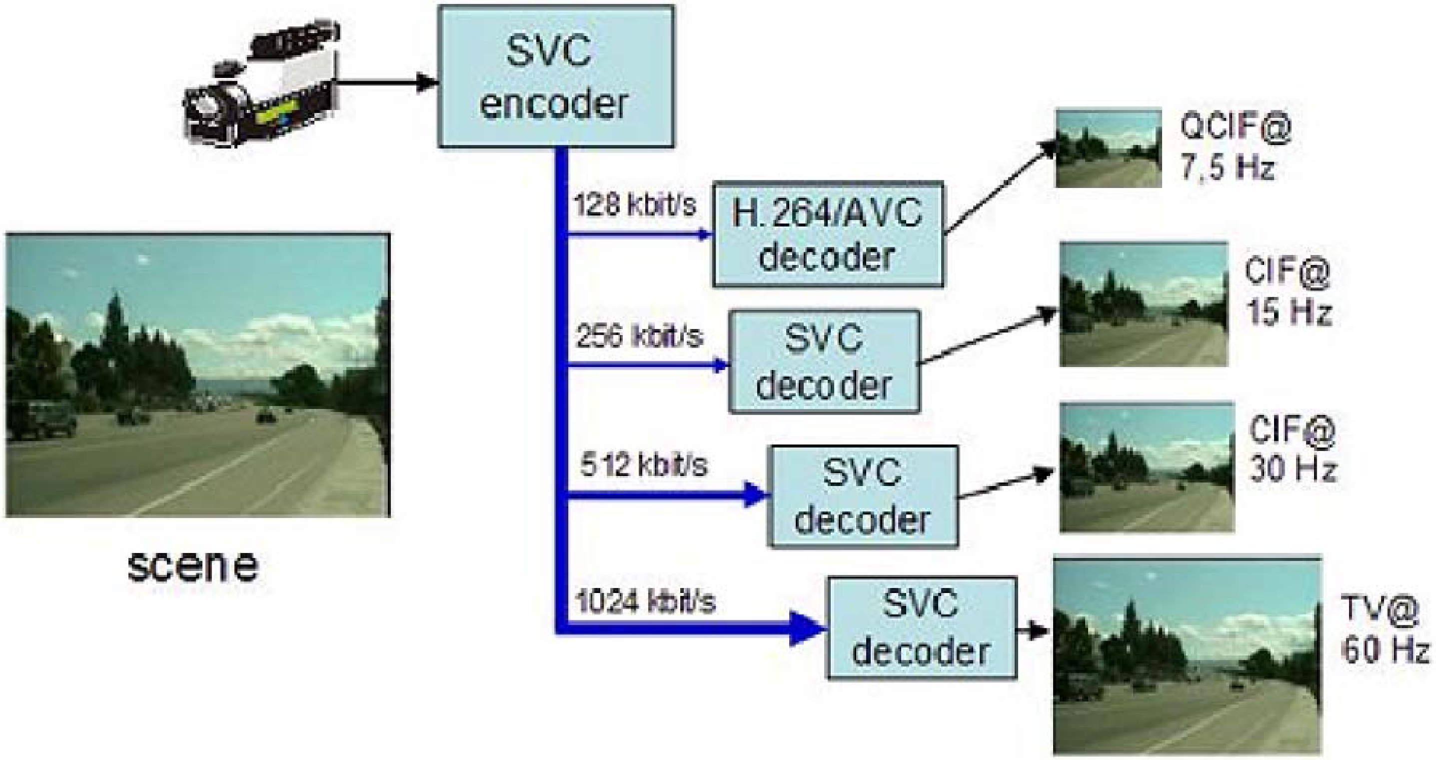
Scalable Video Coding

Prof. V. M. Gadre
Department of Electrical Engineering,
IIT Bombay.

Scalable Video Coding

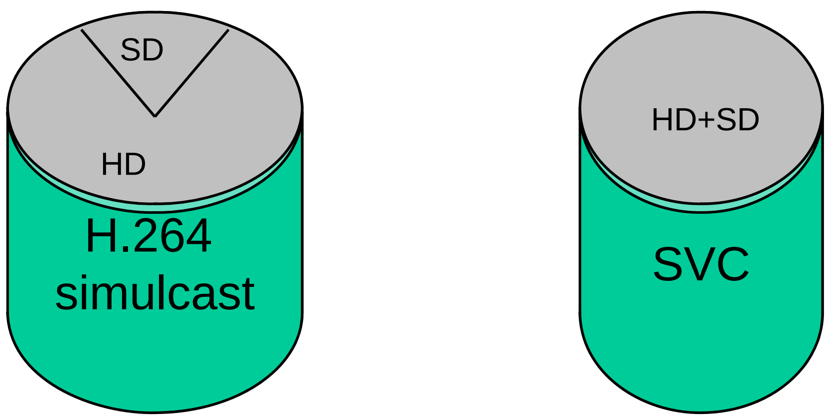
- Video streaming over internet is gaining more and more popularity due to video conferencing and video telephony applications.
- The heterogeneous, dynamic and best effort structure of the internet, motivates to introduce a scalability feature as adapting video streams to fluctuations in the available bandwidths.
- Optimize the video quality for a large range of bit-rates.
- A video bit stream is called scalable if part of the stream can be removed in such a way that the resulting bit stream is still decodable.
- Scalability here implies:
  - Single encode
  - Multiple possibilities to transmit and decode bitstream

Scalable Video Coding



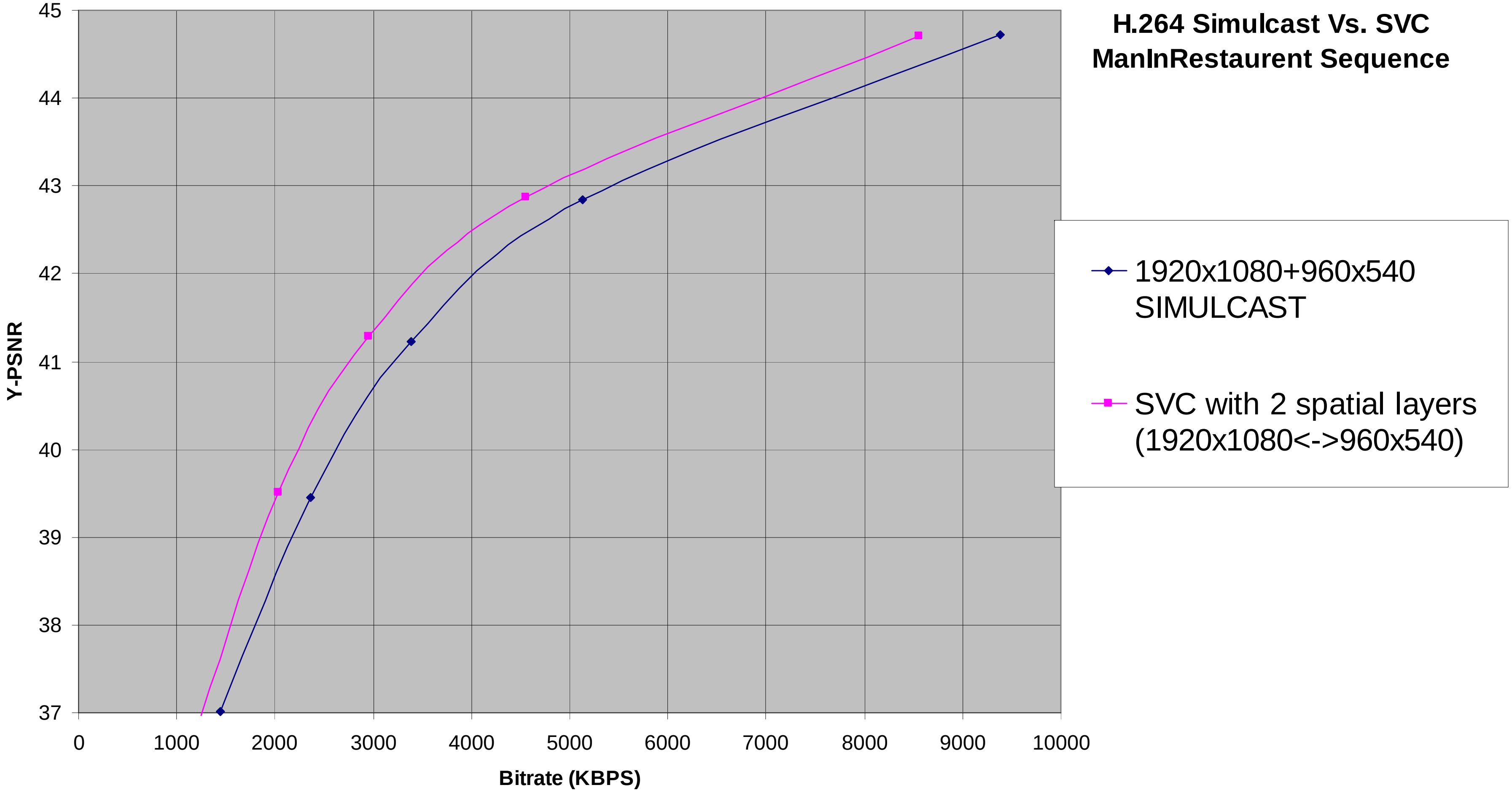
H.264/AVC Simulcast vs. SVC

- Simulcast
  - Transmitting both (multiple) bit-streams
- SVC
  - Transmit a single bit-stream that can be adapted to get any of the bit-stream

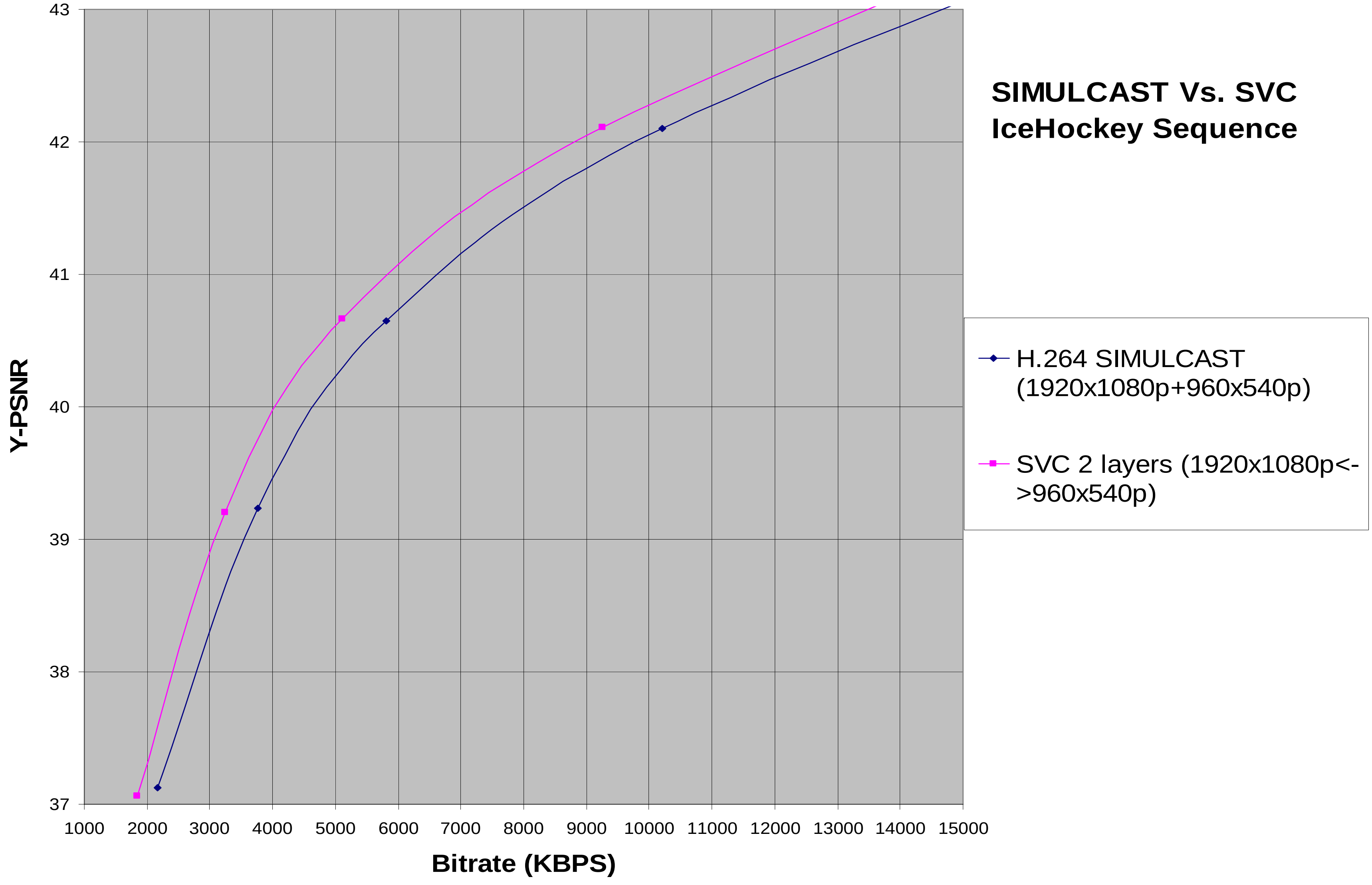


Simulcast needs more bit rate to achieve the same quality

H.264/AVC Simulcast vs SVC



H.264/AVC Simulcast vs. SVC



H.264/AVC Simulcast vs. SVC

- Typical gains in quality by doing SVC spatial scalability (as opposed to Simulcast) may be in the range
  - of 0.5dB to 1.5dB PSNR gain
  - Or equivalently 10 to 30% bit rate reduction
- This gap will be more if there are more than one SNR layer per spatial layer

Requirements from an SVC standard

- Superior coding efficiency compared to simulcasting the supported resolutions in separate bit-streams.
- Similar coding efficiency compared to single layer coding for each subset of bit-stream.
- Minimum increase in decoding complexity.
- Support for a backward compatible base layer.
- Support of simple bit-stream adaptations after encoding.

Functionalities and Applications

- SVC has capability of reconstructing lower resolution or lower quality signals from partial bit streams.
- Partial decoding of the bit stream allows-
  - Graceful degradation in case part of bit stream is lost.
  - Bit-rate adaptation
  - Format adaptation
  - Power adaptation
- Beneficial for transmission services with uncertainties regarding
  - Resolution required at the terminal.
  - Channel conditions or device types.

SVC Basics

- Straight forward extension to H.264 with very limited added complexity
- Layered approach
  - One base layer
  - One or more enhancement layers.
- Base layer is H.264/AVC compliant.
- An SVC stream can be decoded by an H.264 decoder.
- Enhancement layers enable Temporal, Spatial or Quality (SNR) scalability.

SVC Basics

- In Spatial scalability and Temporal Scalability the subset of the bit-stream represent the source content with reduced picture size (Spatial Resolution) or frame rate (Temporal Resolution).
- In case of quality scalability, also known as fidelity or SNR scalability, the subset of the bit-stream provides lower quality. (Lower SNR).
- In rare cases, “region-of-interest” and object based scalability is also required, wherein the subsets of the bit-stream represent spatially contiguous regions of original picture area.
- Multiple scalability features can be combined to support various spatio-temporal resolutions and bit rates within single bit-stream.

SVC Profiles

- SVC Standard defines 3 profiles
  - Scalable Baseline profile
    - Targeted for conversational and surveillance applications.
    - Support for Spatial Scalable coding is restricted to ratios 1.5 and 2, between successive spatial layers.
    - Interlaced video not supported.
  - Scalable High profile
    - Designed for broadcast, storage and streaming applications.
    - Spatial scalable coding with arbitrary resolution ratios supported.
    - Interlaced video supported
  - Scalable High Intra profile
    - Designed for professional applications.
    - Contains only IDR pictures for all layers.
    - All other coding tools are same as Scalable High Profile.

