaller Partition Sizes

Sr No	XDM Parameter	Value to Enable These Features	Description
42	maxMVperMB	4	Enable Inter16x16, Inter16x8, Inter8x16 and Inter8x8 partitions.
43	intra4x4EnableIdc	INTRA4x4_IPSLICES	Enable Intra4x4 modes (Intra16x16 modes are enabled by default).

5.1.1 Results

The PSNR gains due to smaller partition sizes are shown in Table 5:

Table 5. PSNR Gains Due to Smaller Partition Sizes

	PSNR Improvement Due to Use of Smaller Partition Sizes (Inter and Intra) for OMAP3
Average	0.29
Max	1.00
Min	0.00
QCIF Average	0.41
QCIF Max	0.99
QCIF Min	0.00
CIF Average	0.42
CIF Max	1.00
CIF Min	0.21
D1 Average	0.17
D1 Max	0.55
D1 Min	0.00

5.1.2 Analysis

As can be seen, smaller partition sizes are important for certain sequences. On the average there is a 0.29 dB improvement and the maximum PSNR improvement is 1 dB. Therefore, these tools are very important for improving the quality of encoded stream.

However, there is a Mega cycles-per-second (MCPS) impact in using smaller partitions. The MCPS impact (increase in MHz) when these parameters are turned on (w.r.t., the basic configuration) is approximately as follows:

Table 6. Analysis of Smaller Partition Sizes

Sr No	Resolution	MHz Increase	Description
1	QCIF	12	
2	CIF	48	
3	D1	67	

5.2 Analysis of Perceptual Quantization

Perceptual quantization can be turned on by using the following parameter.

Table 7. Analysis of Perceptual Quantization

Sr No	XDM Data Structure	XDM Parameter	Value to Enable This Feature	Description
49	IH264VENC_DynamicParams	perceptualQuant	1	QP allocation based on perceptual criteria.

5.2.1 Results

As the name indicates, the gains out of perceptual quantization are visual/subjective. Sometimes a PSNR decrease is noticed when this tool is turned on and at the same time the visual quality is seen to be remarkably better; therefore, PSNR comparison cannot be used for this tool. SSIM is used to provide an objective measure of visual quality improvement.

SSIM comparison (higher is better) for perceptual quantization:

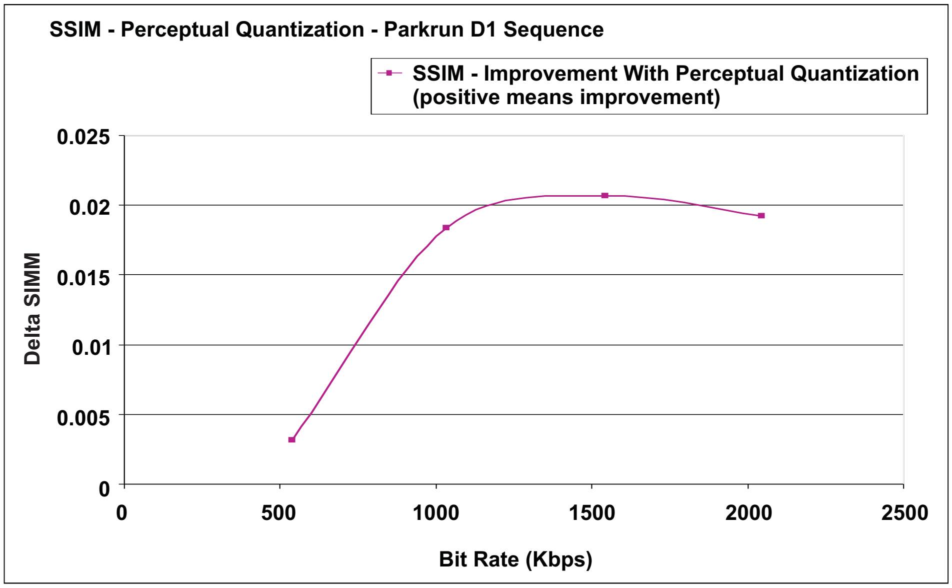

Figure 1. SSIM - Perceptual Quantization - Parkrun D1 Sequence

DMOS comparison (lower is better) for perceptual quantization:

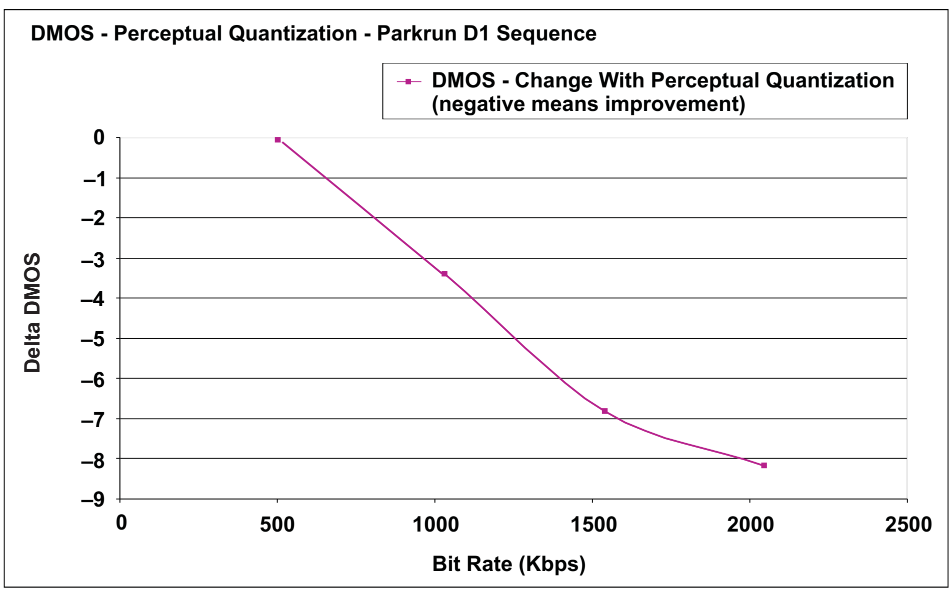

Figure 2. DMOS - Perceptual Quantization - Parkrun D1 Sequence

Figure 2 shows a significant improvement in visual quality of DMOS reduction of up to 8.

5.2.2 Analysis

As can be seen from the graph, there is an improvement in perceptual quality for the parkrun sequence. There are also other sequences that show improved visual quality with perceptual quantization.

The MCPS increase due to perceptual quantization is shown in Table 8.

Table 8. MCPS Increase Due to Perceptual Quantization

Sr No	Resolution	MHz Increase	Description
1	QCIF	1	
2	CIF	4	
3	D1	15	

5.3 *Analysis of Scene Change Detection*

Table 9. Analysis of Scene Change Detection

Sr No	XDM Data Structure	XDM Parameter	Value to Enable This Feature	Description
50	IH264VENC_DynamicParams	sceneChangeDet	1	0: Don't use scene change detection.
				1: Use scene change detection for better encoding (has slight MHz impact).

Scene change detection can benefit rate control and other encoder decisions when the sequence being encoded has frequent scene changes.

Table 10. MCPS Increase Due to Scene Change

Sr No	Resolution	MHz Increase	Description
1	QCIF	1	
2	CIF	1	
3	D1	15	

5.4 *Analysis of Hierarchical Coding*

Hierarchical coding can be turned on by using the following parameter. Hierarchical coding is seen to improve the PSNR of low motion sequences.

Table 11. Analysis of Hierarchical Coding

Sr No	XDM Data Structure	XDM Parameter	Value to Enable This Feature	Description
46	IH264VENC_DynamicParams	hierCodingEnable	1 or 2	0: IPP coding without non-reference frames.
				1: Use non-reference frames if it benefits video quality.
				2: Use non-reference frames alternatively (IpPpP) for improved quality and lower DDR bandwidth.

There is no MHz increase due to hierarchical coding, but it can potentially decrease MHz due to DDR traffic reduction. However, use of this feature can cause the bits consumption to fluctuate between the reference and non-reference frames as the non-reference frames are coarsely quantized to allocate more bits to the reference frames.

