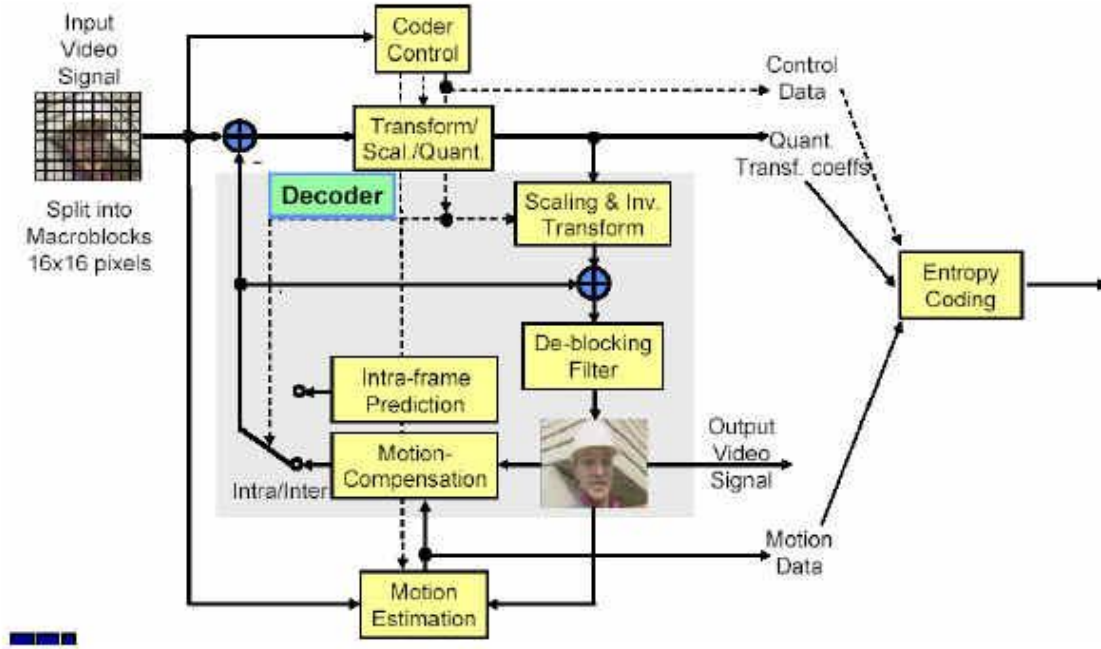
H.264/MPEG-4 AVC (Advanced Video Coding) Decoder Design