SVC – Principle – Single Encoding

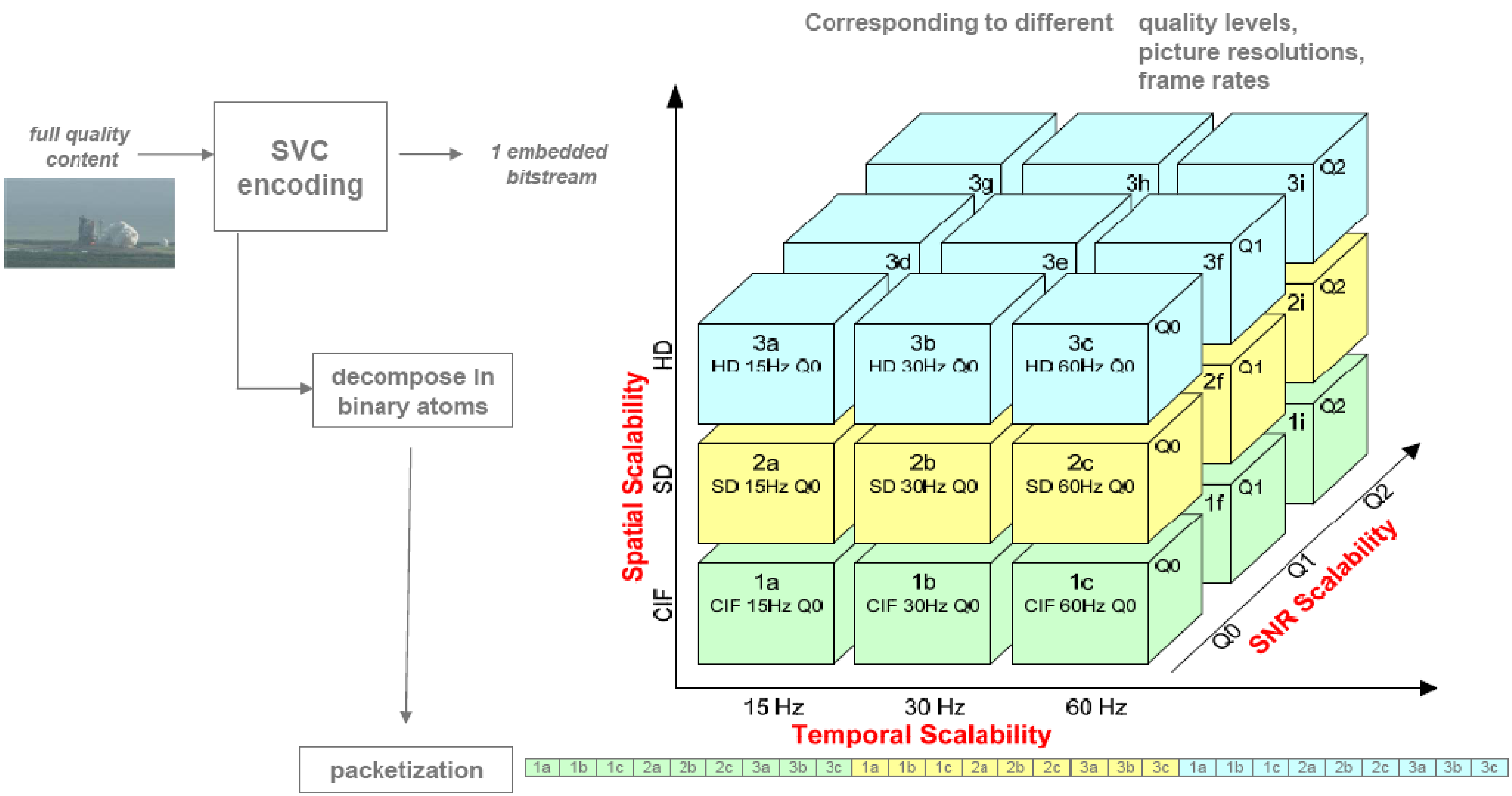


Figure courtesy "Scalable Video Coding Scalable extension of H.264 / AVC" Vincent Botreau, Thomson

SVC – Principle – Multiple Decoding

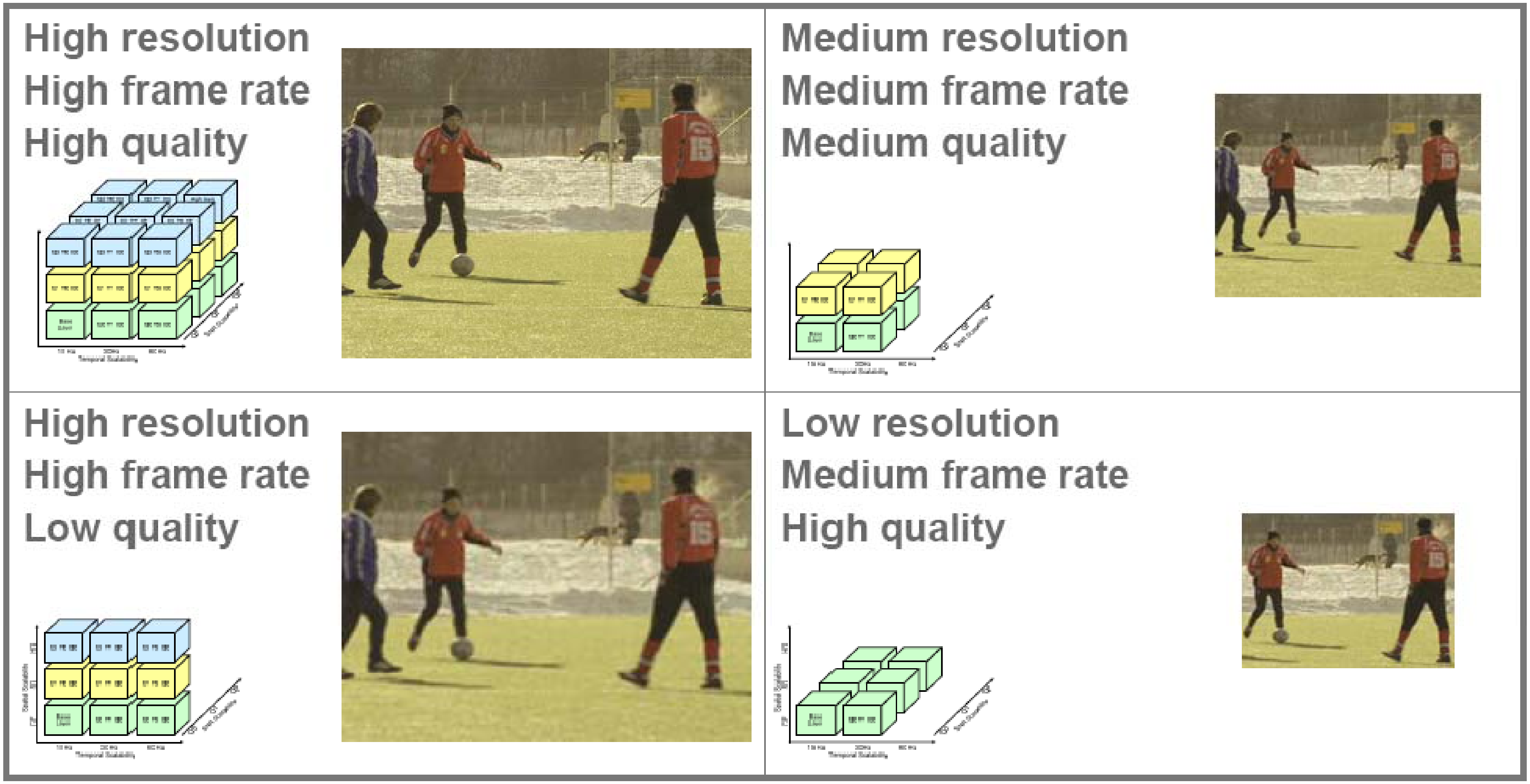


Figure courtesy "Scalable Video Coding Scalable extension of H.264 / AVC" Vincent Botreau, Thomson

Temporal Scalability

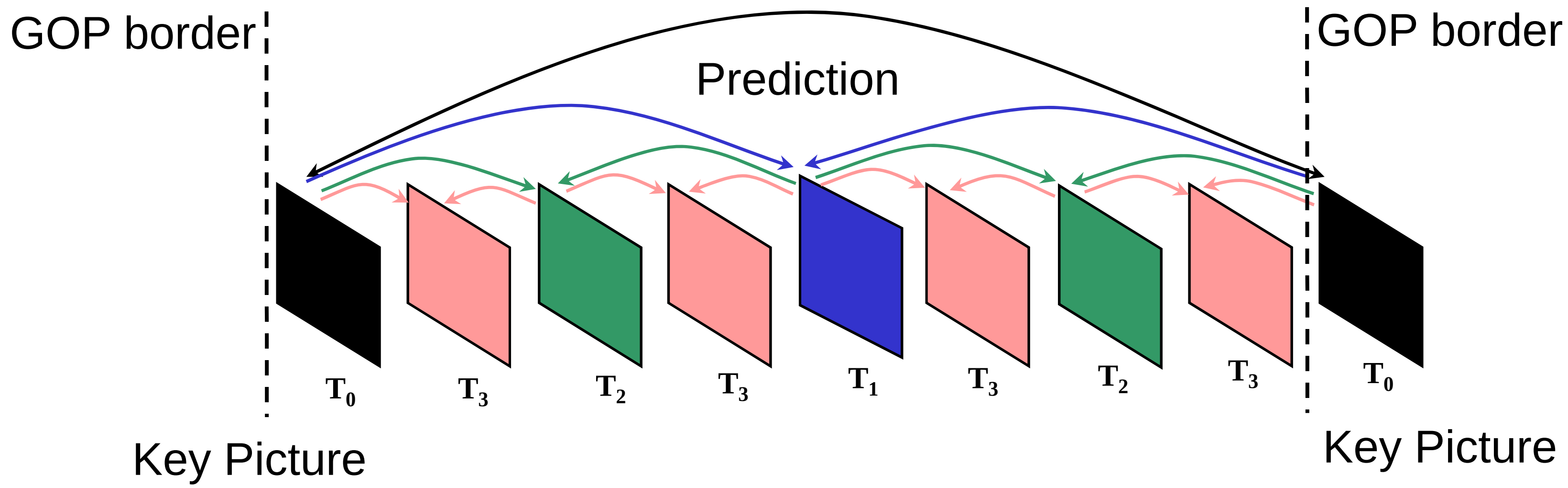
Temporal Scalability

- A bit-stream provides temporal scalability if,
  - The bit-stream obtained by removing the access units of all temporal layer identifier T_x greater than k ($k \in \mathbf{N}$) forms another valid bit-stream. ($x \in \{0,1,2,\ldots\}$) $x=0$ represents base layer.
- H.264/AVC provides high flexibility for Temporal Scalability, due to its Reference Picture Memory Control.
  - H.264 allows coding of pictures with arbitrary temporal dependencies, restricted by maximum usable DPB size. (Use of hierarchical B-pictures)

Temporal Scalability

(Dyadic prediction structure)

Frame Rate = 3.75 fps



T_x : Temporal Layer Identifier

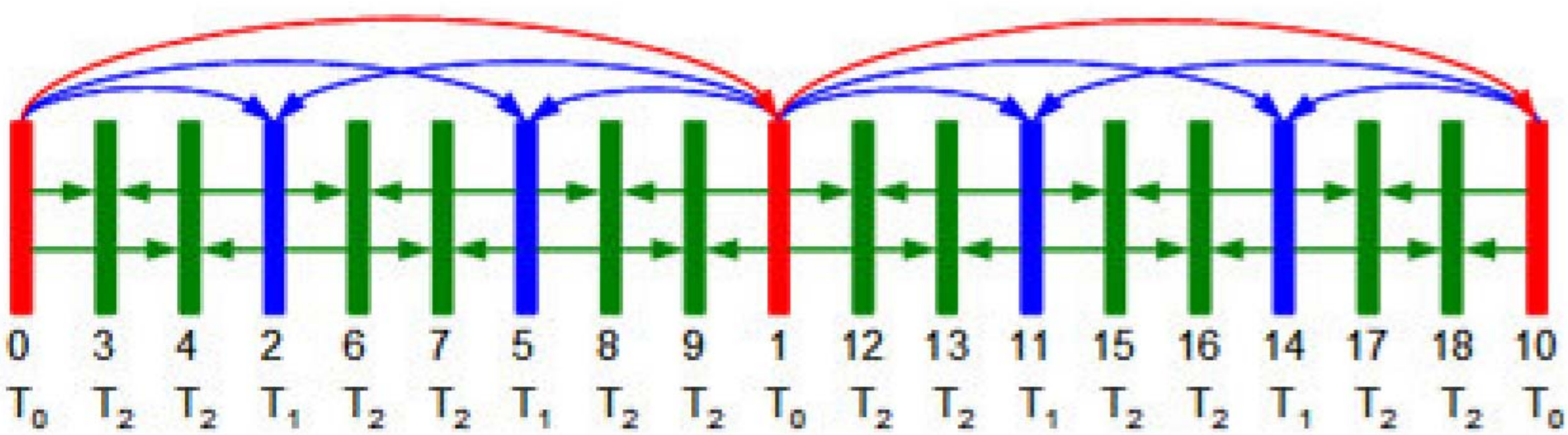
Structural Delay = 7 frames

- **Group of Pictures (GOP)**
  - *Key Picture:* Typically Intra-coded
  - *Hierarchically predicted B Pictures:* Motion-Compensated Prediction

Hierarchical B-pictures

- Temporal scalability with dyadic temporal enhancement layers can be efficiently provided by concept of hierarchical B-pictures.
- The enhancement layer pictures are typically coded as B-pictures, where the reference picture lists 0 and 1 are restricted to temporally preceding and succeeding picture.
  - The temporal layer identifiers, T, of the reference pictures must be less than that of the picture to be predicted.
- The hierarchical prediction structures are not restricted to dyadic case (as shown in previous slide), following slide shows non-dyadic prediction structure.

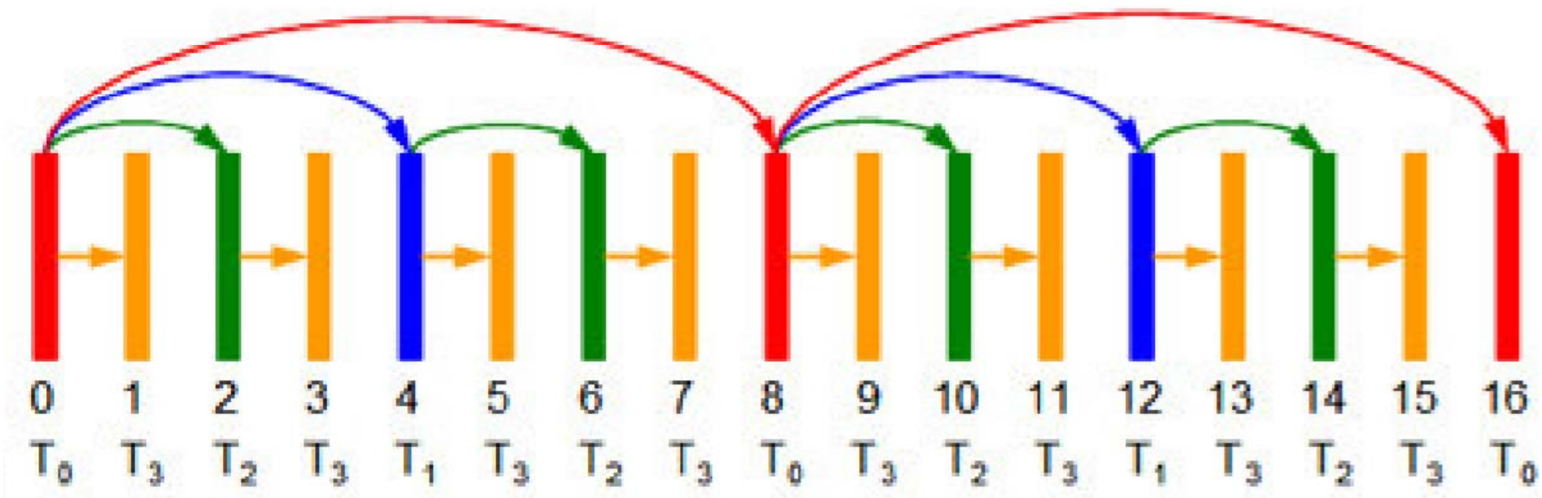
Hierarchical B-pictures



- Above is a non-dyadic prediction structure, which provides 2 independently decodable subsequences with 1/9th and 1/3rd of full frame rate.
- Structural delay = 8 frames

