

# JCTVC-G248

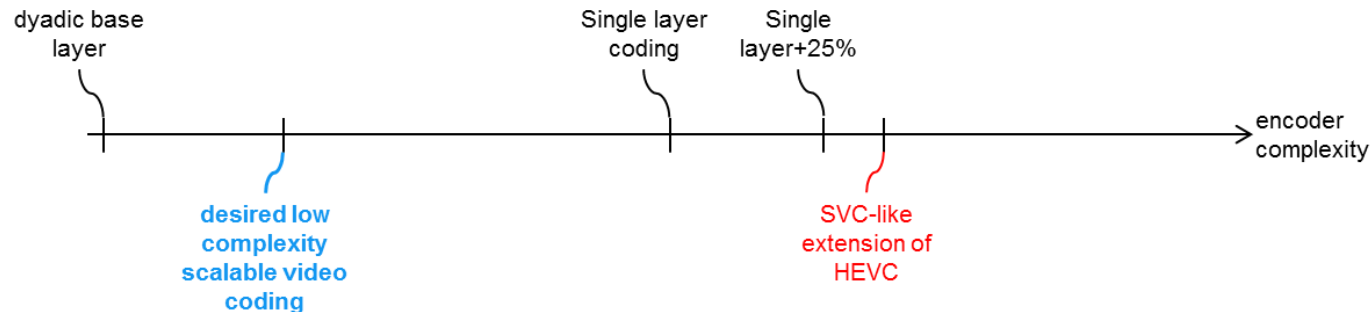
## Low-Complexity Scalable Extension of HEVC intra pictures

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JCT-VC 7<sup>th</sup> Meeting, Geneva 21-30 November, 2011

# Motivation

- Scalability usually increases complexity of non-scalable video codecs
- Here: scalability wanted as a means to reduce complexity
  - While keeping good coding efficiency