H.264/AVC

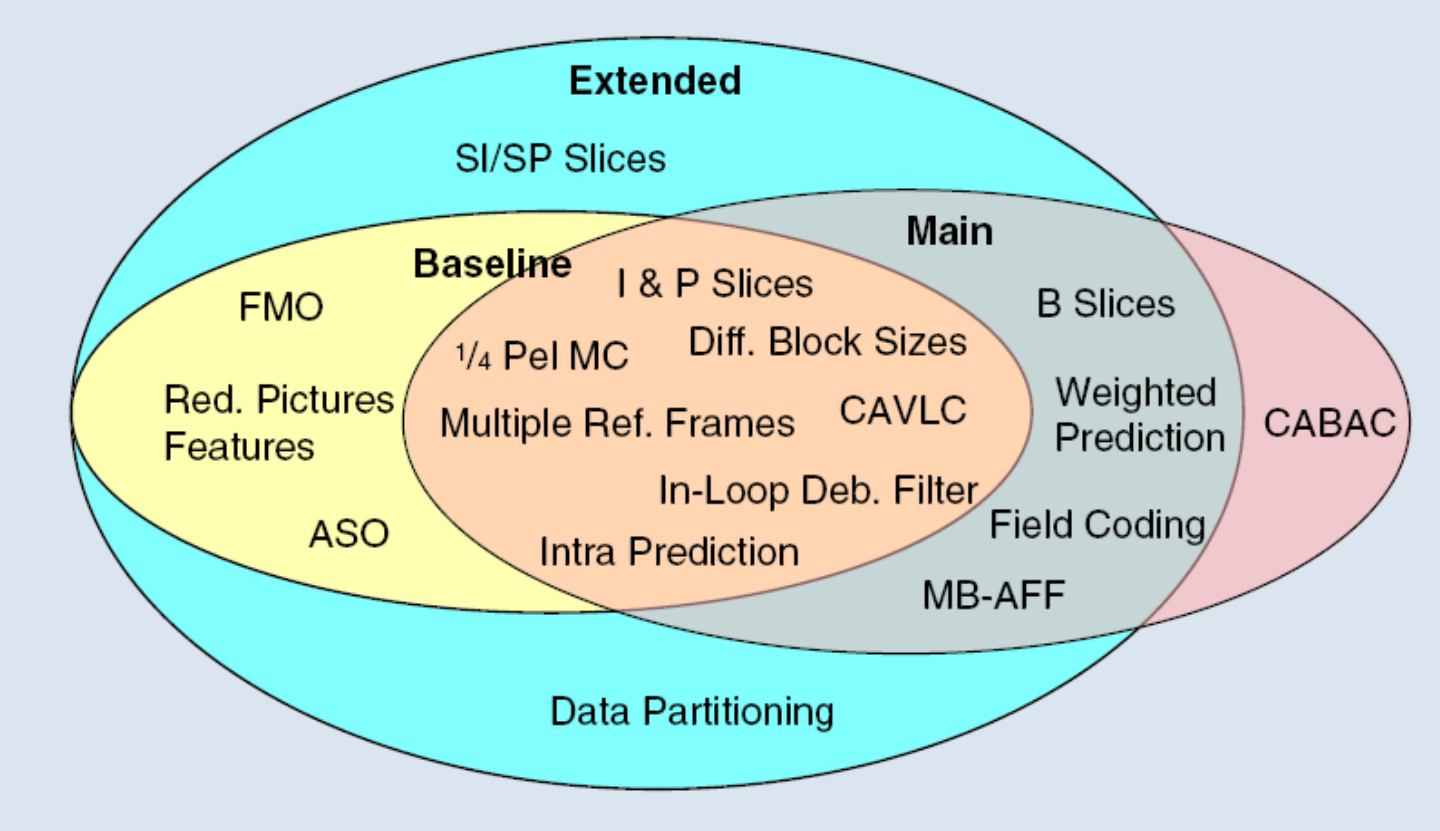
- H.264, a.k.a. MPEG-4 Part 10, is a digital video codec standard written by the ITU-T Video Coding Experts Group (VCEG) and the ISO/IEC Moving Picture Experts Group (MPEG) as the product of a collective partnership effort known as the Joint Video Team (JVT).
- The ITU-T H.264 standard and the ISO/IEC MPEG-4 Part 10 standard (formally, ISO/IEC 14496-10) are technically identical, and the technology is also known as AVC, for Advanced Video Coding.
- Goals:
  - good video quality at bit rates that are substantially lower (e.g., half or less) than what previous standards without excessive complexity
  - applied to a very wide variety of applications (e.g., for both low and high bit rates, and low and high resolution video) and
  - to work well on a very wide variety of networks and systems (e.g., for broadcast, DVD storage, RTP/IP packet networks, and ITU-T multimedia telephony systems).

Video CODEC is a mixture of algorithmic tools

- Tool 1 – Intra frames
- Tool 2 – Motion estimation
- Tool 3 – Search strategies
- Tool 4 – Block Matching
- Tool 5 – B frames
- Tool 6 - Transformation
- Tool 7 - Quantization
- Tool 8 – Entropy coding
- Tool 9 – Deblocking filter



Profiles



Profile : a set of coding tools or algorithms

(EX) Baseline decoder

Level : a degree of capability

(EX) Resolution or speed of decoding

Coding Tools in Profiles

Tools\Profiles	Baseline	Main	Extended	High	High 10	High 4:2:2	High 4:4:4
Intra Prediction	X	X	X	X	X	X	X
4x4 Transform	X	X	X	X	X	X	X
Segmented MC	X	X	X	X	X	X	X
Multiple reference MC	X	X	X	X	X	X	X
Unrestricted MC	X	X	X	X	X	X	X
Luma Quarter pel Chroma 1/8th pel MC	X	X	X	X	X	X	X
CAVLC	X	X	X	X	X	X	X
In-loop Deblocking	X	X	X	X	X	X	X
Slice Groups (FMO/ASO)	X		X				
Redundant Slices	X		X				
Multi-hypothesis MC		X	X	X	X	X	X
CABAC		X		X	X	X	X
MB-AFF		X	X	X	X	X	X
PAFF		X	X	X	X	X	X
Weighted MC		X	X	X	X	X	X
Data partitioning			X				
Spare pictures			X				