6 Benchmarking With Rate Control

This section contains PSNR comparison of the OMAP3 encoder with the JM encoder and encoders based on previous TI platforms when RC is enabled.

6.1 Benchmarking Against JM Encoder With Rate Control

The OMAP3 and JM encoders were compared with CBR rate control settings.

6.1.1 Results

Table 12. PSNR Change of JM17 Over OMAP3

	PSNR Change of JM17 Over OMAP3
Average	0.05
Max	0.26
Min	-0.19
QCIF Average	0.03
QCIF Max	0.14
QCIF Min	-0.19
CIF Average	0.06
CIF Max	0.26
CIF Min	-0.19
D1 Average	0.05
D1 Max	0.22
D1 Min	-0.03

6.1.2 Analysis

The OMAP3 encoder is found to be better in terms on PSNR, this might be giving a hint that the JM rate control may not be working correctly in certain situations.

6.2 Benchmarking Against Previous Platforms With Rate Control

The OMAP3 and JM encoders were compared with CBR rate control settings.

6.2.1 Results

Table 13. OMAP3 and JM Encoder Compared With CBR Rate Control Settings

	PSNR Change of OMAP2430_CBR Over OMAP3_CBR	PSNR Change of C64XPLUS_CBR Over OMAP3_CBR
Average	-0.28	-0.27
Max	0.72	0.61
Min	-1.07	-0.94
QCIF Average	-0.34	-0.33
QCIF Max	0.00	0.00
QCIF Min	-0.84	-0.73
CIF Average	-0.32	-0.32
CIF Max	0.31	0.16
CIF Min	-0.96	-0.77
D1 Average	-0.23	-0.22
D1 Max	0.72	0.61
D1 Min	-1.07	-0.94

6.2.2 Analysis

The OMAP3 encoder is found to be better in terms on PSNR compared to the older platforms.

7 Recommended Encoder Configurations for Specialized Use Cases

7.1 Recommended Configurations for Best Encoder Quality in Camcorder/Storage/Streaming/Surveillance Use Cases

These use cases can use the storage (VBR) rate control and periodic intra frames. In fact, any encoder use case that allows the use of periodic intra frames can use this configuration.

Smaller partition sizes and perceptual quantization can be used if MHz allows, depending on the specific OMAP3 variant and the resolution of video being encoded.

Table 14. Parameters for Specialized Use Cases

Sr No	XDM Data Structure	XDM Parameter	Value	Description
1	IVIDENC1_Params	encodingPreset	XDM_USER_DEFINED	This configuration allows specifying additional parameters.
2	-do-	rateControlPreset	IVIDEO_LOW_DELAY	IVIDEO_LOW_DELAY: Fast reacting CBR configuration. IVIDEO_STORAGE: Slow reacting VBR Configuration IVIDEO_NONE: Fixed QP encoding
3	-do-	maxHeight	NS [1]	
4	-do-	maxWidth	NS [1]	
5	-do-	maxFrameRate	NS [1]	
6	-do-	maxBitRate	NS [1]	
7	-do-	dataEndianness	1	
8	-do-	maxInterFrameInterval	0	
9	-do-	inputChromaFormat	1	
10	-do-	inputContentType	0	
11	IVIDENC1_DynamicParams	inputHeight	NS [1]	

(1) NS = Not specified, depends on actual application.

Table 14. Parameters for Specialized Use Cases (continued)