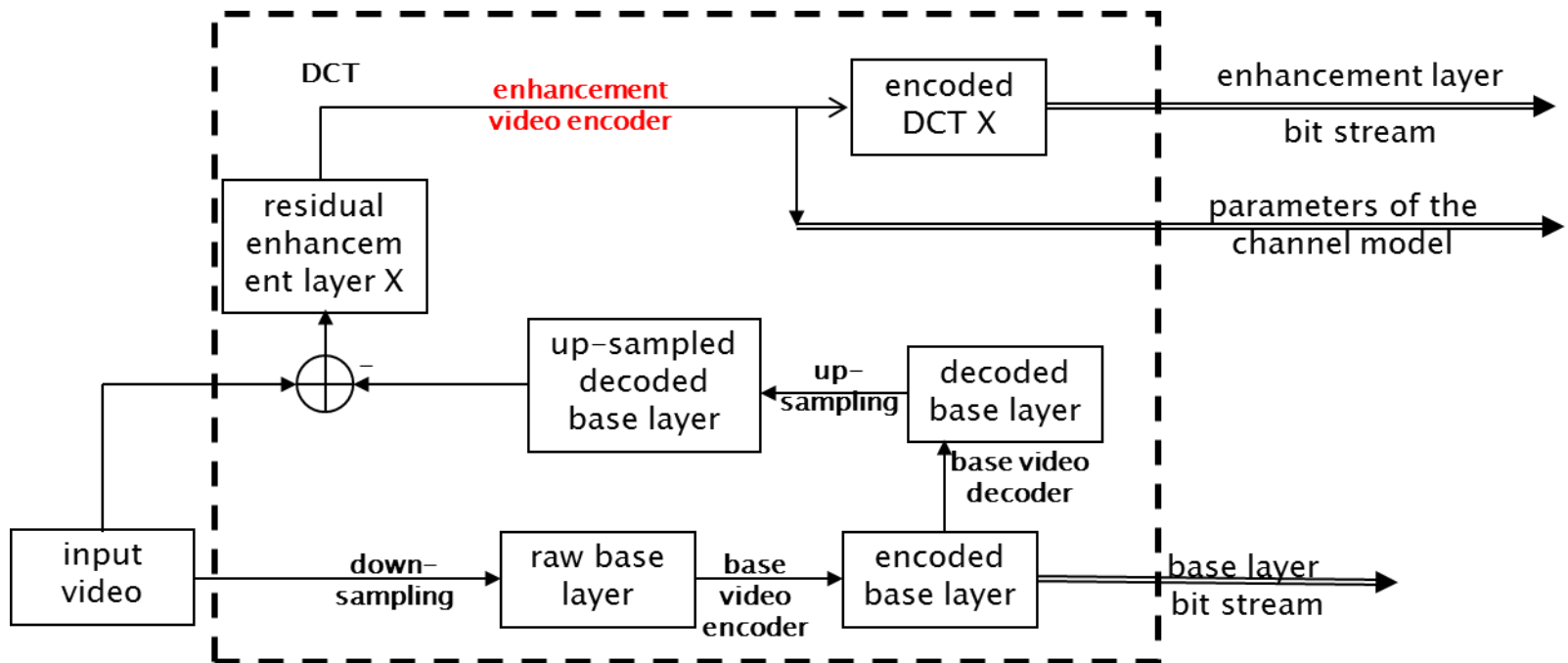


- Additional desired features:
  - Highly parallelizable coding/decoding processes
  - Spatial random access: ability to extract and decode a spatial area from the video stream