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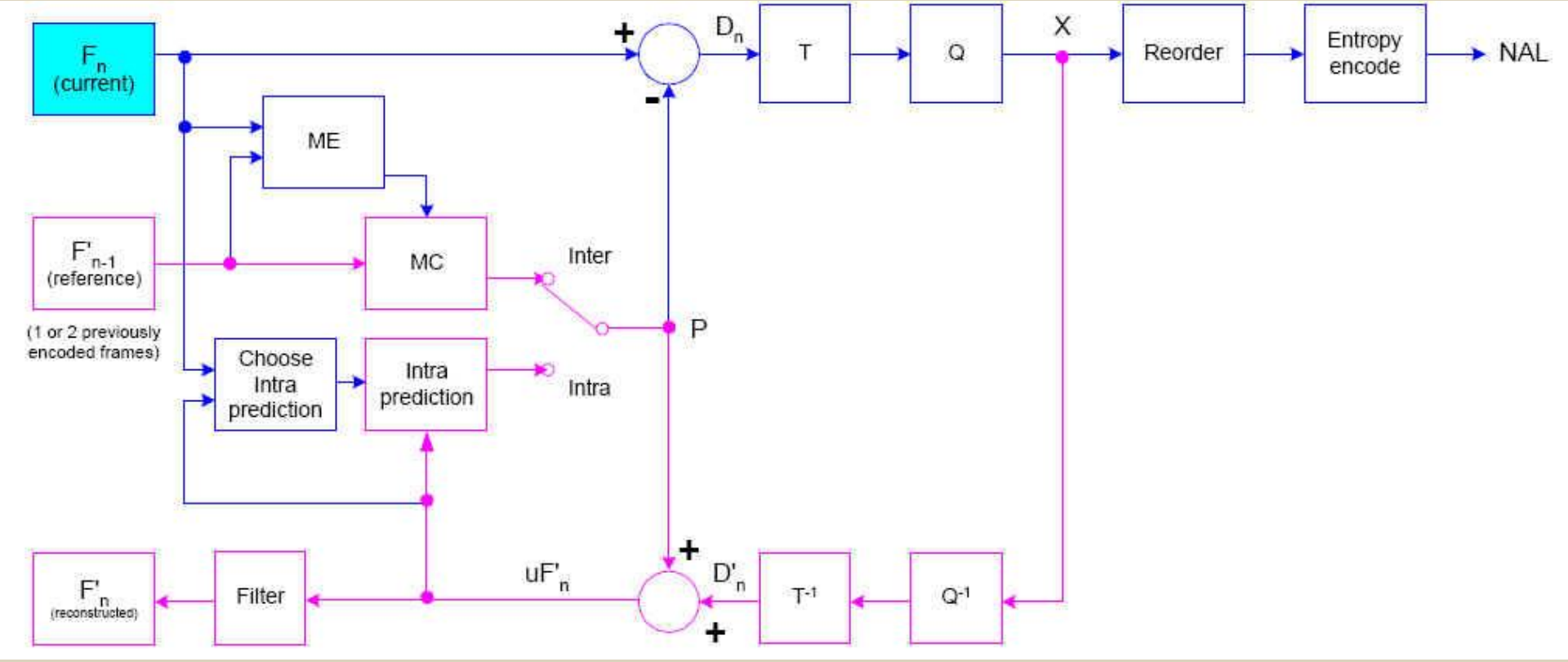