Sr No	XDM Data Structure	XDM Parameter	Value	Description
12	-do-	inputWidth	NS [(1)]	
13	-do-	refFrameRate	NS [(1)]	
14	-do-	targetFrameRate	NS [(1)]	
15	-do-	targetBitRate	NS [(1)]	Target bit rate value for encoding. See recommended values in the next section.
16	-do-	intraFrameInterval	30, 60 or 120 [(2)]	Typically set as a multiple of frame rate in common use cases.
17	-do-	generateHeader	0	
18	-do-	captureWidth	0	
19	-do-	forceFrame	0	
20	-do-	interFrameInterval	interFrameInterval	
21	-do-	mbDataFlag	mbDataFlag	
22	IH264VENC_Params	profileIdc	66	
23	-do-	levelIdc	30	
24	-do-	rcAlgo	0	Not needed - used only if rateControlPreset == IVIDEO_USER_DEFINED.
25	-do-	searchRange	48	
26	IH264VENC_Dynamic Params	qpIntra	28	
27	-do-	qpInter	28	
28	-do-	qpMax	51	
29	-do-	qpMin	10	Can use 0, but 10 is found to be better to handle various kind of situations.
30	-do-	lfDisableIdc	0	
31	-do-	quartPelDisable	0	
32	-do-	airMbPeriod	0	
33	-do-	maxMBsPerSlice	0	
34	-do-	maxBytesPerSlice	0	
35	-do-	sliceRefreshRowStartNumber	0	
36	-do-	sliceRefreshRowNumber	0	
37	-do-	filterOffsetA	0	
38	-do-	filterOffsetB	0	
39	-do-	log2MaxFNumMinus4	0	
40	-do-	chromaQPIndexOffset	0	
41	-do-	constrainedIntraPredEnable	0	
42	-do-	picOrderCountType	IH264_POC_ TYPE_0	
43	-do-	maxMVperMB	1	1: Enable only 16x16 partitions 4: Enable smaller partitions
44	-do-	intra4x4EnableIdc	INTRA4x4_ IPSLICES	INTRA4x4_NONE: Enable only Intra16x16 mode INTRA4x4_ISLICES: Enable smaller partitions for Intra for I frames INTRA4x4_IPSLICES: Enable smaller partitions for Intra for all frames (has MHz increase)
45	-do-	mvDataEnable	0	

(2) You might want to use something different than the recommended value.

Table 14. Parameters for Specialized Use Cases (continued)

Sr No	XDM Data Structure	XDM Parameter	Value	Description
46	-do-	hierCodingEnable	0	0: IPP coding without non-reference frames 2: Use non-reference frames alternatively for improved quality and lower DDR bandwidth 1: Use non-reference frames if it benefits video quality
47	-do-	streamFormat	IH264_BYTE_ STREAM	
48	-do-	intraRefreshMethod	IH264_ INTRAREFRESH_ NONE	
49	-do-	perceptualQuant	0	0: Quantization parameter is optimized for PSNR 1: Quantization Parameter usage for better visual quality (has slight MHz impact)
50	-do-	sceneChangeDet	0	0: Don't use scene change detection 1: Use scene change detection for better encoding (has slight MHz impact)
51	-do-	pfNalUnitCallBack	NULL	
52	-do-	numSliceASO	0	
53	-do-	asoSliceOrder [MAXNUMSLCGPS]	[0,0,0,0,0,0,0,0]	
54	-do-	numSliceGroups	0	
55	-do-	sliceGroupMapType	0	
56	-do-	sliceGroupChange DirectionFlag	0	
57	-do-	sliceGroupChangeRate	0	
58	-do-	sliceGroupChangeCycle	0	
59	-do-	sliceGroupParams [MAXNUMSLCGPS]	[0,0,0,0,0,0,0,0]	

7.2 Recommended Configurations for Improved Encoder Quality and Error Resilience in Video Teleconferencing and Other Full Duplex Real-Time Communications Use Cases

These use cases correspond to realtime communications on a bit rate constrained channel. Typically, these use cases don't use periodic intra frames, but uses intra macroblock refresh instead. Constrained intra prediction is needed if intra macroblock refresh is used. Low delay (CBR) rate control is recommended.

Smaller partition sizes and perceptual quantization can be used if MHz allows, depending on the specific OMAP3 variant and the resolution of video being encoded.