Figure courtesy "Overview of Scalable Video Coding extension of H.264 / AVC" SCHWARZ et al., IEEE Transactions on circuits and Systems for Video Technology, Sept. 2007

Hierarchical B-pictures



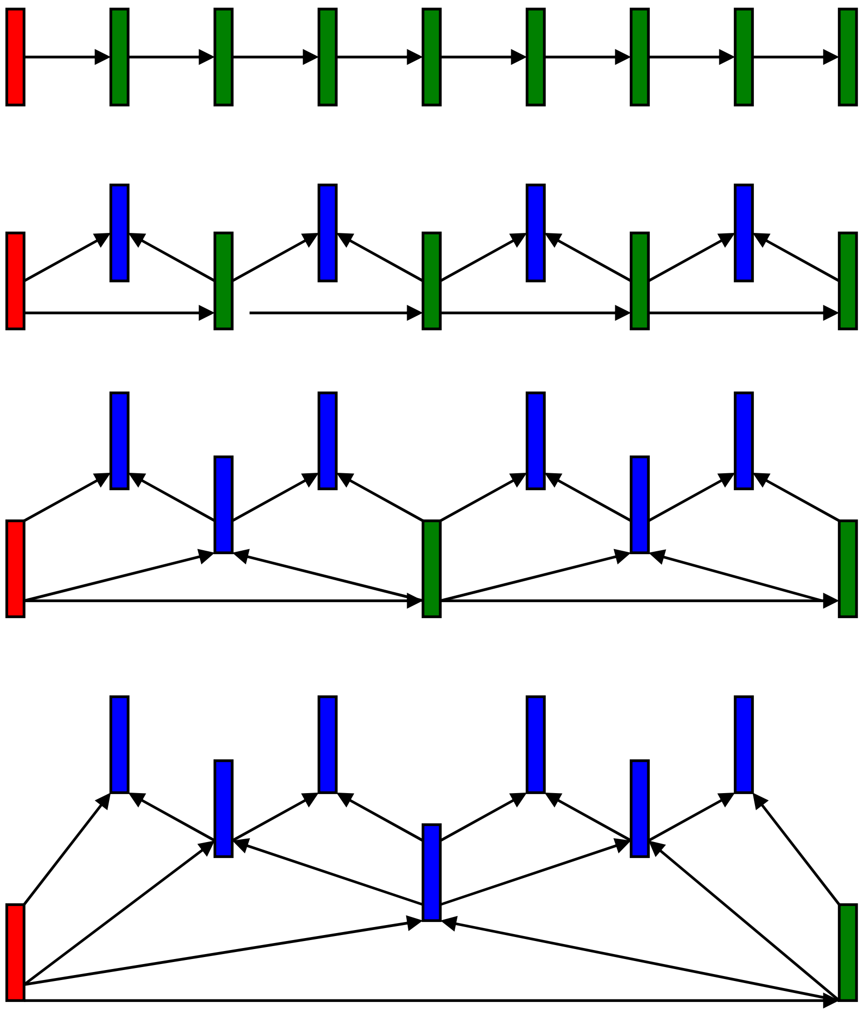
- Above is a non-dyadic prediction structure, which provides 0 structural delay, but low coding efficiency, compared to above examples.
- Any chosen prediction structure need not be constant over time. It can be arbitrarily modified, e.g., to improve coding efficiency.

Figure courtesy "Overview of Scalable Video Coding extension of H.264 / AVC" SCHWARZ et al., IEEE Transactions on circuits and Systems for Video Technology, Sept. 2007

Group Of Pictures (GOP)

- The set of pictures between two successive pictures of the temporal base layer together with the succeeding base layer picture is referred to as GOP.
- Selection GOP size has direct effects on Coding Efficiency and structural delay.

Group Of Pictures (GOP)



- IPP : GOP Size 1
  - No Temporal scalability
  - Only Temporal Level 0
- IBP : GOP Size 2
  - Temporal Levels 0, 1
- GOP Size 4
  - Temporal Levels 0, 1, 2
- GOP Size 8
  - Temporal Levels 0, 1, 2, 3

Coding efficiency of Hierarchical Prediction Structures

DSP Lab

- Analysis of coding efficiency for hierarchical B-pictures without any delay constraint (High Delay Test Sequences) indicates that the coding efficiency can be continuously improved with increase in GOP size.
  - Increasing GOP size increases delay
- PSNR gains of about 1 db can be achieved using this.
- Maximum coding efficiency is achieved for GOP size between 8 and 32 pictures.

Coding efficiency of Hierarchical Prediction Structures

DSP Lab

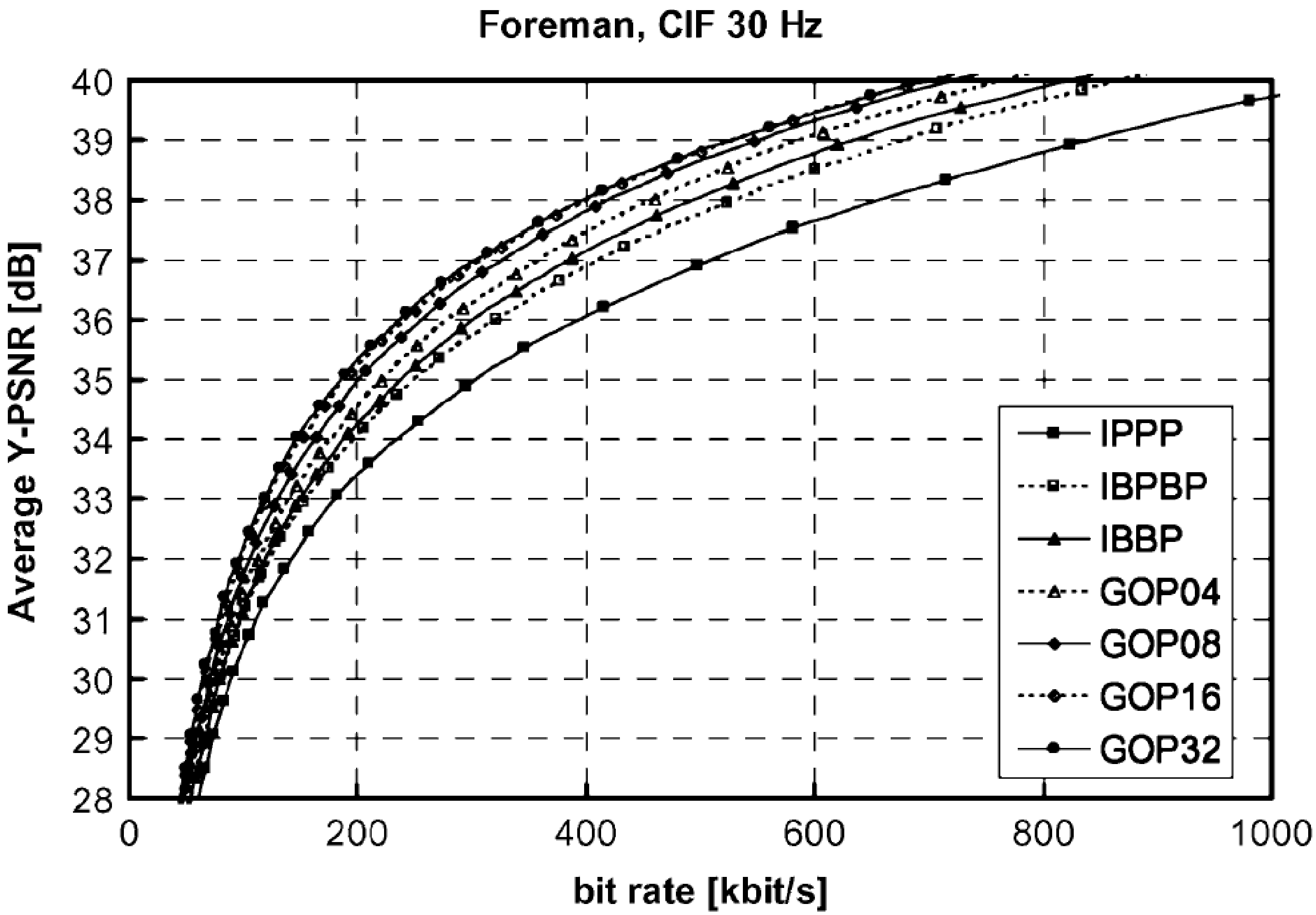


Figure courtesy "Overview of Scalable Video Coding extension of H.264 / AVC" SCHWARZ et al., IEEE Transactions on circuits and Systems for Video Technology, Sept. 2007

Coding efficiency of Hierarchical Prediction Structures

- Analysis of coding efficiency of hierarchical prediction structures for low delay test sequences indicate that the coding efficiency improvements are significantly smaller compared to those of high delay test sequences.
- From these observations it can be deduced that providing temporal scalability may result in minor losses in coding efficiency for low delay applications, but significant improvement in coding efficiency can be achieved for high delay applications.

Effect of varying QP for Enhancement Layer

DSP Lab

- The coding efficiency for hierarchical prediction structure depends on how QP is chosen for different temporal layers.
  - Pictures of Base Layer should be coded with highest fidelity, since they are useful as references for motion-compensated prediction of pictures of pictures of further temporal layers.
  - Pictures of temporal layer T_k should be coded with higher QP compared to temporal layer T_m ($k > m$)
  - Though this sometime causes larger PSNR fluctuations inside a GOP, the overall subjective quality is improved.

Temporal Scalability

DSP Lab

- If B pictures are quantized heavily,
  - larger GOP size gives larger PSNR improvement

Video Coding Experiment with H.264/AVC

- Foreman, CIF 30Hz @ 132 kbit/s
- Performance as a function of N

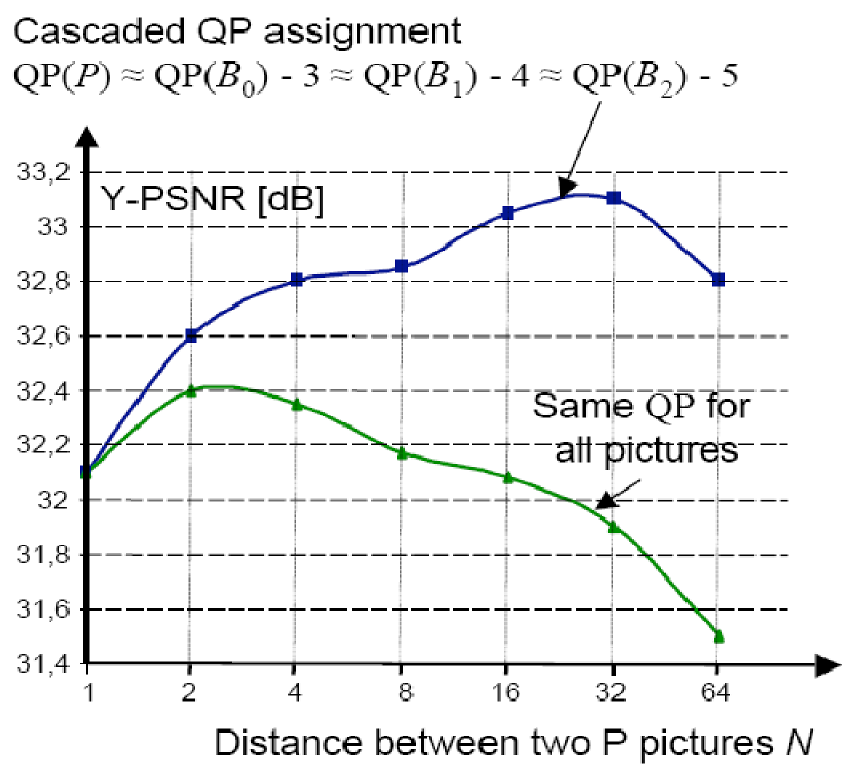


Figure courtesy JVT-W132: "Scalable Video Coding" Thomas Wiegand, HHI

Temporal Scalability

IPP : 2.2MBPS, YPSNR 30.71dB
Frame 1 : 68208 bits, 30.70dB, average QP: 36

GOP Size 8: 2.1MBPS, YPSNR 31.47dB
Frame 1: 33688 bits, 30.97dB, average QP: 37
Subjective quality much better

Thus temporal scalability with Hierarchical-B coding comes with an improvement in subjective and objective quality

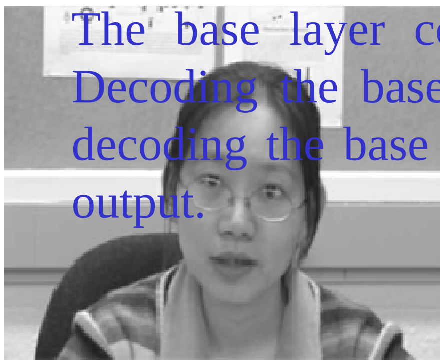
- However H-B has higher delay and bit rate fluctuation
- May not be suitable for extreme low delay applications

Spatial Scalability

Spatial Scalability

DSP Lab

The base layer contains a reduced-resolution version of each coded frame. Decoding the base layer alone produces a low-resolution output sequence and decoding the base layer with enhancement layer(s) produces a higher-resolution output.



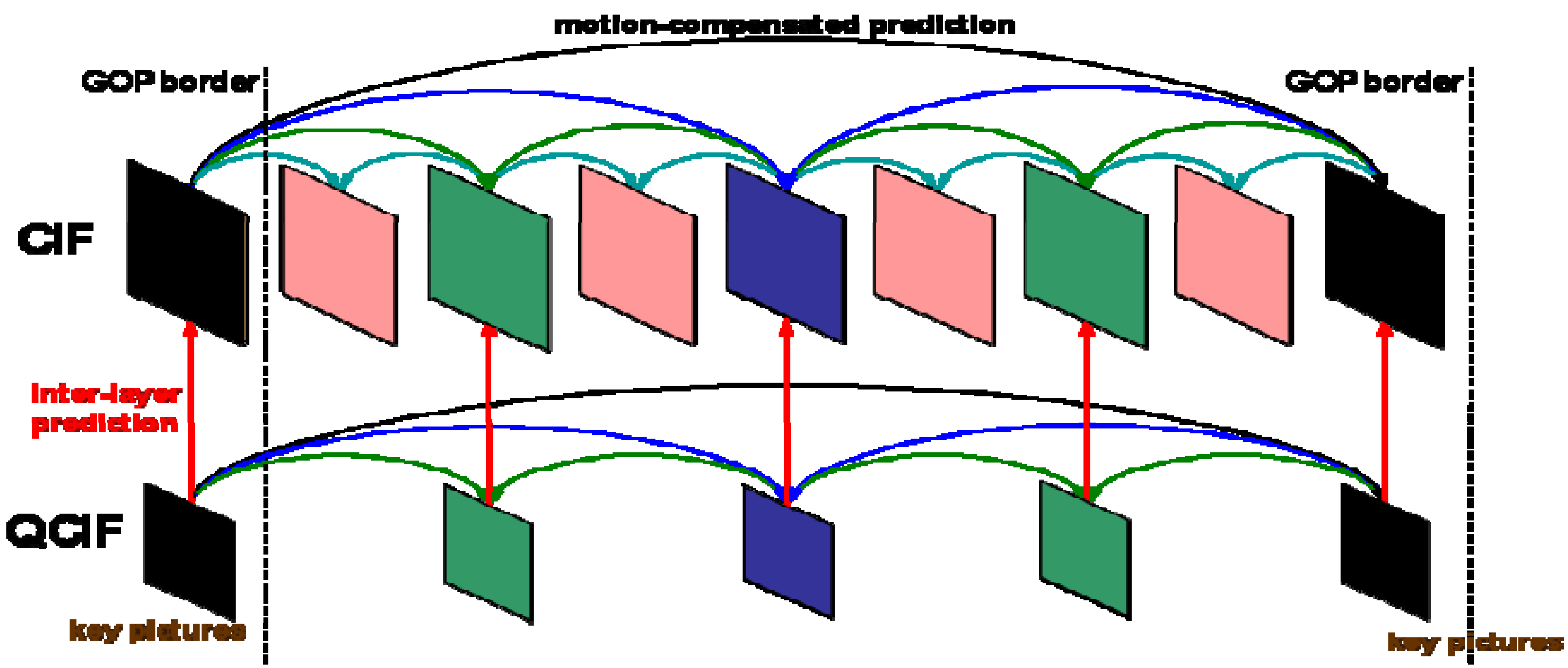
Spatial Scalability

- A single-layer decoder decodes only the base layer to produce a reduced-resolution output sequence.
- A multi-layer decoder can reconstruct a full-resolution sequence.
- Decoding process
  - Decode the base layer and up-sample to the original resolution.
  - Decode the enhancement layer.
  - Add the decoded residual from the enhancement layer to the decoded base layer to form the output frame.