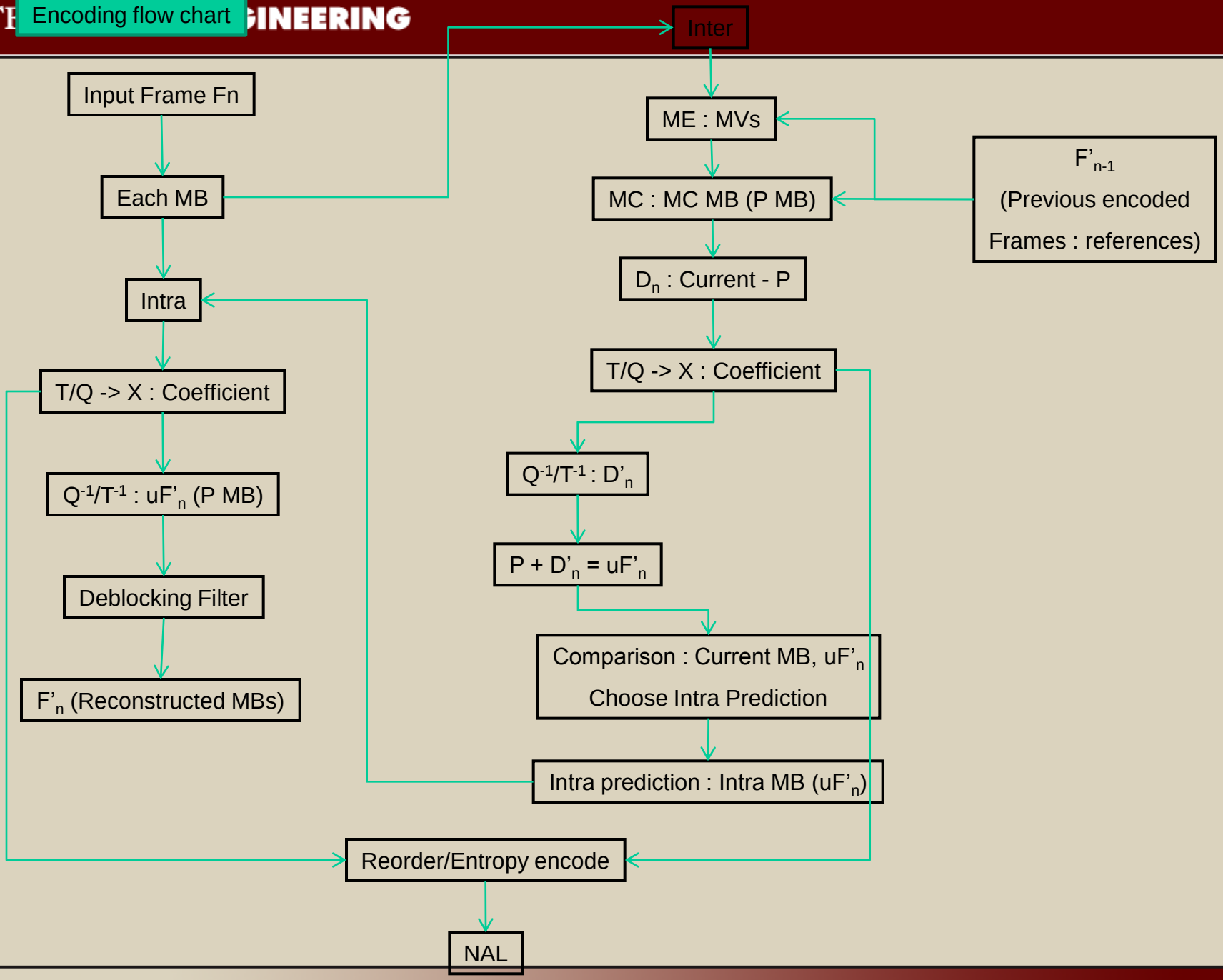
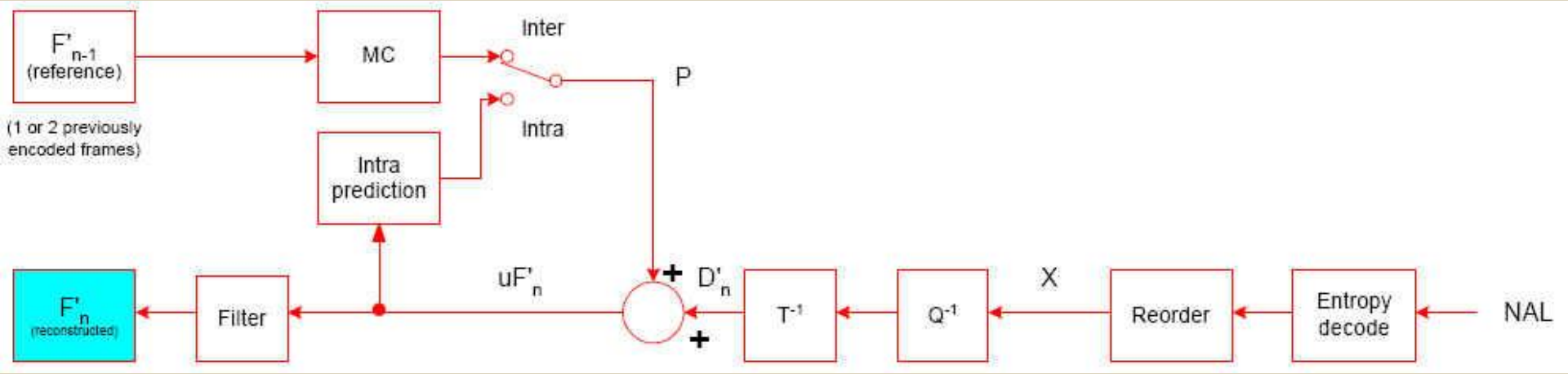
Encoding Block Diagram