Table 15. Parameters for Real-Time Communications Use Cases

Sr No	XDM Data Structure	XDM Parameter	Value	Description
1	IVIDENC1_Params	encodingPreset	XDM_USER_DEFINED	This configuration allows specifying additional parameters.
2	-do-	rateControlPreset	IVIDEO_LOW_DELAY	IVIDEO_LOW_DELAY: Fast reacting CBR configuration IVIDEO_STORAGE: Slow reacting VBR Configuration IVIDEO_NONE: Fixed QP encoding
3	-do-	maxHeight	NS [(1)]	
4	-do-	maxWidth	NS [(1)]	

(1) NS = Not specified, depends on actual application.

Table 15. Parameters for Real-Time Communications Use Cases (continued)

Sr No	XDM Data Structure	XDM Parameter	Value	Description
5	-do-	maxFrameRate	NS [1]	
6	-do-	maxBitRate	NS [1]	
7	-do-	dataEndianness	1	
8	-do-	maxInter FrameInterval	0	
9	-do-	inputChromaFormat	1	
10	-do-	inputContentType	0	
11	IVIDENC1_ DynamicParams	inputHeight	NS [1]	
12	-do-	inputWidth	NS [1]	
13	-do-	refFrameRate	NS [1]	
14	-do-	targetFrameRate	NS [1]	
15	-do-	targetBitRate	NS [1]	Target bit rate value for encoding. See recommended values in the next section.
16	-do-	intraFrameInterval	0	Typically, intra frames are not used in VTC, but intra refresh is used.
17	-do-	generateHeader	0	
18	-do-	captureWidth	0	
19	-do-	forceFrame	0	
20	-do-	interFrameInterval	0	
21	-do-	mbDataFlag	0	
22	IH264VENC_Params	profileIdc	66	
23	-do-	levelIdc	30	
24	-do-	rcAlgo	0	Not needed - used only if rateControlPreset == IVIDEO_USER_DEFINED.
25	-do-	searchRange	48	
26	IH264VENC_ DynamicParams	qpIntra	28	
27	-do-	qpInter	28	
28	-do-	qpMax	51	
29	-do-	qpMin	10	Can use 0, but 10 is found to be better to handle various kind of situations.
30	-do-	lfDisableIdc	0	
31	-do-	quartPelDisable	0	
32	-do-	airMbPeriod	30 or 60 or 120 [2]	Specifies the number of frames required to intra refresh the complete frame. Typically a multiple of frame rate. Smaller this number, higher the error resilience.
33	-do-	maxMBsPerSlice	0	
34	-do-	maxBytesPerSlice	0	0: ignored Otherwise: Number of bytes per slice (typically less than MTU size) for H.241 video conferencing use case.
35	-do-	sliceRefreshRowStart Number	0	
36	-do-	sliceRefreshRow Number	0	
37	-do-	filterOffsetA	0	

[2] NS = Not specified, depends on actual application.

Table 15. Parameters for Real-Time Communications Use Cases (continued)

Sr No	XDM Data Structure	XDM Parameter	Value	Description
38	-do-	filterOffsetB	0	
39	-do-	log2MaxFNumMinus4	0	
40	-do-	chromaQPIndexOffset	0	
41	-do-	constrainedIntraPred Enable	1	0: constrained intra prediction is not used. 1: constrained Intra prediction is enabled – increases error resilience – decreases quality
42	-do-	picOrderCountType	IH264_POC_TYPE_0	
43	-do-	maxMVperMB	1	1: Enable only 16x16 partitions 4: Enable smaller partitions
44	-do-	intra4x4EnableIdc	INTRA4x4_IPSLICES	INTRA4x4_NONE: Enable only Intra16x16 mode INTRA4x4_ISLICES: Enable smaller partitions for Intra for I frames INTRA4x4_IPSLICES: Enable smaller partitions for Intra for all frames (has MHz increase)
45	-do-	mvDataEnable	0	
46	-do-	hierCodingEnable	0	0: IPP coding without non-reference frames 2: Use non-reference frames alternatively for improved quality and lower DDR bandwidth 1: Use non-reference frames if it benefits video quality
47	-do-	streamFormat	IH264_BYTE_STREAM	
48	-do-	intraRefreshMethod	IH264_INTRAREFRESH_ RDOPT_MBS	IH264_INTRAREFRESH_NONE: intra refresh is not used IH264_INTRAREFRESH_CYCLIC_MBS or IH264_INTRAREFRESH_RDOPT_MBS: different intra refresh strategies for error resilience
49	-do-	perceptualQuant	1	0: Quantization parameter is optimized for PSNR 1: Quantization Parameter usage for better visual quality (has slight MHz impact)
50	-do-	sceneChangeDet	1	0: Don't use scene change detection. 1: Use scene change detection for better encoding (has slight MHz impact)
51	-do-	pfNalUnitCallBack	NULL	
52	-do-	numSliceASO	0	
53	-do-	asoSliceOrder [MAXNUMSLCGPS]	[0,0,0,0,0,0,0,0]	
54	-do-	numSliceGroups	0	
55	-do-	sliceGroupMapType	0	
56	-do-	sliceGroupChange DirectionFlag	0	
57	-do-	sliceGroupChange Rate	0	
58	-do-	sliceGroupChange Cycle	0	