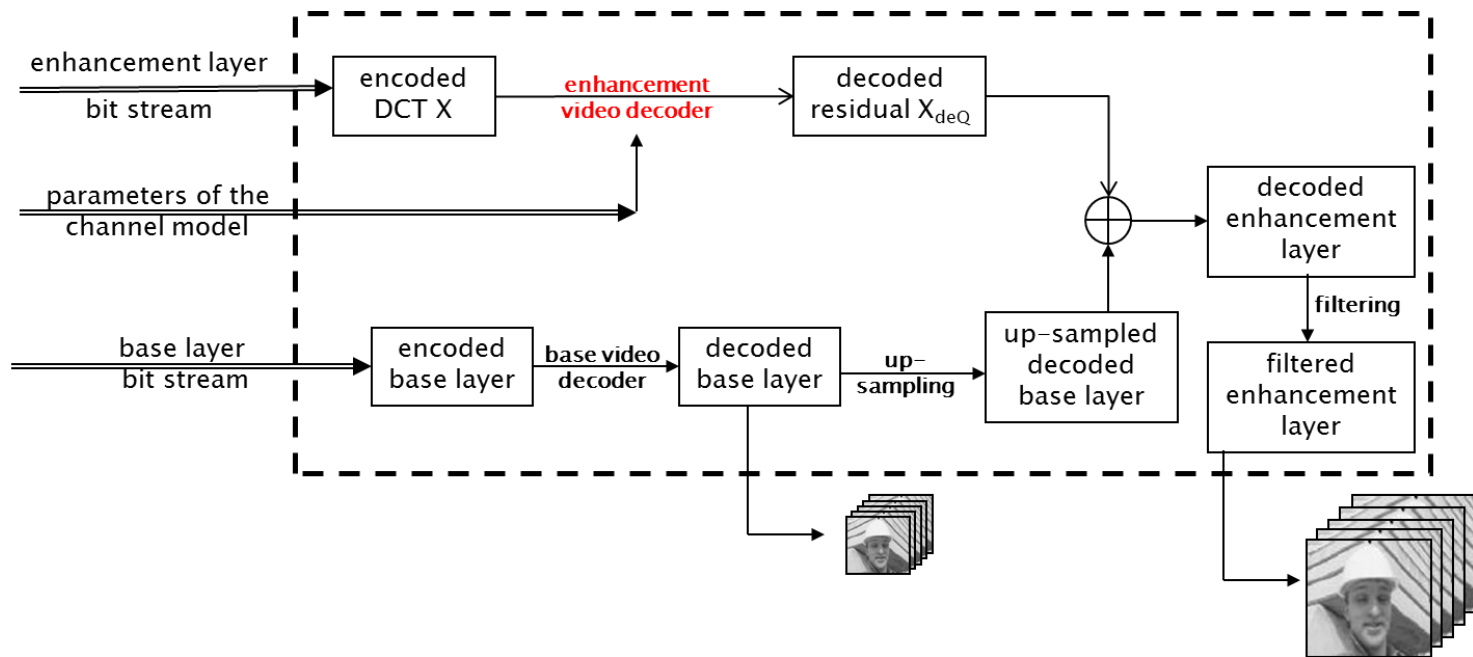
# Principle of the proposed approach

- Only one coding mode used in the enhancement layer
  - Inter-layer intra prediction (analogous to I\_BL in H.264/SVC)
  - Suppression of all spatial dependencies between neighboring blocks in the enhancement pictures
    - No spatial prediction
    - Non context-based and non-adaptive entropy coding
- Low-complexity intra residual texture coding/decoding process