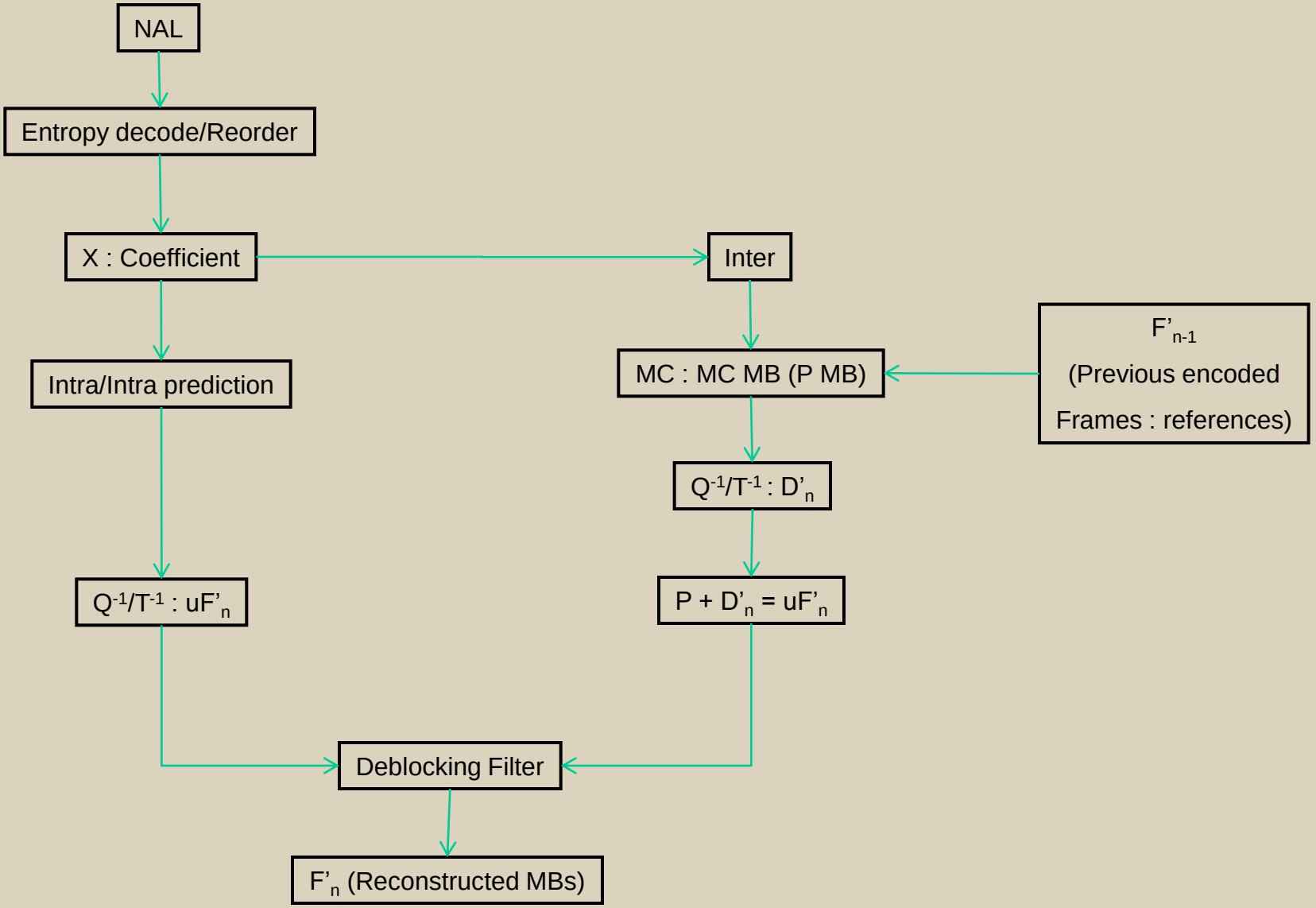


Encoding flow chart



Decoding Block Diagram

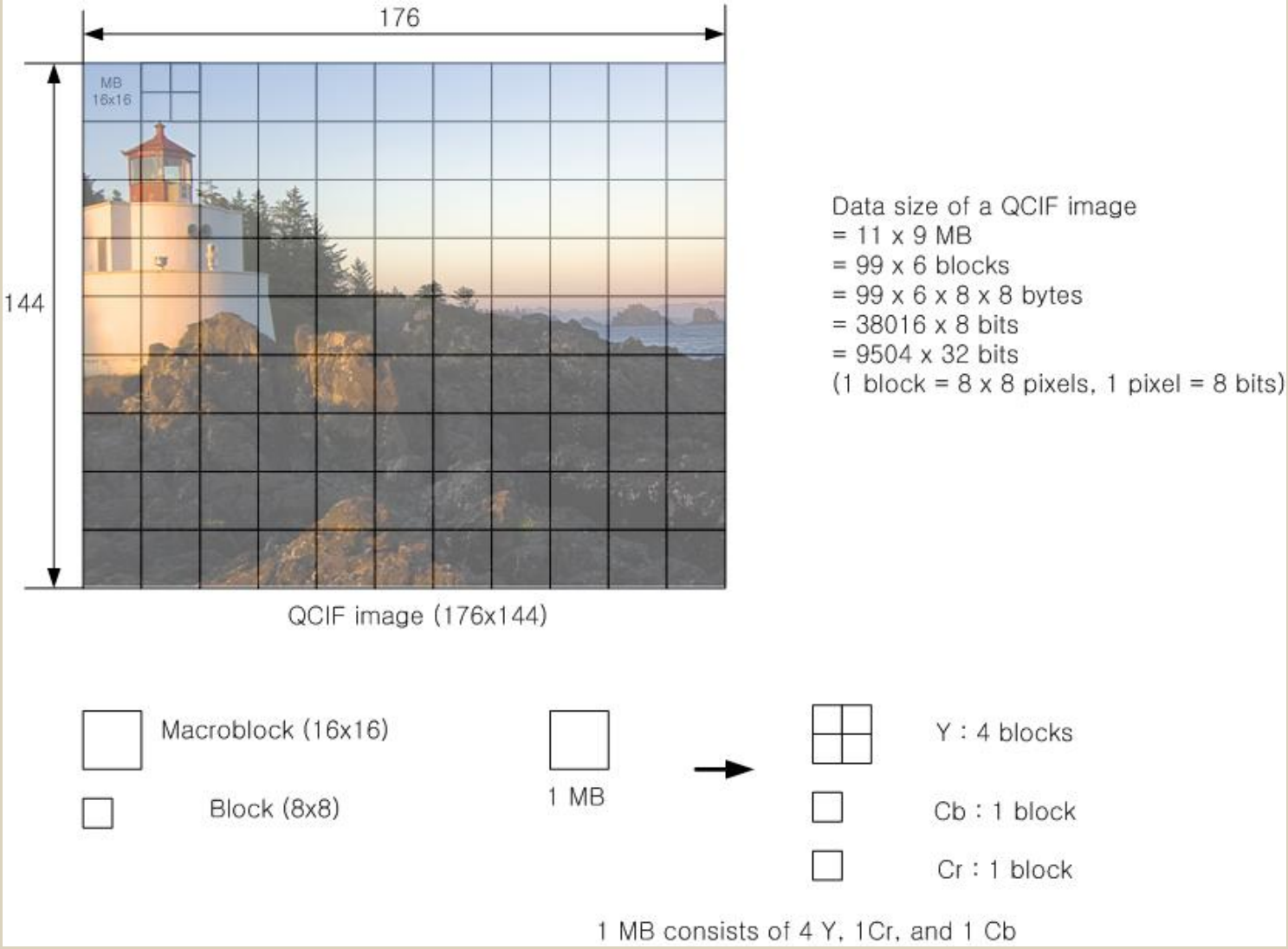



NAL
Entropy decode/Reorder
X : Coefficient
Inter
Intra/Intra prediction
MC : MC MB (P MB)
F'n-1
(Previous encoded
Frames : references)
Q-1/T-1 : D'n
Q-1/T-1 : uF'n
P + D'n = uF'n
Deblocking Filter
F'n (Reconstructed MBs)