Table 15. Parameters for Real-Time Communications Use Cases (continued)

Sr No	XDM Data Structure	XDM Parameter	Value	Description
59	-do-	sliceGroupParams [MAXNUMSLCGPS]	[0,0,0,0,0,0,0,0]	

8 Cycles Required for Various Configurations

The MCPS required for encoding in various resolutions and configurations is shown in Table 16. The measurement is done in a standalone OMAP3 system (i.e., without concurrent audio running).

Table 16. MCPS Required for Encoding in Various Resolutions and Configurations

Parameters	QCIF (30 fps)	CIF (30 fps)	D1 (30fps) Stockholm 720x480 30fps 420p 302fr	D1 (30fps) Tractor 720x480 30fps 420p 300fr
1 MV, INTRA4X4_NONE, perceptualQuant = 0, sceneChangeDet = 0	41.234	125.581	357.972	376.742
1 MV, INTRA4X4_ISCLICES, perceptualQuant = 0, sceneChangeDet = 0	41.788	128.548	363.838	388.213
1 MV, INTRA4X4_ISCLICES, perceptualQuant = 1, sceneChangeDet = 1	43.834	135.356	382.639	402.468
4 MV, INTRA4X4_NONE, perceptualQuant = 0, sceneChangeDet = 0	53.353	155.486	441.348	474.668
4 MV, INTRA4X4_ISCLICES, perceptualQuant = 1, sceneChangeDet = 1	55.408	164.879	463.422	495.106
1 MV, INTRA4X4_IPSCLICES, perceptualQuant = 1, sceneChangeDet = 1	58.410	197.907	464.277	557.340
4 MV, INTRA4X4_IPSCLICES, perceptualQuant = 0, SceneChangeDet = 0	69.910	228.418	543.177	665.906
4 MV, INTRA4X4_IPSCLICES, perceptualQuant = 1, SceneChangeDet = 1	72.532	238.239	578.790	711.783

As seen from Table 16, the MHz required for D1 encoding varies from about 376 MCPS to about 711 MCPS depending on the exact configuration used. Depending on the available MHz in the DSP, one of the above configurations can be used.

9 Recommended Bit Rate Values for Encoding

Table 17 shows the recommended bit rate values to be used for encoding various resolutions.

Table 17. Recommended Bit Rate Values for Encoding Various Resolutions

Sr. No.	Video Quality Range	Resolution	Bit Rate Value (bits per second)
1	High quality	QCIF	256000
2	High quality	CIF	1000000
3	High quality	VGA/D1	4000000
1	Standard quality	QCIF	128000
2	Standard quality	CIF	500000
3	Standard quality	VGA/D1	2000000
1	Low quality	QCIF	64000
2	Low quality	CIF	256000
3	Low quality	VGA/D1	1000000

10 References

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3. Z. Wang, A. C. Bovik, H. R. Sheikh and E. P. Simoncelli, *Image Quality Assessment: From Error Visibility to Structural Similarity*," IEEE Transactions on Image Processing, vol. 13, no. 4, pp. 600-612, Apr. 2004.
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