Spatial Scalability

- In each spatial layer, motion compensation, and intra-prediction are employed similar to that of single layer coding.
- To improve coding efficiency, *inter-layer prediction* mechanisms are employed.

Spatial Scalability



- Inclusion of Inter layer prediction modes
    - Interlayer motion prediction
    - Interlayer Residual prediction etc.

Interlayer Prediction in Spatial Scalability

- Main goal is to enable usage of as much lower layer information as possible, to improve coding efficiency of the enhancement layers.
- Traditionally the prediction signal is formed based on up-sampled reconstructed lower layer signal or by averaging such up-sampled signal with temporal prediction signal.
- The interlayer prediction does not work as well as temporal prediction especially in case of sequences with slow motion and high spatial detail.

Interlayer Prediction in Spatial Scalability

- To improve the coding efficiency for spatial scalable coding two additional interlayer prediction concepts are added.
  - Prediction of macroblock modes and associated motion parameters.
  - Prediction of residual signal.
- Additionally one more mode '*Inter layer Intra prediction*' is added to take care of the case when the co-located lower layer macroblock is intra coded.

Use of *“base_mode_flag”*

- For spatial enhancement layers SVC includes a new macroblock mode, which is signaled by *“base_mode_flag”.*
- For this macroblock type, only a residual signal (no additional side information such as intra prediction modes or motion parameters) is transmitted.
- When *base_mode_flag = 1*
  - The macroblock is predicted by *“inter layer intra prediction”* mode if co-located 8x8 sub-block lies inside an Intra coded macroblock. (intra_BL)
  - The macroblock is predicted by *“interlayer motion prediction”* mode, when reference layer macroblock is inter coded. (BL_skip)
- These modes are not used when the flag is zero.

Inter Layer Motion Prediction

- The partitioning data of the enhancement layer macroblock together with the associated motion vectors are derived from the corresponding data of co-located 8x8 block in the reference layer.
- The macroblock partitioning is obtained by up-sampling the corresponding partitioning of co-located 8x8 block in reference layer.
- Each MxN sub macroblock partition in the 8x8 reference block corresponds to (2M)x(2N) macroblock partition in enhancement layer.
- The motion vectors are derived by scaling the reference layer motion vector by 2.

Inter Layer Intra Prediction

- The corresponding reconstructed intra signal itself, of the reference layer is up-sampled.
- Luma component is up-sampled using one-dimensional 4-tap FIR filters in both horizontal and vertical direction.
- Chroma components are up-sampled by simple bilinear filters.
- In this way, it is avoided to reconstruct the inter coded macroblocks in the reference layer, and *Single Loop Decoding* is provided.

Inter Layer Residual Prediction

- Can be employed for all inter coded macroblocks, irrespective of *base_mode_flag*.
- This is the mechanism that involves using the base layer prediction residual to predict the enhancement layer prediction residual.
- Permits an enhancement layer video stream to be decoded with only one motion compensation loop at the enhancement layer and no motion compensation needs to be done at base layer.
- Reduces decoder complexity.
- The up-sampled residual of the co-located reference layer block is subtracted from the enhancement layer residual and only the resulting difference is encoded.

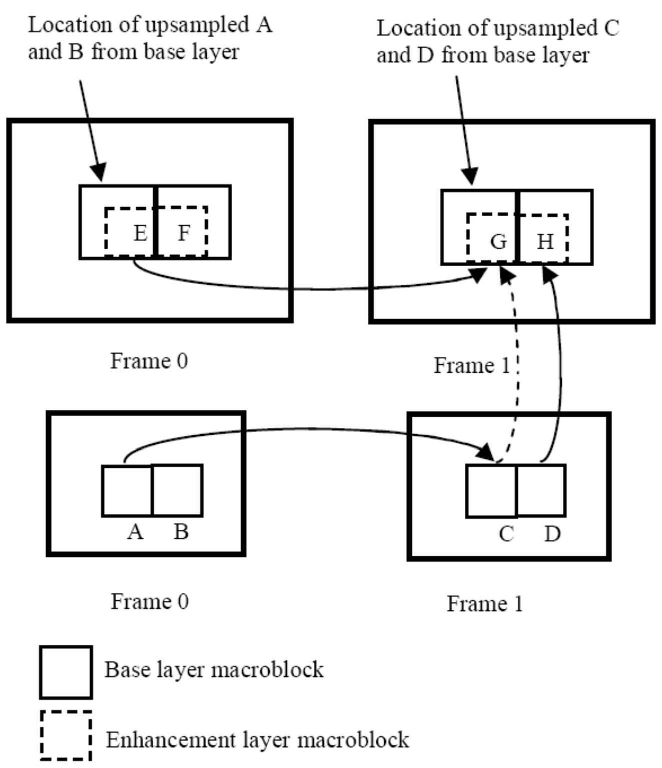
Inter Layer Residual Prediction

- Example: The EL macroblocks E,F,G, H, covered by only one up sampled macroblock, A,B,C,D.
- Without RP: EL macroblock G is predicted from EL macroblock E, written as P_{EG},

  $E(G) = O(G) – P_{EG}$
- With RP: The residual of BL macroblock C, i.e. $O(C) – P_{AC}$ is also used, to form a prediction for G.

  $E(G) = O(G) – P'_{EG} – U(O(C) - P_{AC})$

  P'_{EG} : Prediction formed from macroblock E under residual prediction mode.



O (·) : Original Pixels

E (·) : Prediction Residual

U (·) : Upsampling function

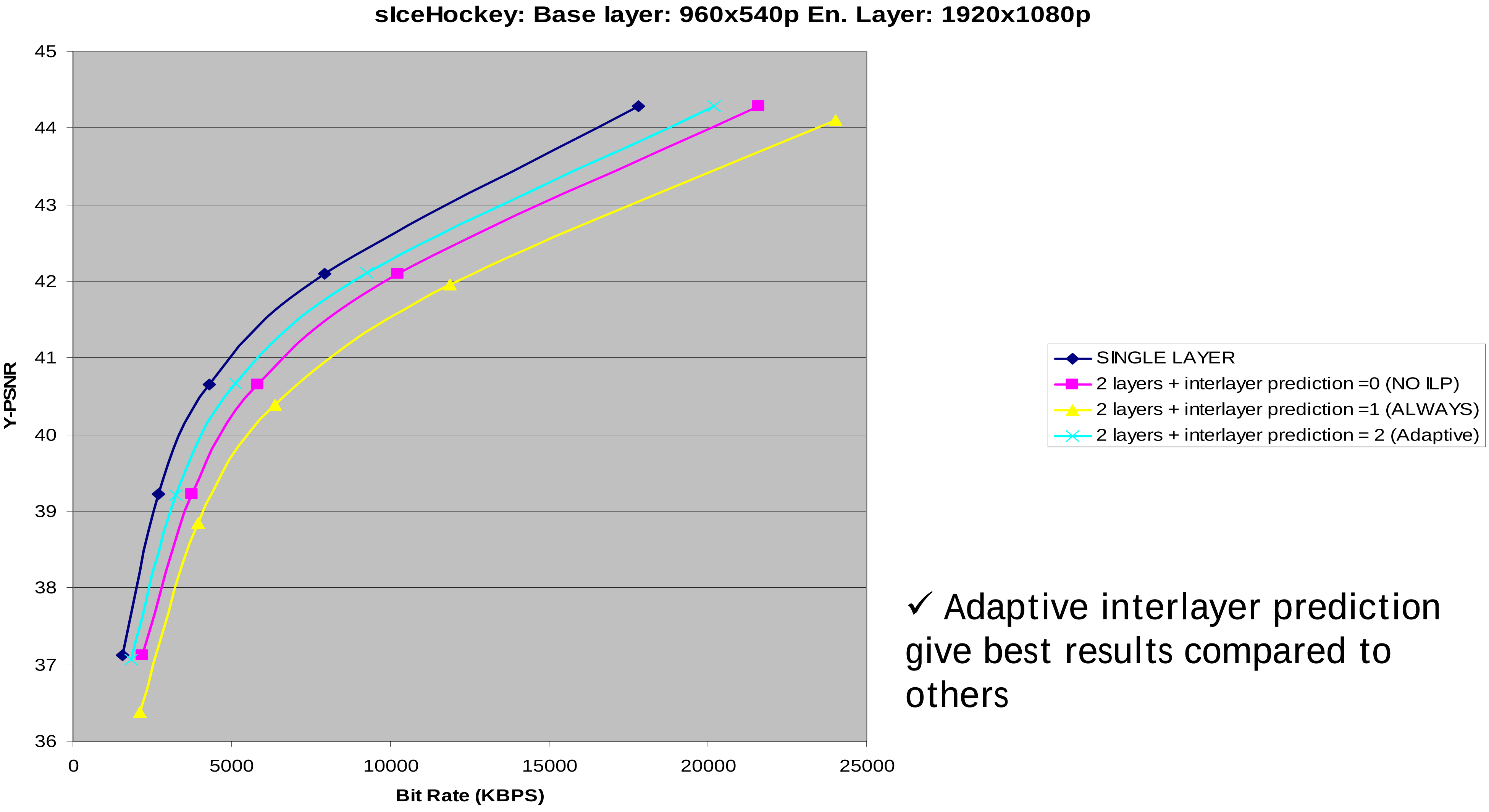
Extended Spatial Scalability

- SVC also supports arbitrary downsampling factors and defines appropriate upsampling filers.
- This is required in many applications where different display sizes from broadcasting, communications and IT environments are commonly mixed, having different aspect ratios (like 4:3 or 16:9 etc).
- Cropping of appropriate layers is defined to take care of these.
- Non-integer scaling ratios lead to more complex relationships between macroblocks between layers and thus limiting the use of interlayer prediction.

Analysis of Interlayer Prediction

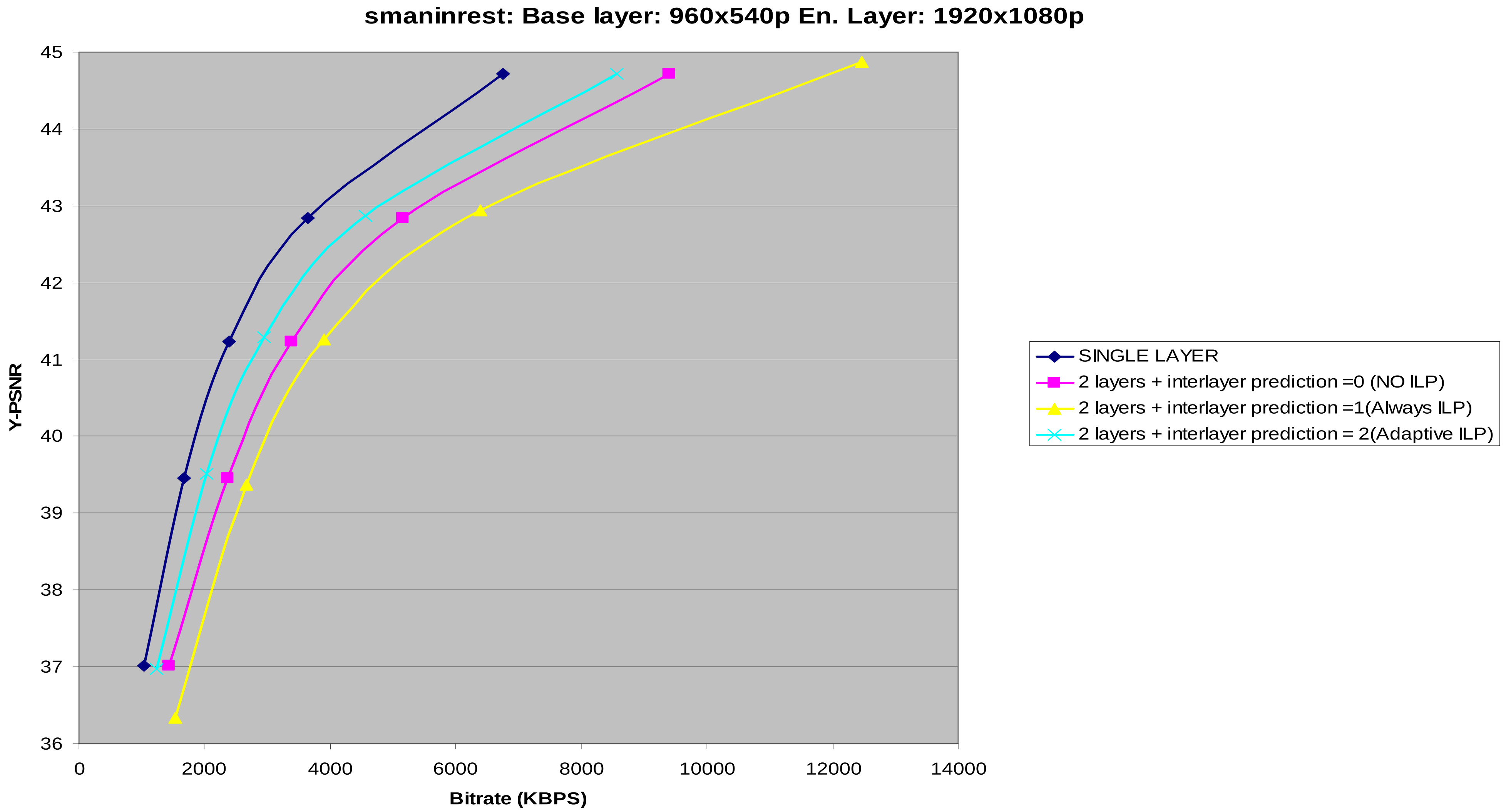
- JVT, MPEG and VCEG jointly release a reference software JSVM (Joint Scalable Video Model)
- JSVM supports 3 interlayer prediction options
  - No interlayer prediction
  - Always interlayer prediction
  - Adaptive interlayer prediction