# Overall encoder architecture

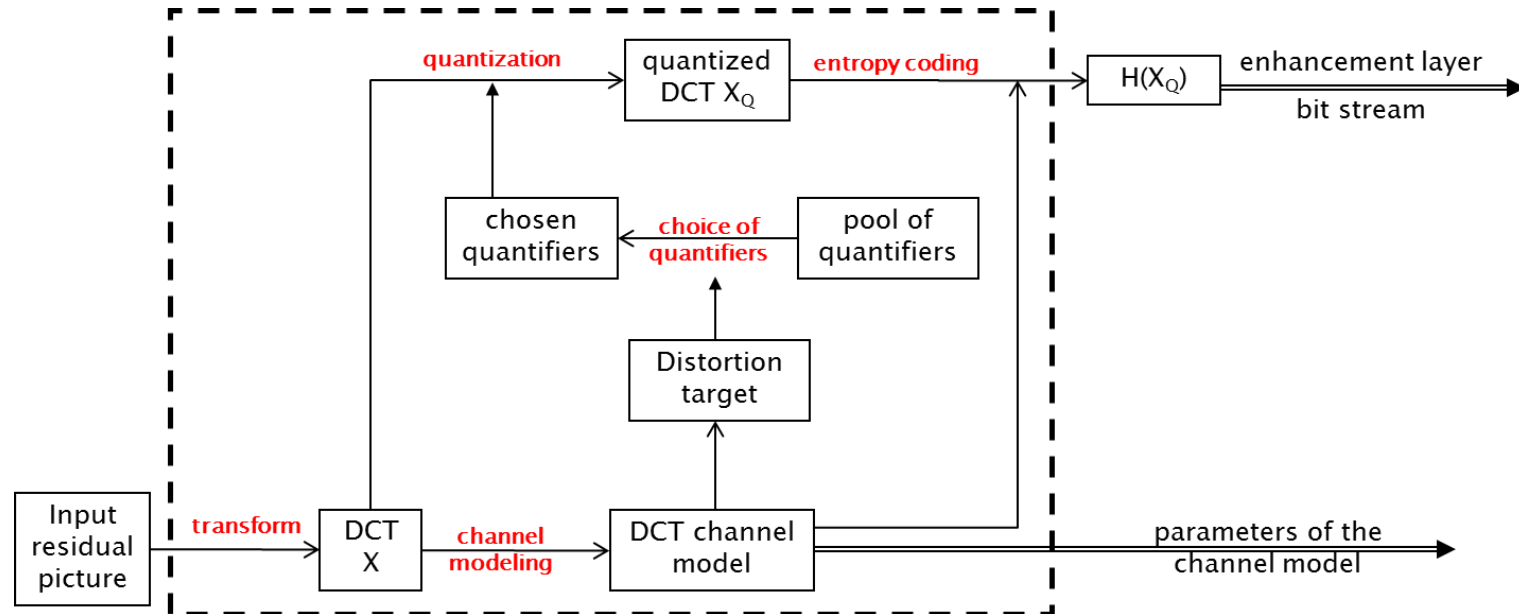


# Overall decoder architecture



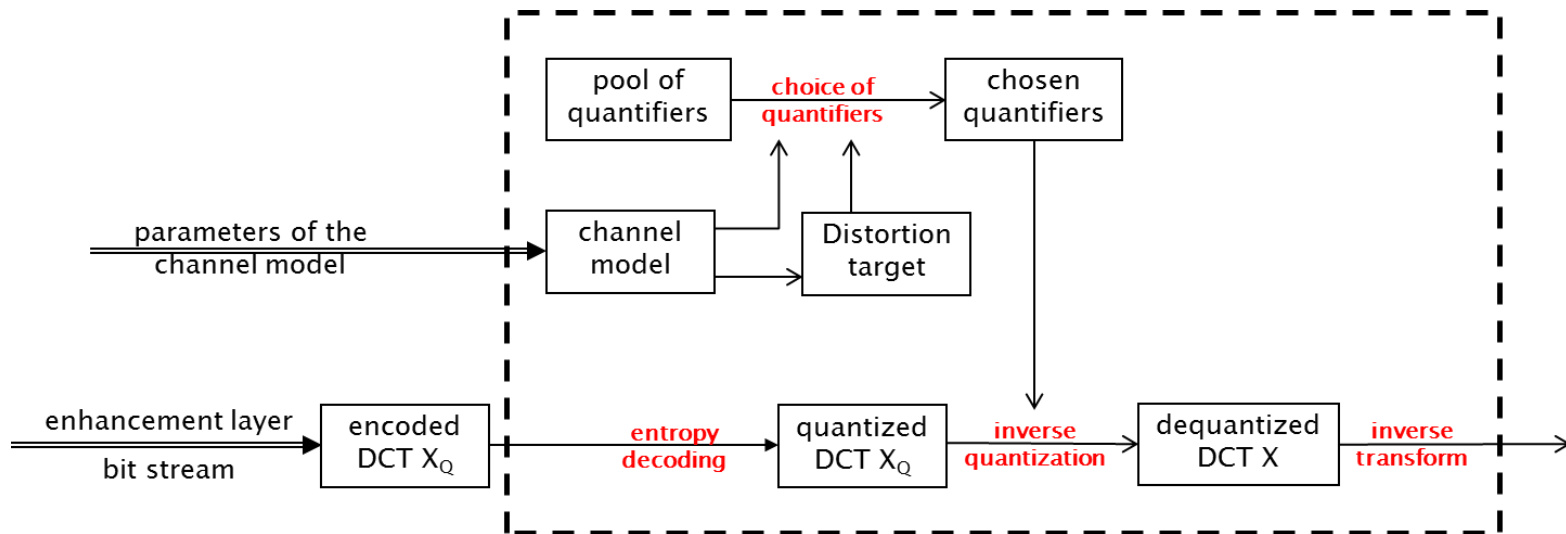
# Residual data coding process

- DCT coefficients modeled by a Generalized Gaussian Distribution (GGD)
- Pool of rate distortion optimal quantifiers computed off-line
- Distortion targets balanced between DCT channels
- Entropy coding: fixed probabilities computed off-line



# Residual data decoding process

- DCT coefficients GGD model received from the encoder
- Pool of rate distortion optimal quantifiers available at the decoder
- Distortion targets balanced between DCT channels (like the encoder)
- Entropy decoding: fixed probabilities computed off-line