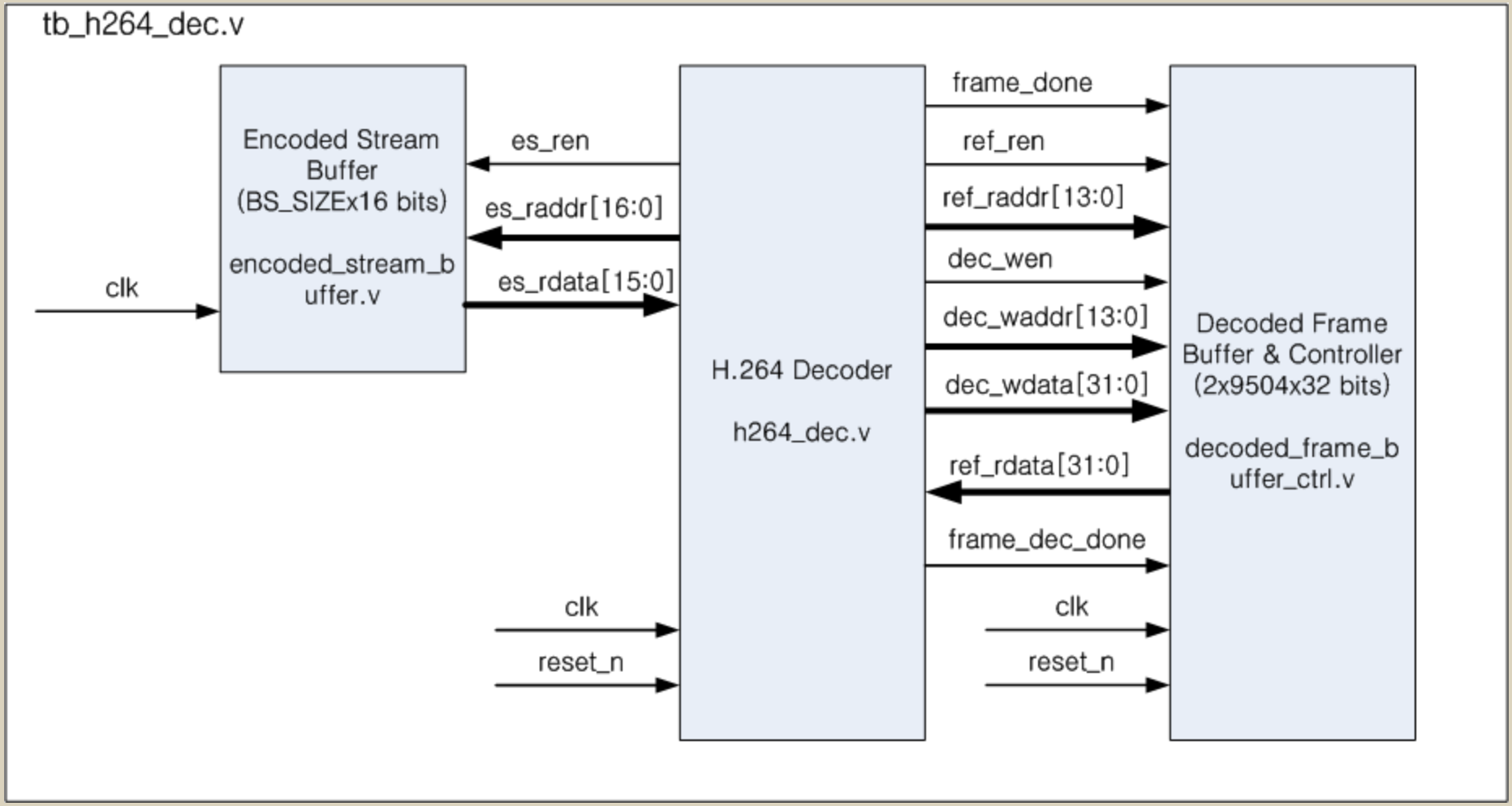
H.264/AVC Decoder Architecture

- Video decoder (VDEC) is H.264/AVC baseline decoder
- Dedicated, full hardwired ASIC design without utilizing any GPP/DSP cores
- RTL coded in Verilog-HDL
- Real-time H.264/AVC baseline decoding of QCIF(176x144) resolution
  - Intra/inter prediction
  - 4:2:0 sampling
  - Deblocking filter
  - CAVLC/Exp-Golomb
  - No B pictures