Comparison of ILP modes

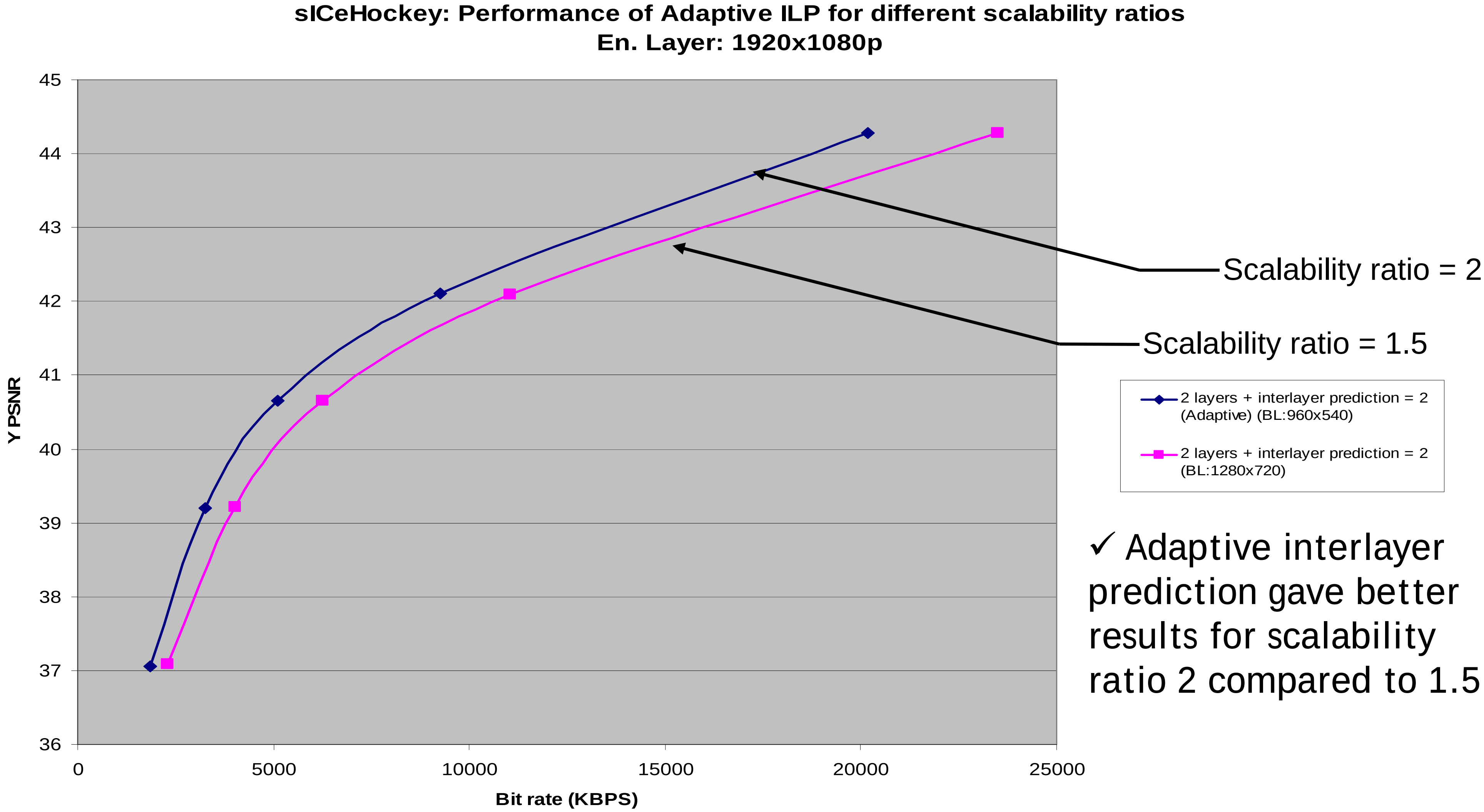


✓ Adaptive interlayer prediction give best results compared to others

Comparison of ILP modes

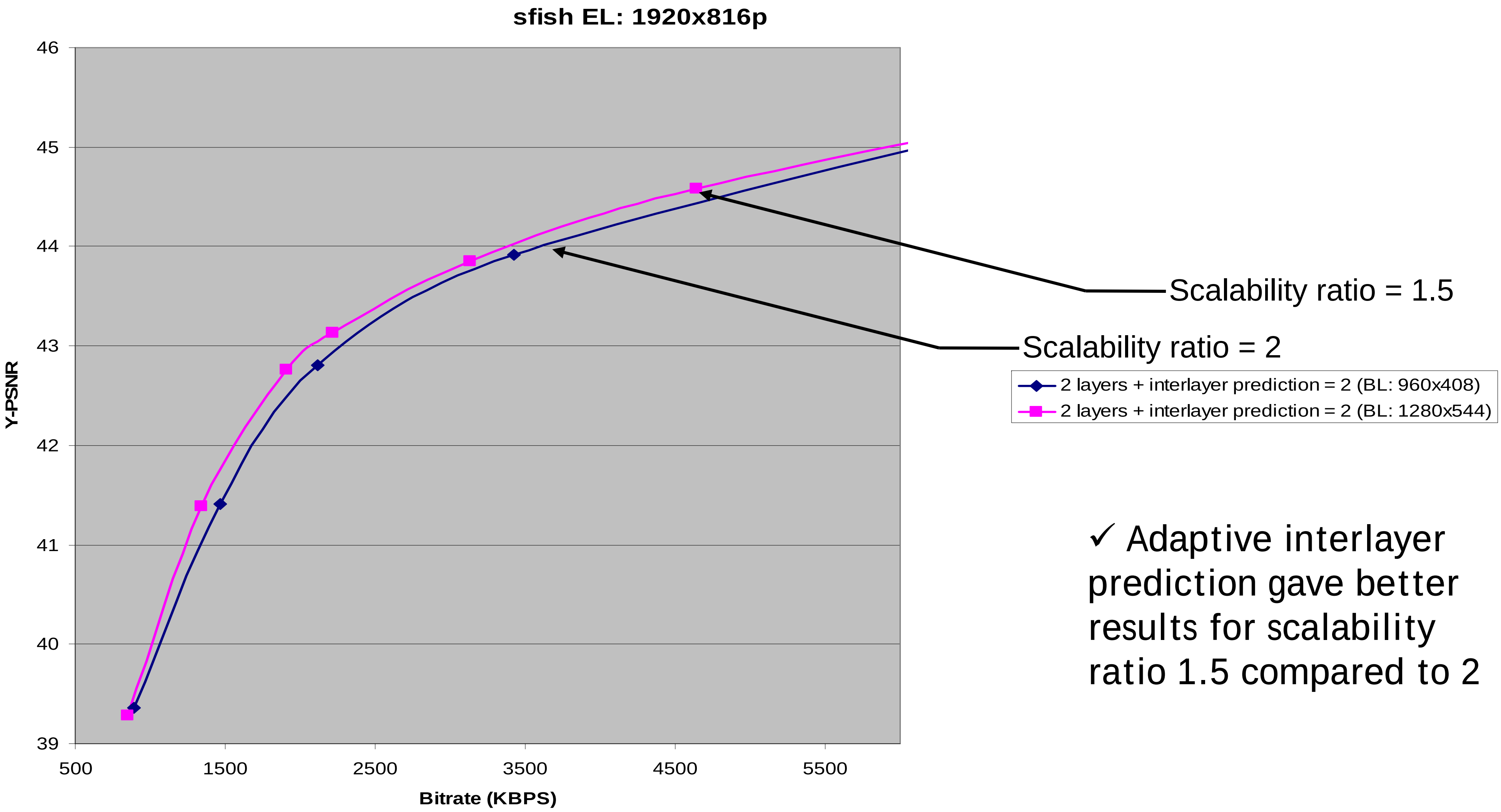


Adaptive ILP for diff. scalability ratios



✓ Adaptive interlayer prediction gave better results for scalability ratio 2 compared to 1.5

Adaptive ILP for diff. scalability ratios



- ✓ Adaptive interlayer prediction gave better results for scalability ratio 1.5 compared to 2

Adaptive ILP for diff. scalability ratios

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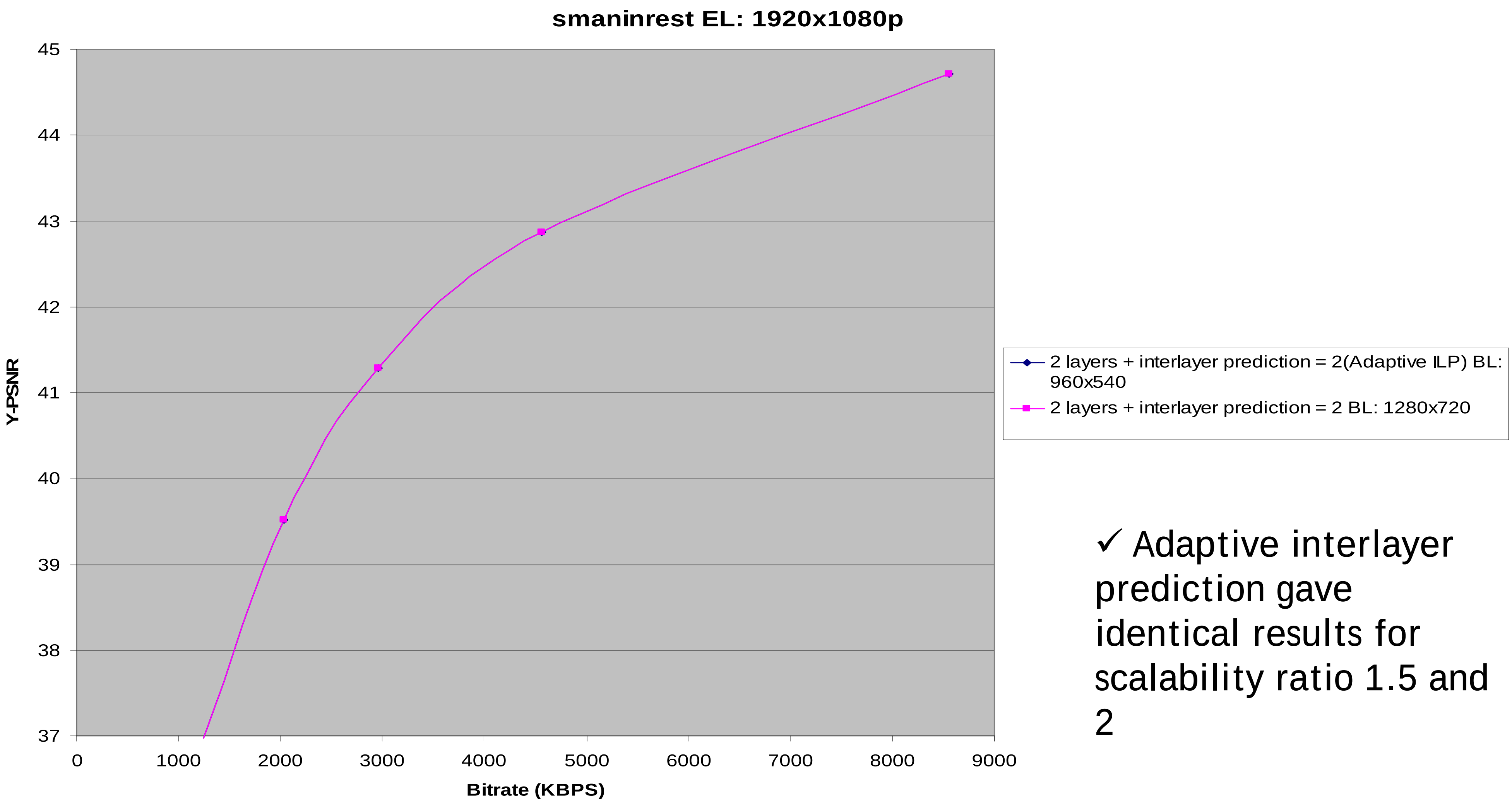
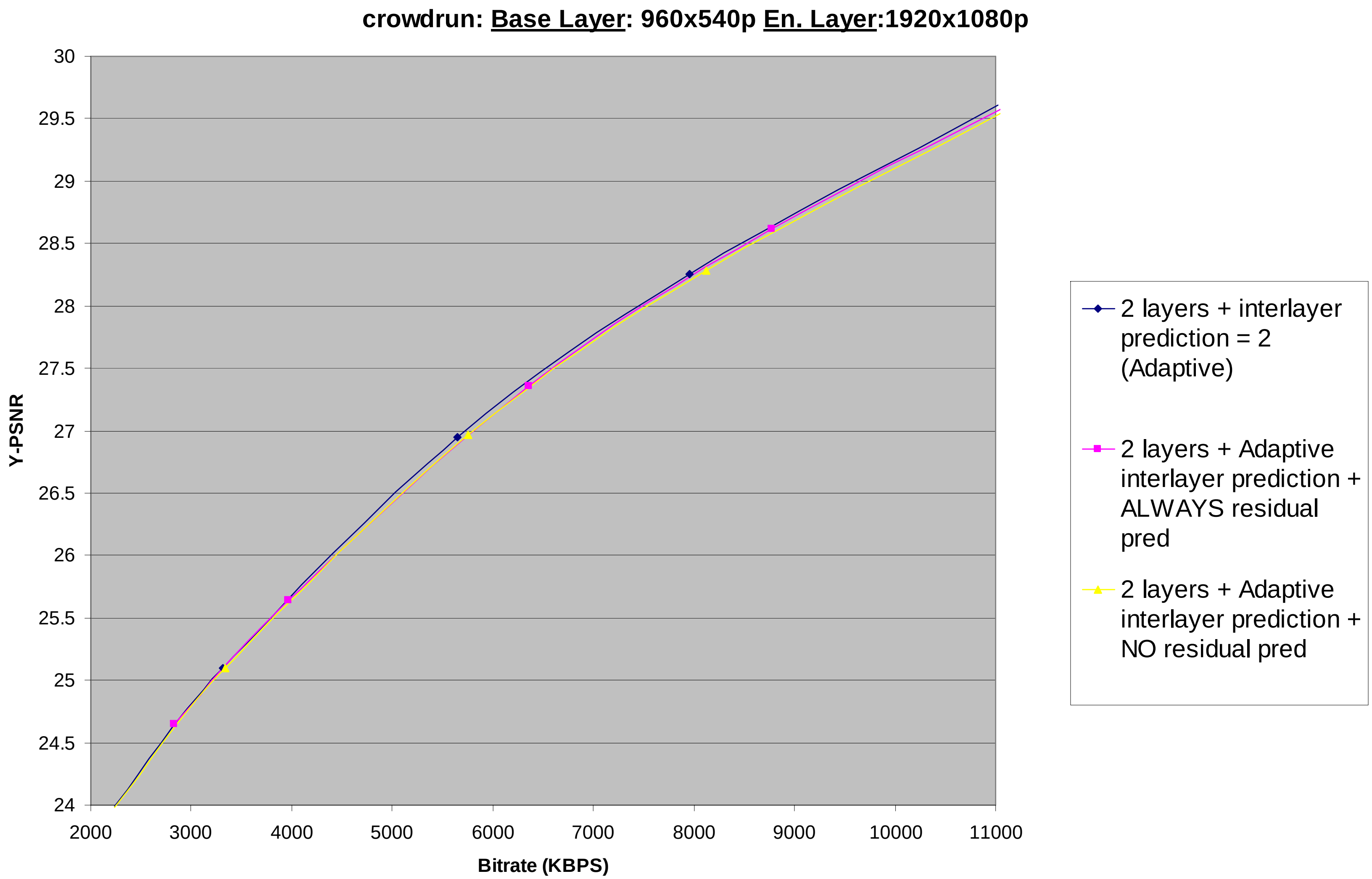


✓ Adaptive interlayer prediction gave identical results for scalability ratio 1.5 and 2

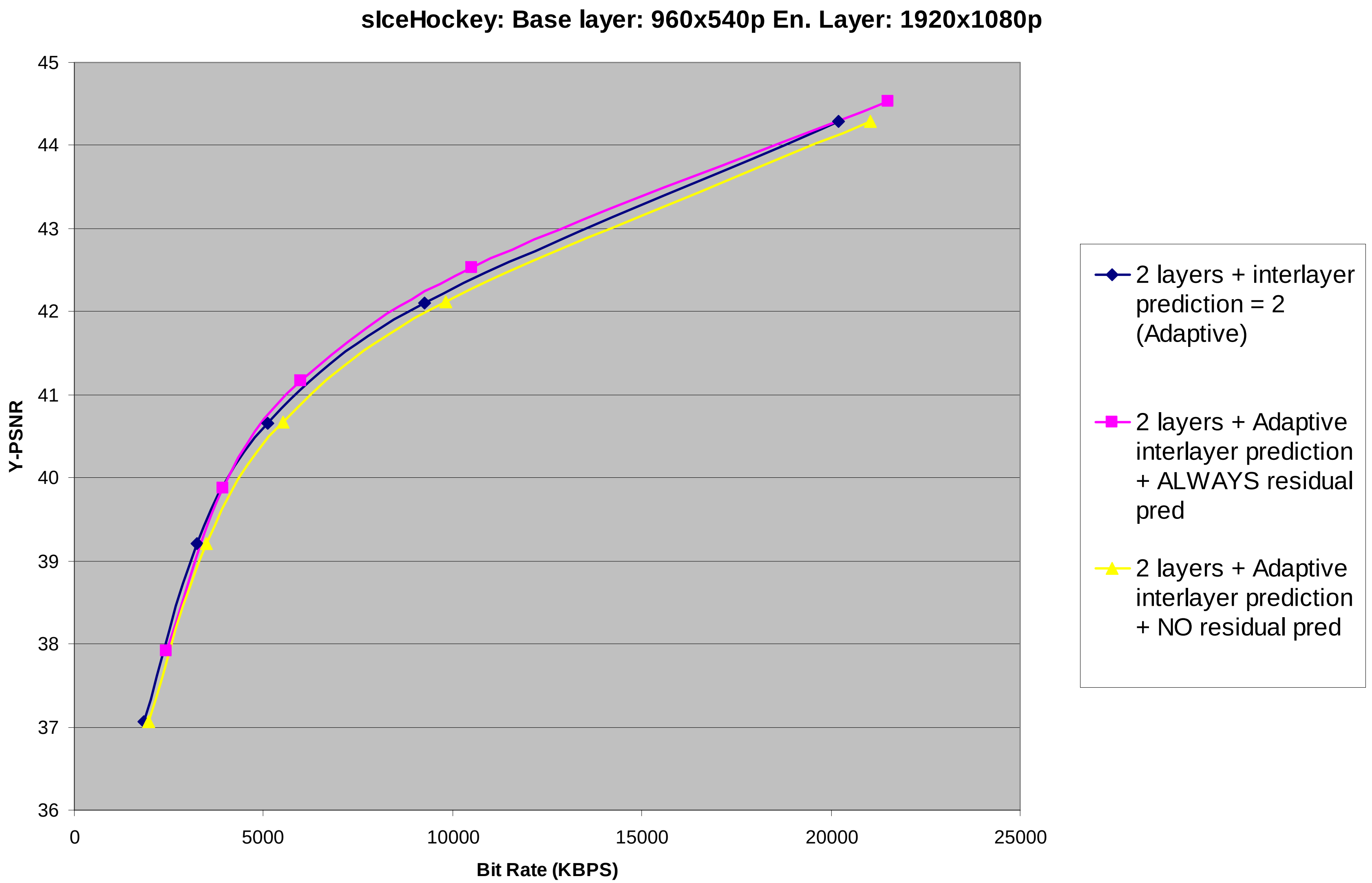
Adaptive ILP for diff. scalability ratios

- Performance of adaptive interlayer prediction varies based on the scalability ratio (1.5 or 2)
  - Reasons for this still need to be analyzed.