# Experiments

- Dyadic spatial scalability. Comparisons between 3 coding configurations:
  - HEVC single layer: HM4.0, Intra LoCo mode, QP values 22, 27, 32, 37
  - HEVC simulcast: HM4.0 base layer, Intra LoCo mode,  $\mathbf{QP_{enh} = QP_{base} - 2}$  (as in JCTVC-F290)
  - Proposed low-complexity INTRA enhancement pictures. PSNR values close to those of HM4.0
- SNR scalability. Comparisons between 3 configurations:
  - HEVC single layer: HM4.0, Intra LoCo, QP = 22, 27, 32, 37
  - HEVC simulcast:  $\mathbf{QP_{enh} = QP_{base} + 3}$
  - Proposed low-complexity INTRA
- A non-parallelized version of the proposed INTRA codec is used for the tests

# Obtained results: dyadic spatial scalability

				HM 4,0				Proposed low-complexity intra					
		QP base	QP top	Simulcast	Base	Single-layer	Y psnr	kbps	Y psnr	U psnr	V psnr	delta simul	delta single
4K	Traffic	20	22	155611	48734	106877	43,37	127185	43,26	42,37	44,39	-26,4	11,31
		25	27	90727	30501	60226	40,16	68171	40,15	39,16	41,24		
		30	32	52777	18332	34445	37,08	37227	37,09	36,83	38,96		
		35	37	29974	10358	19616	34,04	20468	33,97	35,85	37,98		
	PeopleOnStreet	20	22	164134	54643	109491	43,24	122717	43,14	43,05	43,26	-28,8	10,36
		25	27	98965	34677	64288	39,82	75665	40,18	41,58	42,06		
		30	32	58819	21419	37400	36,70	43908	37,08	40,16	40,83		
		35	37	35339	12983	22356	33,85	24358	33,89	38,56	39,41		
Class B 1072p	Kimono	20	22	34565	11556	23009	42,70	23257	42,72	42,61	43,20	-35,6	0,39
		25	27	19596	7011	12585	40,99	12550	40,94	41,31	41,91		
		30	32	11238	4106	7132	38,92	7167	38,93	40,23	40,99		
		35	37	6208	2210	3998	36,47	4057	36,56	39,15	40,17		
	ParkScene	20	22	74831	20326	54505	41,72	61769	41,87	41,64	42,36	-24,9	7,17
		25	27	41957	12314	29643	38,59	32002	38,65	38,38	39,38		
		30	32	22416	6943	15473	35,56	16639	35,58	37,39	38,70		
		35	37	11034	3450	7584	32,70	8058	32,70	36,36	38,04		
	Cactus	20	22	142505	36103	106402	40,48	117555	40,57	39,66	42,19	-20,1	15,70
		25	27	73399	22568	50831	37,93	58239	37,86	37,90	39,49		
		30	32	40969	13333	27636	35,68	32115	35,63	37,19	38,45		
		35	37	22441	7346	15095	33,24	17253	33,21	36,31	37,20		
	BasketballDrive	20	22	96020	22542	73478	41,19	85018	41,26	42,00	41,77	-13,2	25,22
		25	27	44239	13497	30742	38,66	39182	38,69	41,05	40,62		
		30	32	24024	8004	16020	36,84	21424	36,94	40,18	39,63		
		35	37	13596	4557	9039	34,83	11768	34,90	39,07	38,36		
	BQTerrace	20	22	233964	44692	189272	42,37	210785	42,28	41,14	43,43	-10,8	19,36
		25	27	111132	28520	82612	37,04	101418	37,17	39,01	41,83		
		30	32	60284	17444	42840	34,46	56614	34,54	38,22	40,94		
		35	37	33312	9918	23394	31,99	30045	32,00	37,30	39,97		
Class A												-27,6	10,8
Class B												-20,9	13,6
All												-22,8	12,79
Time geomean								6499,4					
Time ratio: proposed scalable approach (base+enh) vs. base layer only											154,01%		
Time ratio: proposed scalable approach (base+enh) vs. HEVC single layer											42,91%		
Time ratio: proposed scalable approach (base+enh) vs. HEVC simulcast											33,55%		