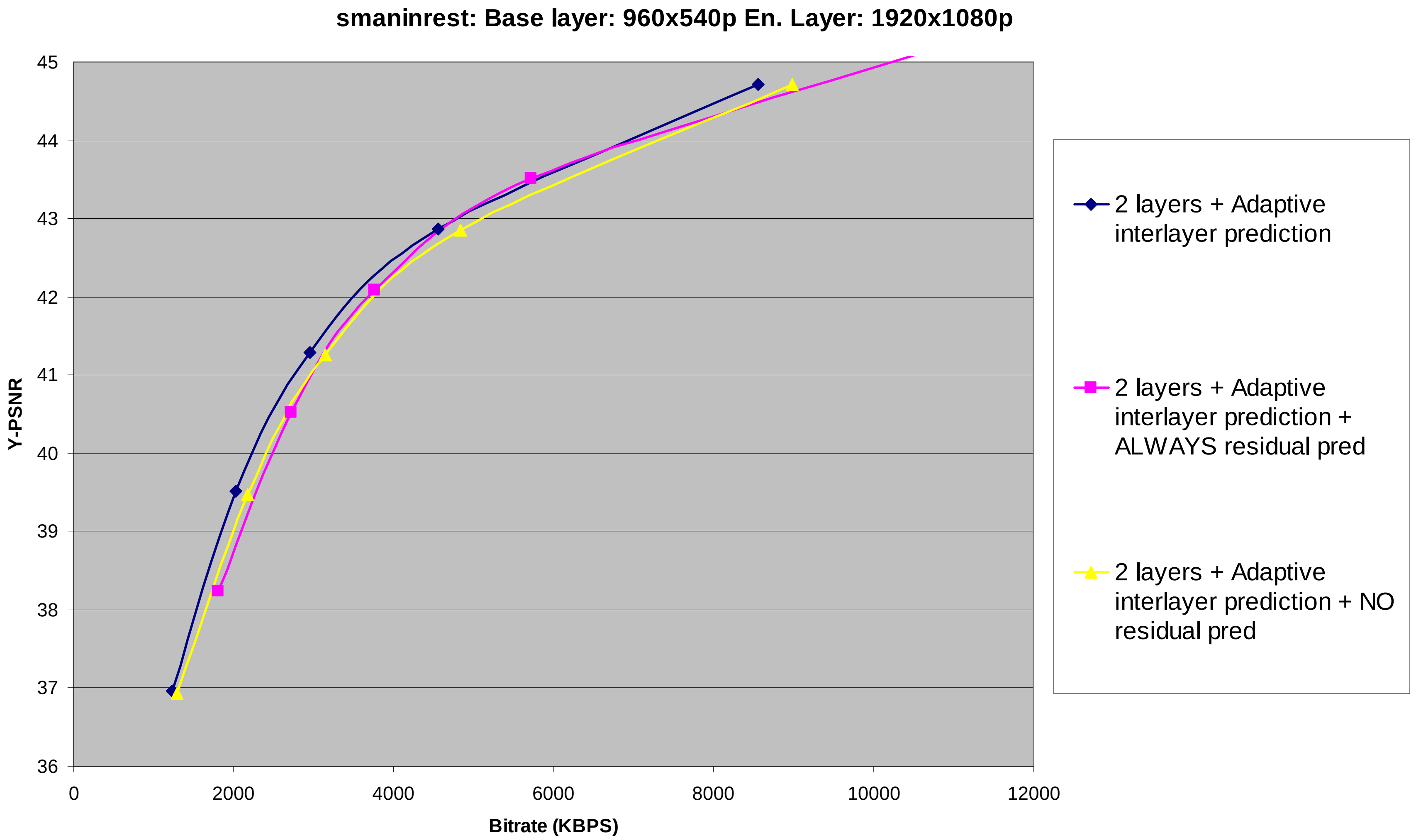
Interlayer Residual Prediction (RP)



Interlayer Residual Prediction (RP)



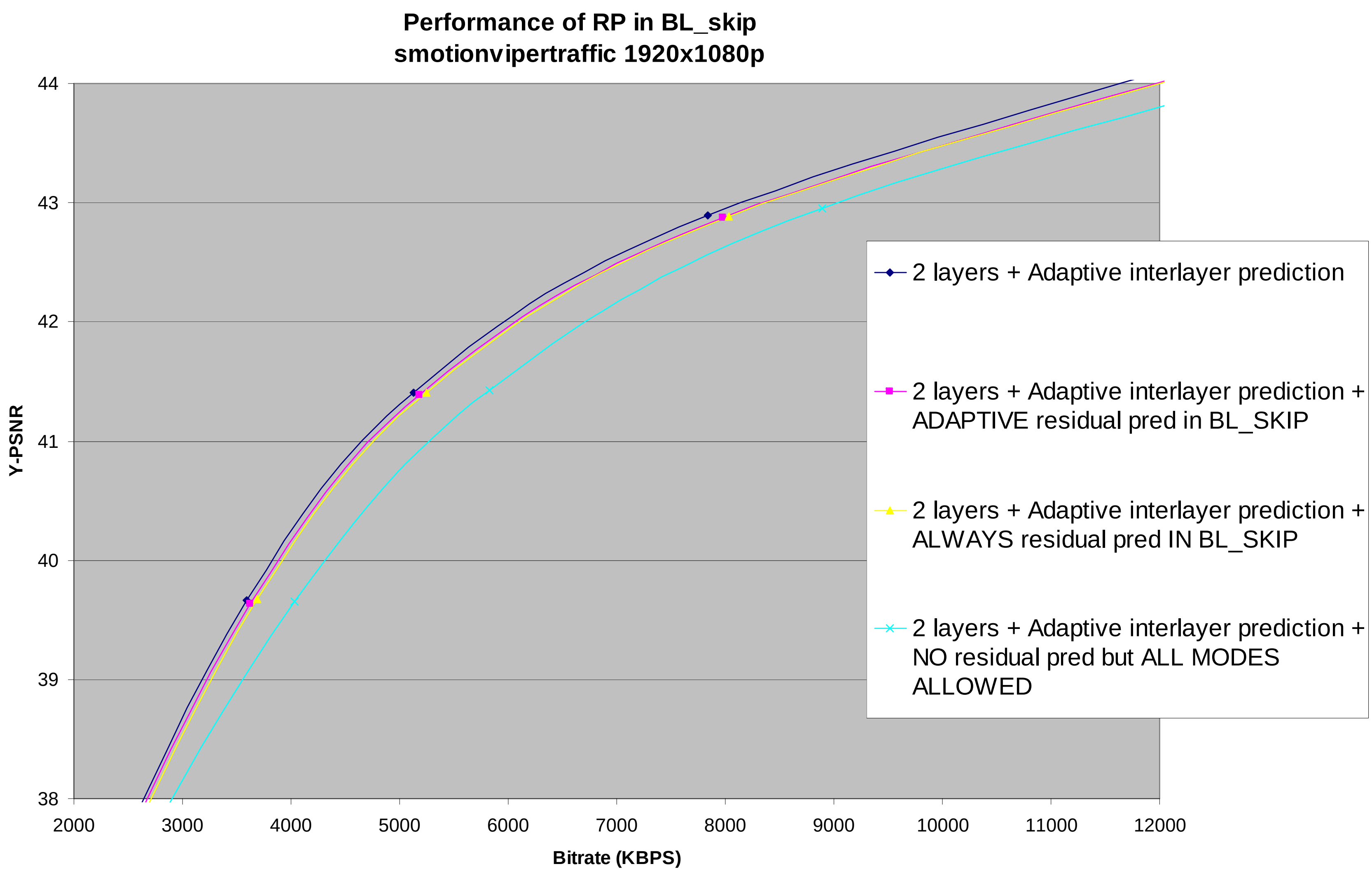
Interlayer Residual Prediction (RP)



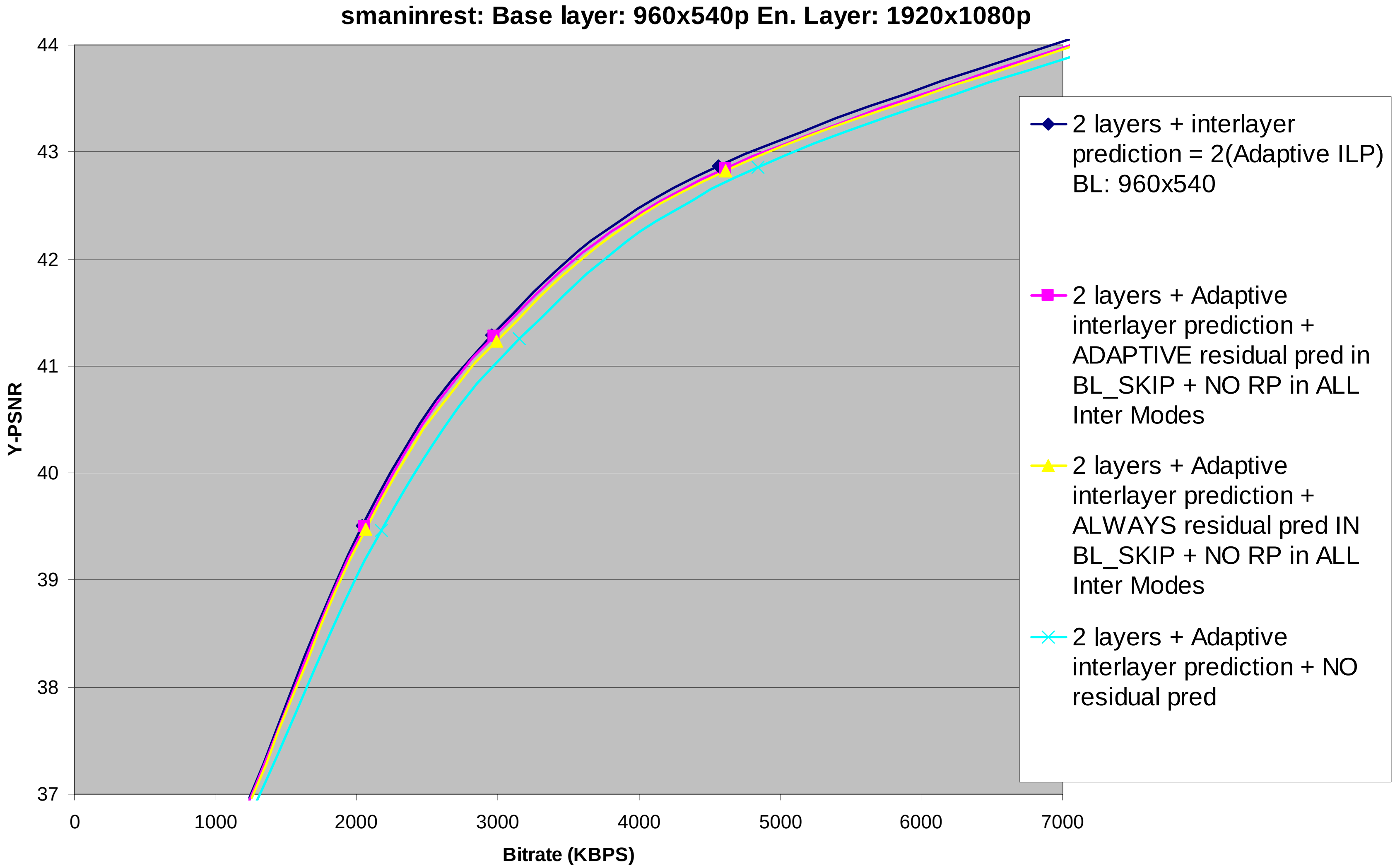
Interlayer Residual Prediction (RP)

- Adaptive residual prediction is required as ALWAYS Residual Prediction does not guarantee good performance