# Obtained results: SNR scalability

				HM 4,0				Proposed low-complexity intra					
		QP base	QP top	Simulcast	Base	Single layer	Y psnr	kbps	Y psnr	U psnr	V psnr	delta simul	delta single
Class A 4K	Traffic	25	22	182871	75994	106877	43,37	115115	43,33	42,57	44,57	-38,3	5,73
		30	27	103920	43694	60226	40,16	64028	40,31	39,53	41,51		
		35	32	58995	24550	34445	37,08	36185	37,01	37,98	39,95		
		40	37	33174	13558	19616	34,04	21079	33,99	36,90	38,95		
	PeopleOnStreet	25	22	189461	79970	109491	43,24	115655	43,26	44,56	44,41	-38,8	5,87
		30	27	111189	46901	64288	39,82	67697	39,86	42,83	43,04		
		35	32	64689	27289	37400	36,70	40966	36,86	41,06	41,59		
		40	37	38826	16470	22356	33,85	24478	33,88	39,82	40,58		
Class B 1072p	Kimono	25	22	38953	15944	23009	42,70	23826	42,76	43,41	44,47	-40,0	2,48
		30	27	21687	9102	12585	40,99	13129	41,05	42,12	42,88		
		35	32	12171	5039	7132	38,92	7434	38,99	40,87	41,64		
		40	37	6735	2737	3998	36,47	4200	36,54	39,97	40,87		
	ParkScene	25	22	92610	38105	54505	41,72	56502	41,82	41,83	42,32	-36,8	5,57
		30	27	50164	20521	29643	38,59	31349	38,65	40,08	40,54		
		35	32	25635	10162	15473	35,56	16726	35,60	38,48	39,31		
		40	37	12260	4676	7584	32,70	8346	32,74	37,35	38,66		
	Cactus	25	22	172981	66579	106402	40,48	110043	40,75	40,21	43,01	-37,0	6,29
		30	27	86515	35684	50831	37,93	52125	37,82	39,08	41,45		
		35	32	46837	19201	27636	35,68	29702	35,63	38,09	39,89		
		40	37	25357	10262	15095	33,24	16697	33,18	37,32	38,70		
	BasketballDrive	25	22	115822	42344	73478	41,19	76501	41,21	43,61	44,86	-35,7	7,54
		30	27	51487	20745	30742	38,66	31396	38,56	42,41	43,17		
		35	32	27316	11296	16020	36,84	17360	36,80	41,13	41,45		
		40	37	15373	6334	9039	34,83	10685	34,92	40,17	40,11		
	BQTerrace	25	22	306902	117630	189272	42,37	184918	41,84	41,68	43,62	-36,8	5,17
		30	27	137841	55229	82612	37,04	88694	37,19	40,28	42,51		
		35	32	72645	29805	42840	34,46	45892	34,35	38,98	41,40		
		40	37	39270	15876	23394	31,99	27442	32,10	38,13	40,67		
	Class A											-38,6	5,8
	Class B											-37,2	5,4
	All											-37,6	5,52

# Results analysis

- Spatial scalability: 12.79% bitrate increase over HEVC single layer
- SNR scalability: 5.5% bitrate increase over HEVC single layer
- Encoding complexity of proposed scalable approach (base + enhancement) is lower than that of non-scalable HEVC

# Conclusion

- Proposed approach characteristics:
  - Low complexity scalable coding: complexity of single layer coding is reduced in spatial scalability
  - Obtained coding efficiency shows reasonable cost of scalability compared to non-scalable HEVC
  - Coding/decoding process is highly parallelizable
  - Spatial random access feature is easily provided
- **Interesting rate distortion performances can be obtained with a very low complexity INTRA scalable coding process**
- **Recommendation:**
  - **We propose to consider very low complexity requirements in the design of HEVC scalable extension**
  - **Testing conditions imposing limited encoder complexity are desired**