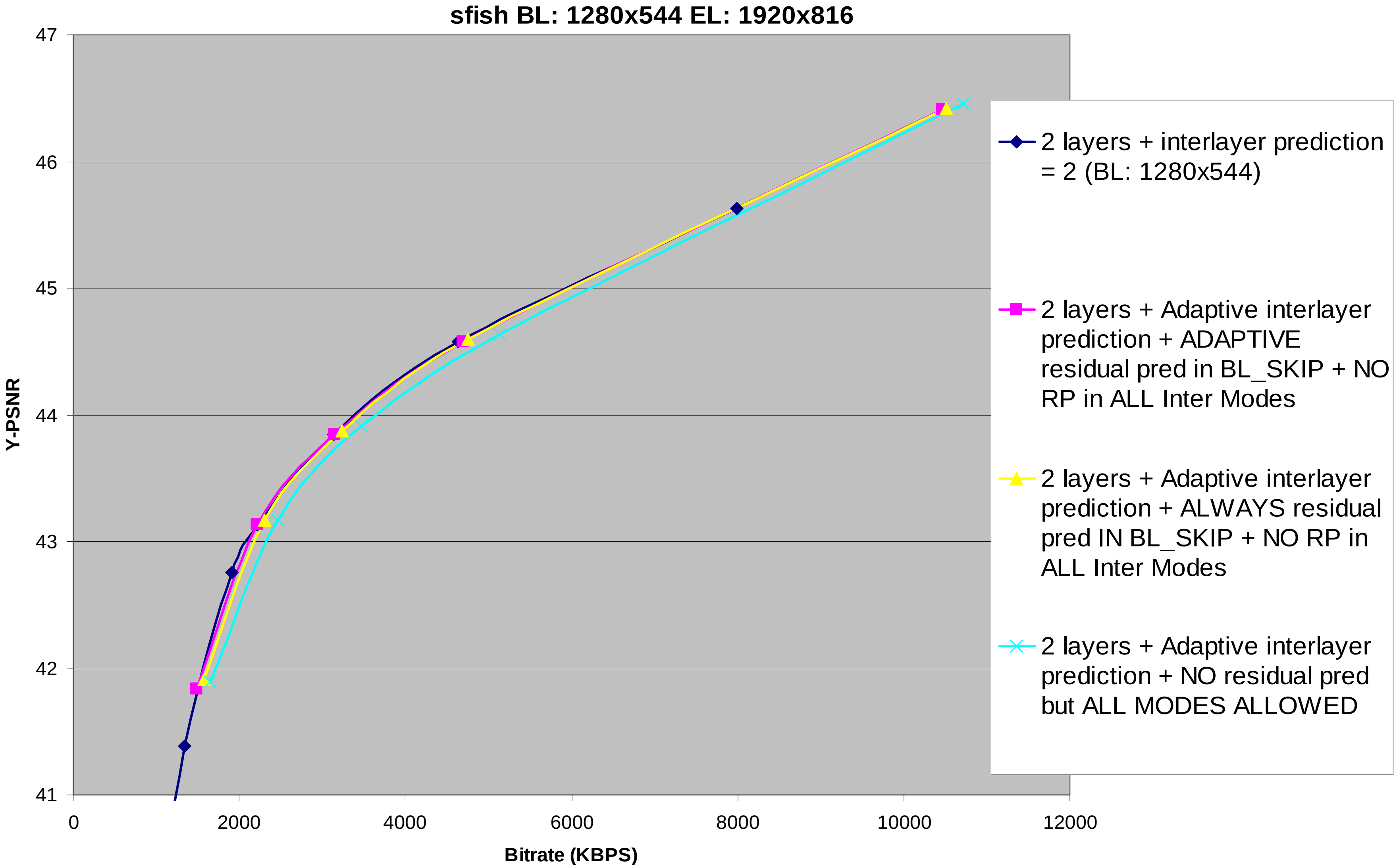
Performance of RP in BL_skip mode



Performance of RP in BL_skip mode



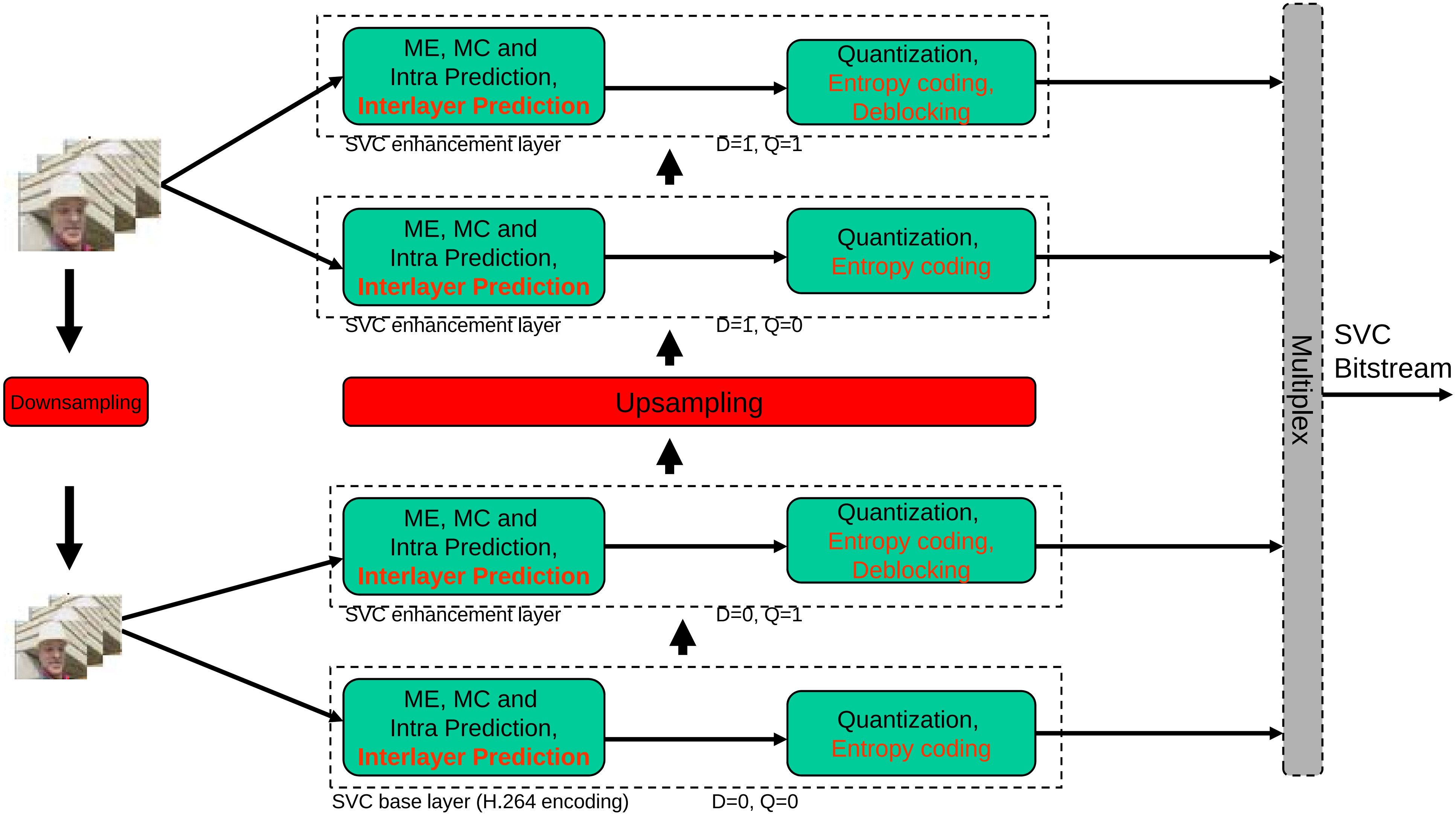
Performance of RP in BL_skip mode



Performance of RP in BL_skip mode

- Adaptive residual prediction in BL_skip mode and Always residual prediction in BL_skip mode give good results even after disabling the residual predictions in ALL the inter modes, thus reducing a large amount of complexity

Spatial + SNR Scalability Encoding

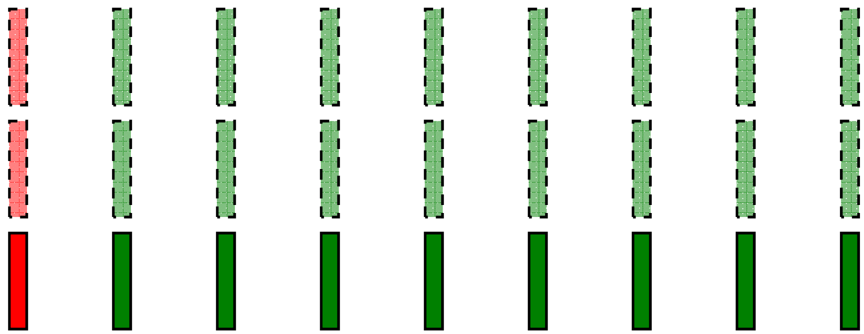


SNR (Quality) Scalability

SNR Scalability

- Types
  - Coarse Grain Scalability (CGS)
  - Medium Grain Scalability (MGS)
  - Fine Grain Scalability (FGS)
    - Not supported by SVC standard because of very poor enhancement layer coding efficiency.
- Bit rate adaptation at same spatial/temporal resolution
- Provides graceful degradation of quality
- Error resilience

SNR (Quality) scalability



Quality Level 2

Quality Level 1

Quality Level 0

SNR Layer 0

SNR Layer 1

SNR Layer 2

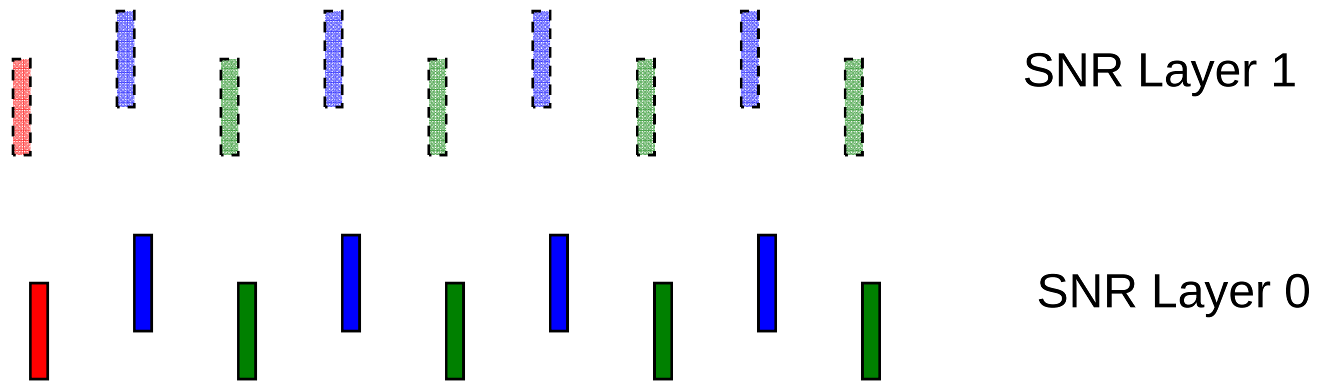
SVC supports up to 16 SNR layers for each spatial layer

CGS SNR Scalability

- Coarse Grain Scalability
  - Can be considered as a special case of Spatial scalability except for identical picture sizes at the enhancement layer.
  - Enhancement layer coded with lower quantization parameter.
  - Only allows few selected bit rates to be supported in the scalable bit stream.

MGS SNR Scalability

- Medium Grain Scalability (MGS)
  - Throwing away an entire SNR enhancement layer results in rapid loss in quality
  - The enhancement layer SNR packets can be removed in any order to reduce bit rate
    - Removing the right packets can provide a graceful degradation in quality
  - Example:
    - The (dotted) blue packets could be removed first to achieve a slight reduction in bit rate
    - If we still need some more reduction in bit rate, dotted red/green packets could also be removed.

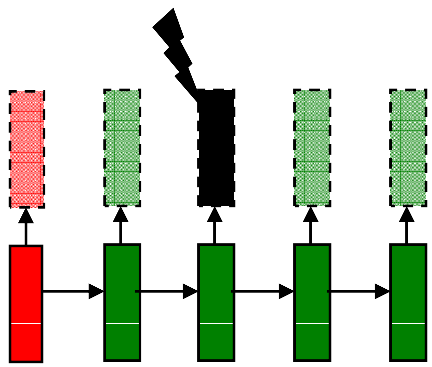


SNR Scalability and Drift

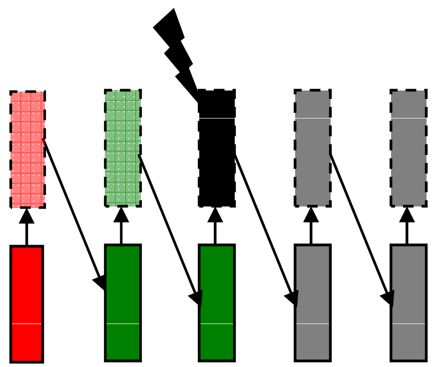
- *Drift*: Effect of lack of synchronization between motion-compensated prediction loops at encoder and decoder.
  - The synchronization loss may occur due to removal of quality refinement packets from the bit stream at decoder.
- There is a tradeoff between enhancement layer coding efficiency and drift.

SNR Scalability and Drift

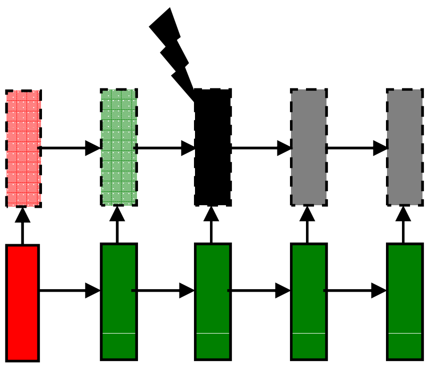
- Previously used concepts for trading off Enhancement layer coding efficiency and Drift



- BL only control
- No Drift propagation
- Efficient BL , in-efficient EL
- MPEG4 FGS



- EL only control
- Drift propagation in Both BL and EL
- In-Efficient BL , efficient EL
- MPEG2 FGS



- Two-loop control
- No Drift in BL
- Drift propagation in EL only
- High complexity
- Efficient BL, medium efficient EL
- H.262,H.263, MPEG4

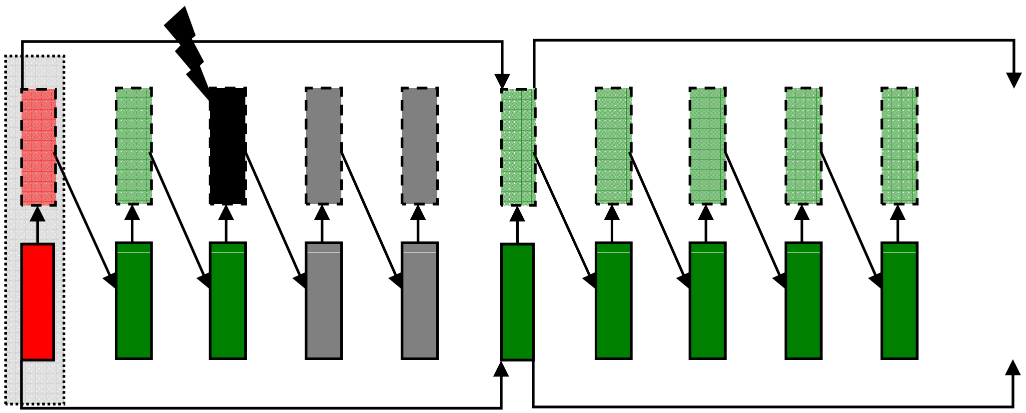
“Key Pictures” in SVC

- SVC can use a combination of the three schemes described earlier
  - Using Key pictures to close the drift
- Key Pictures for containing the drift
  - Normal pictures : Uses highest quality level reconstruction for MCP
  - Key Pictures (Closed loop Pictures) : Uses lowest quality level reconstruction for MCP
  - Drift doesn’t propagate beyond the key picture

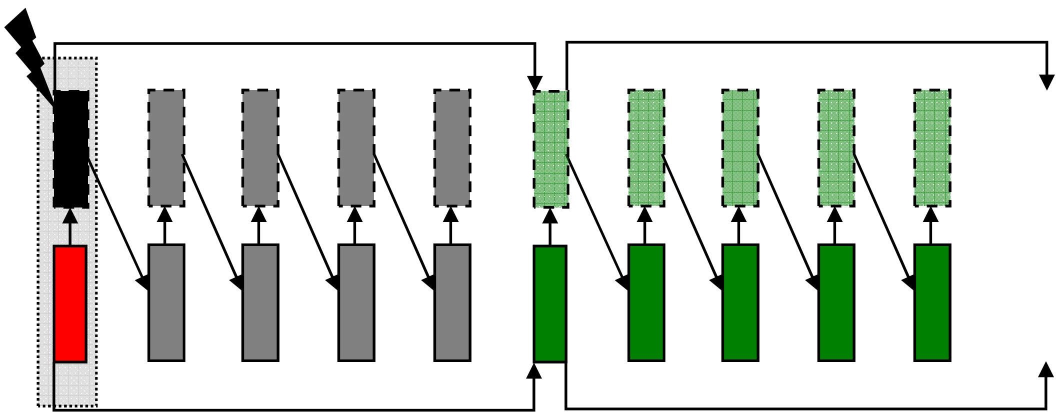
“Key Pictures” in SVC

- Requires both lowest quality and highest quality to be reconstructed at key pictures
- In order to limit decoding overhead for Key pictures, SVC do not allow change of motion parameters between base and enhancement layer representations of Key pictures.
- This means enhancement quality levels are not allowed motion refinement for key pictures
    - Only one Motion Compensation is sufficient
    - Single loop decoding is possible in key pictures too!

"Key Pictures" in SVC



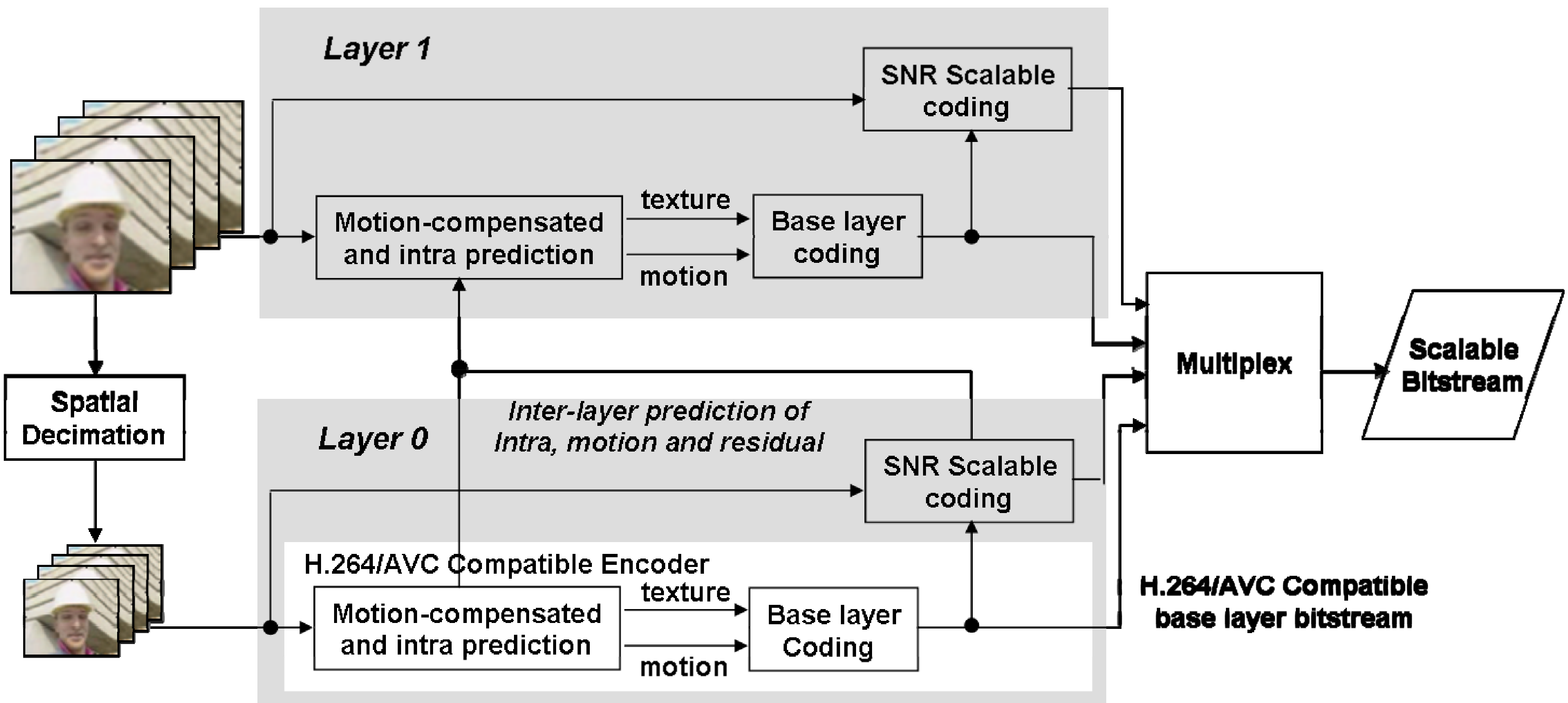
Example: Drift due to intermediate picture



Example: Drift due to first EL picture itself

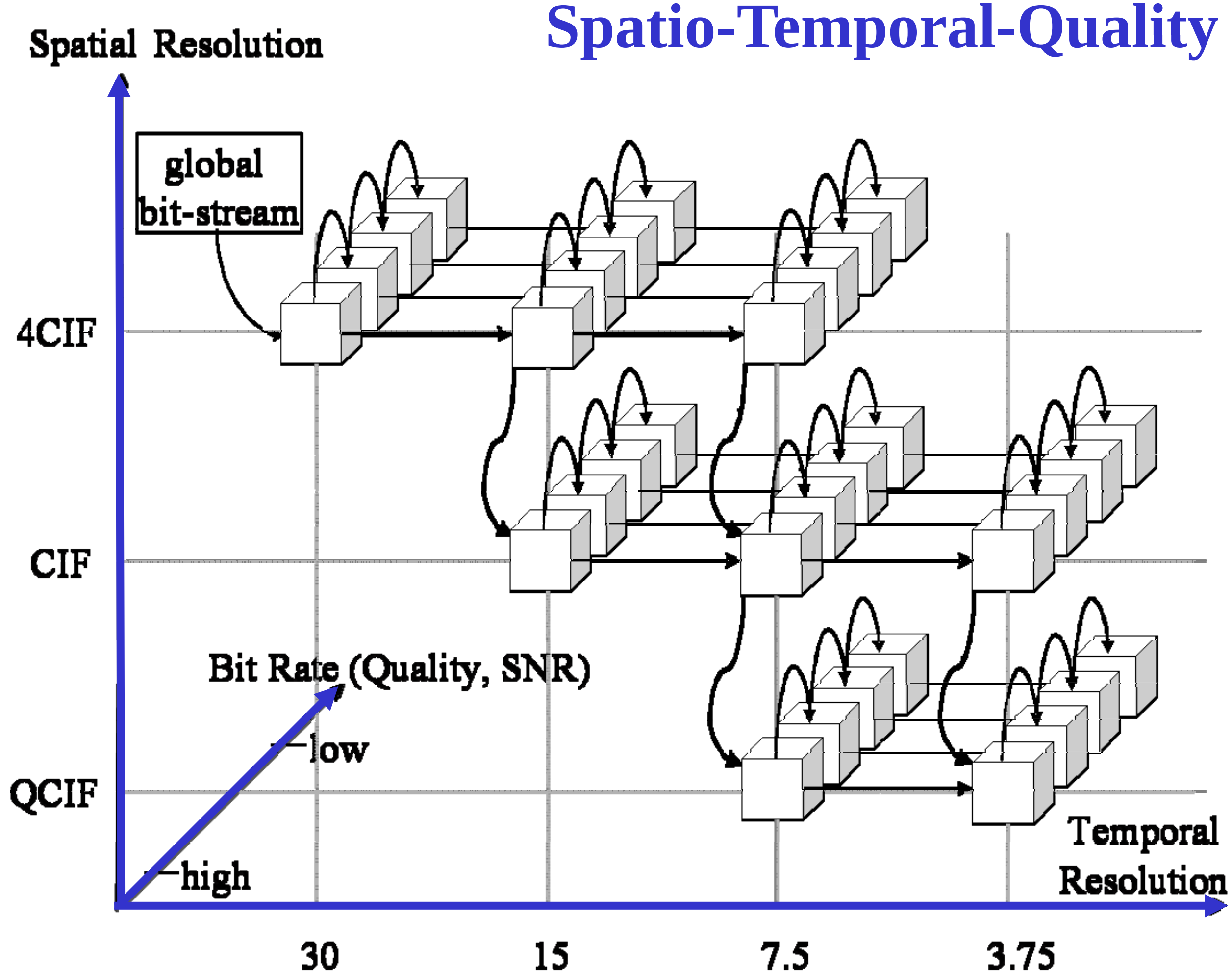
- The drift propagates only until the next key picture.
- The base layer key frame needs to be de-blocked twice.
  - The fully decoded base layer key frame as reference for next key frame
  - The partially decoded key frame used for interlayer prediction

SVC Encoder


Layer 1
SNR Scalable coding
texture
Motion-compensated and intra prediction
Base layer coding
motion
Spatial Decimation
Multiplex
Scalable Bitstream
Inter-layer prediction of Intra, motion and residual
Layer 0
SNR Scalable coding
H.264/AVC Compatible Encoder
texture
Motion-compensated and intra prediction
Base layer Coding
motion
H.264/AVC Compatible base layer bitstream

SVC: Combined Scalability

Spatio-Temporal-Quality Cube



Mode Decision Algorithms

Mode Decision

- Multiple coding modes in H.264
  - Variable block size ranging from 16x16 to 4x4
  - Inter and intra coding
- Key:
  - Some how try to reduce the candidate modes before finding the rate distortion cost
- SVC extension adds more modes.
  - Advantage of layered structure
- Best coding mode is selected by trade-off between rate and distortion performance of each mode.
  - Computationally expensive if exhaustively searched through all the coding modes.
- Fast Mode Decision algorithms are required.

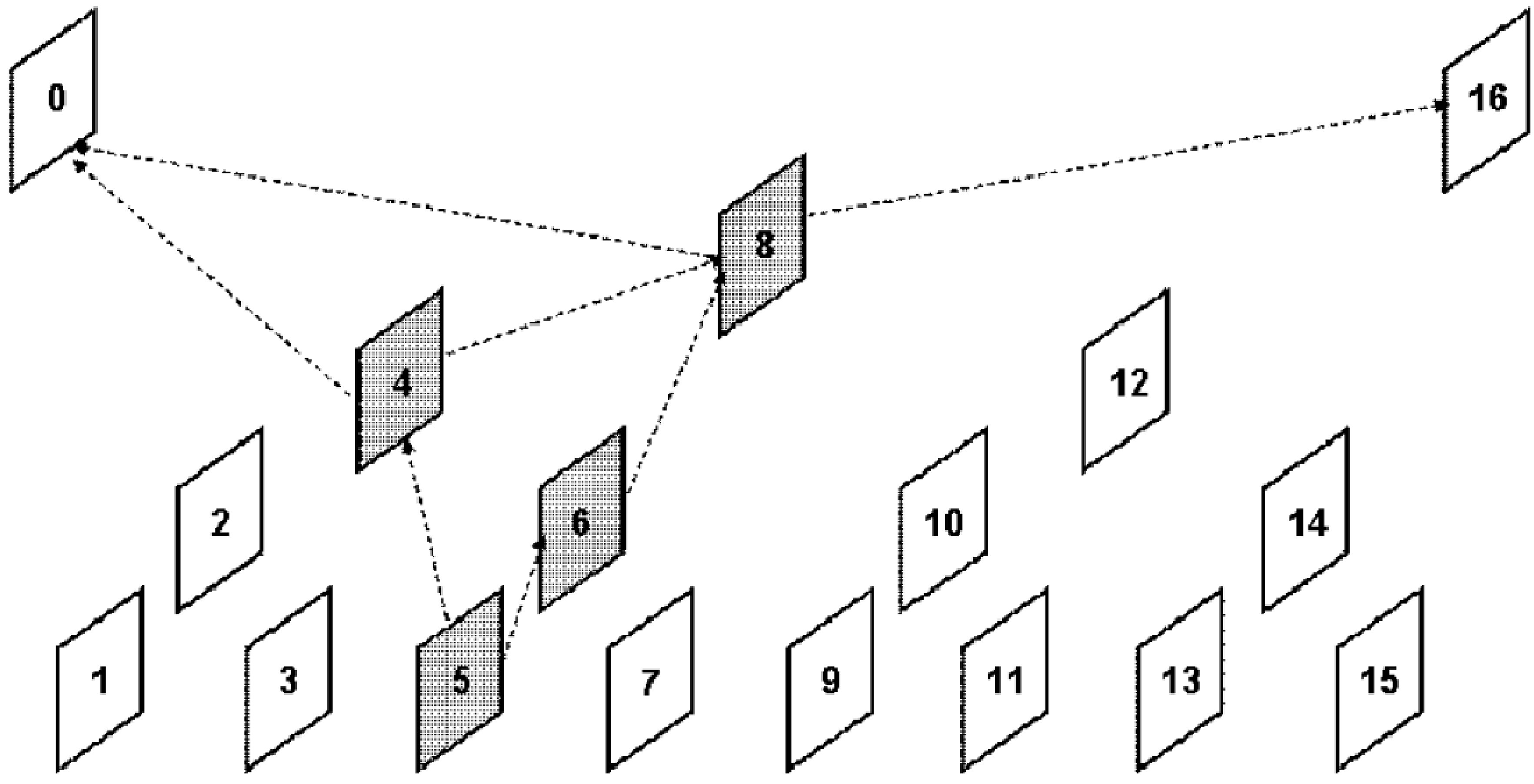
Fast Mode Decision for Adaptive GOP structure

Chih- Wei Chiou et al., "Fast mode decision Algorithms for Adaptive GOP structure in Scalable Extension of H.264/AVC"

- Adaptive GOP structure
  - Adaptively changes the size of the GOPs according to temporal characteristics of video.
- Early terminate the mode decision based on
  - Average motion vector magnitude and
  - Number of Intra coded macroblocks
- Larger motion vectors and large number of intra coded macroblocks → high temporal activity → smaller GOP size (and vice versa)

- If we put it in simple words
  - Compute the average motion vector magnitude (|MV|) and number of intra coded macroblocks (numIntra) for full sized GOP.
  - If $|MV|<TH_{MV}$ or if $numIntra<TH_{numIntra}$ then stop
  - Else continue the routine computation

Mode History Map based Mode Decision



Early skip scheme

Sunhee Lim et al., “Fast coding mode decision for Scalable Video Coding”

- Takes advantage of relation between levels in GOP
- When a macroblock at reference frame of low level has the SKIP mode, the macroblock at higher level also tends to have a SKIP mode.
- If macroblock mode of references is all SKIP modes, it is reasonable to consider only SKIP and P16x16 modes as candidate mode.

Mode decision at Enhancement layer from Base Layer

DSP Lab

He Li et al., “Fast mode decision for Spatial Scalable Video Coding”

- Uses the mode prediction at the base layer for prediction at enhancement layer.
- The candidate modes at enhancement layer are reduced based on the actual mode at base layer.

Base Layer Mode	Enhancement layer mode set
Intra 4x4	BL_Pred and Intra 4x4
Intra 16x16	BL_Pred and Intra 16x16
Inter 16x16	BL_Pred and Inter 16x16 and SKIP
Inter 16x8,8x16 or 8x8	Choose Best two modes, BL_pred, SKIP

Mode decision in inter-layer prediction using zero motion blocks

DSP Lab

Bumshik Lee et al., “A Fast mode selection scheme in Interlayer Prediction of H.264 Scalable Extension coding”

- Considers motion vectors as well as integer transform coefficients of the residual for mode prediction at enhancement layer.
- For non-zero motion blocks, the integer transform coefficients of the residual between current macroblock and motion compensated macroblock by predicted motion vectors from base layer, is considered.
- For ZMB or ZCB, inter 16x16 mode is used.
- For others, RD costs are computed for a number of candidate modes.

Mode decision based on Psycho-Visual Characteristics

Yun-Da Wu et al., “The Motion Attention Directed Fast mode decision for Spatial and CGS Scalable Video Coding”

- Explores the psycho-visual characteristics to decide the mode.
  - Moving objects usually attract more human attention than static ones.
- Defines a motion attention model, which generates a motion attention map based on the motion vectors estimation scheme.
- Visually more attended regions of the frame, undergo the usual exhaustive search scheme.
- For visually less attended regions of the frame, fast mode decision algorithm is applied similar to the one proposed by He Li et al.

Layer adaptive mode decision

Hung-Chih Lin et al., “Layer Adaptive Mode decision and Motion Search for Scalable Video Coding with Combined CGS and Temporal scalability”

- Explores the correlation between base and enhancement layers.
- Mode of next layer is predicted from previous layer.
- The subordinate layer is divided in two regions with QP<33 and QP>33
- If QP of reference layer is >33 then inter layer prediction is skipped, since the reference layer would be of lower quality.
- If QP of reference layer is < 33 then all the modes with interlayer prediction are considered for testing.

Research Areas

- Mode decision is computationally most expensive process in video coding, as described in the previous slides, efforts are made in reducing these computation and predict the modes faster.
- Coding of Enhancement layer can be done more effectively if, the base layer is coded sub-optimally such that it can be maximally utilized in *interlayer prediction.*
- Investigate the effect of various rate distortion algorithms.

DSP Lab

Thank You

No ILP

- Following modes are evaluated
  - Inter 16x16
  - Inter 16x8
  - Inter 8x16
  - Inter 8x8
  - BL_skip
  - All intra modes

(Inter 16x16, Inter 16x8, Inter 8x16, Inter 8x8, BL_skip:) All without Residual Prediction

Back

Always ILP

- Only BL_skip (with residual prediction) mode is evaluated

Back

Adaptive ILP

- Following modes are evaluated
  - Inter 16x16
  - Inter 16x8
  - Inter 8x16
  - Inter 8x8
  - BL_skip
  - All intra modes

(Inter 16x16, Inter 16x8, Inter 8x16, Inter 8x8, BL_skip:) All with and without Residual Prediction

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H.264/AVC Encoder