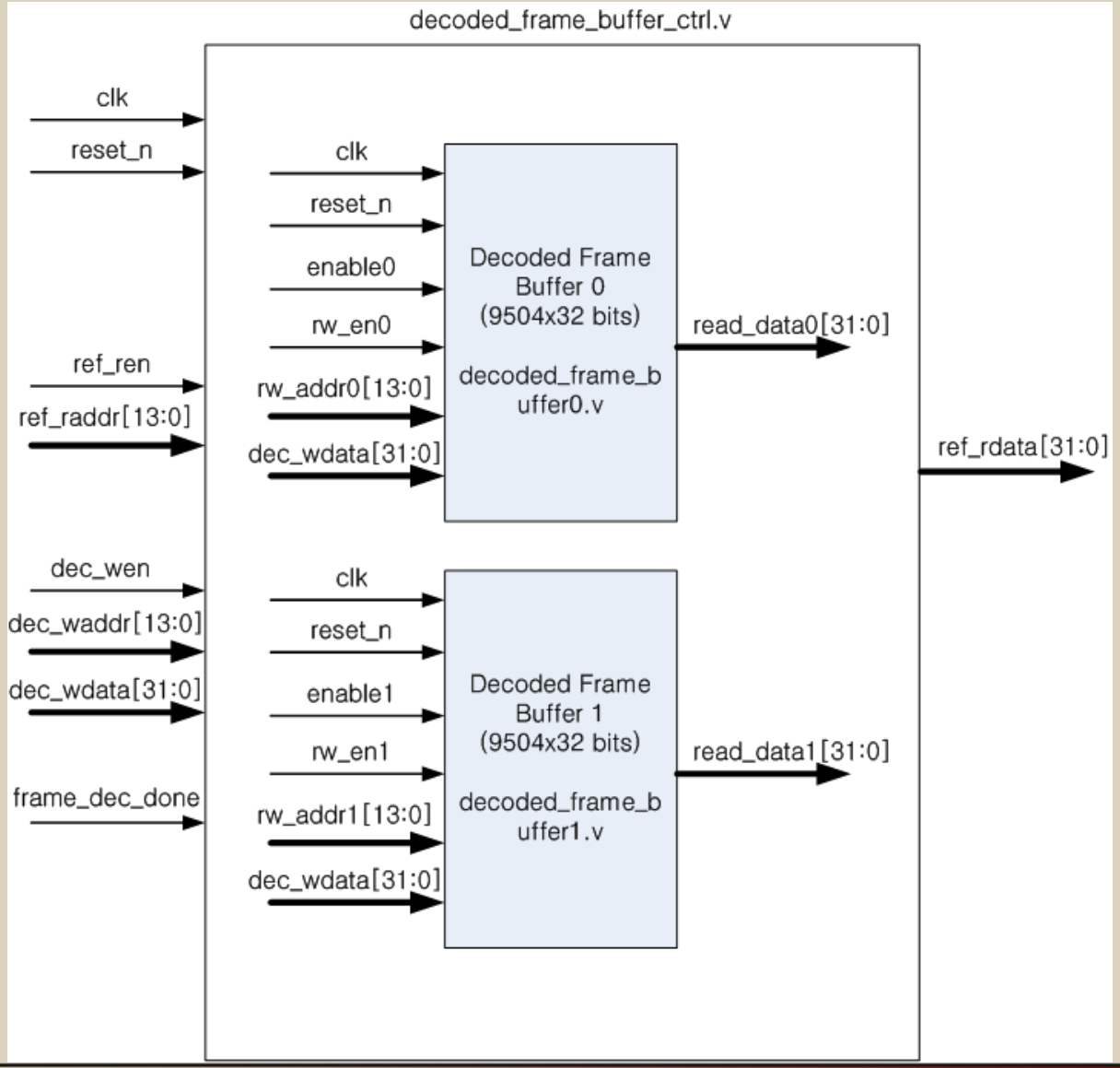
H.264/AVC Decoder frame resolution



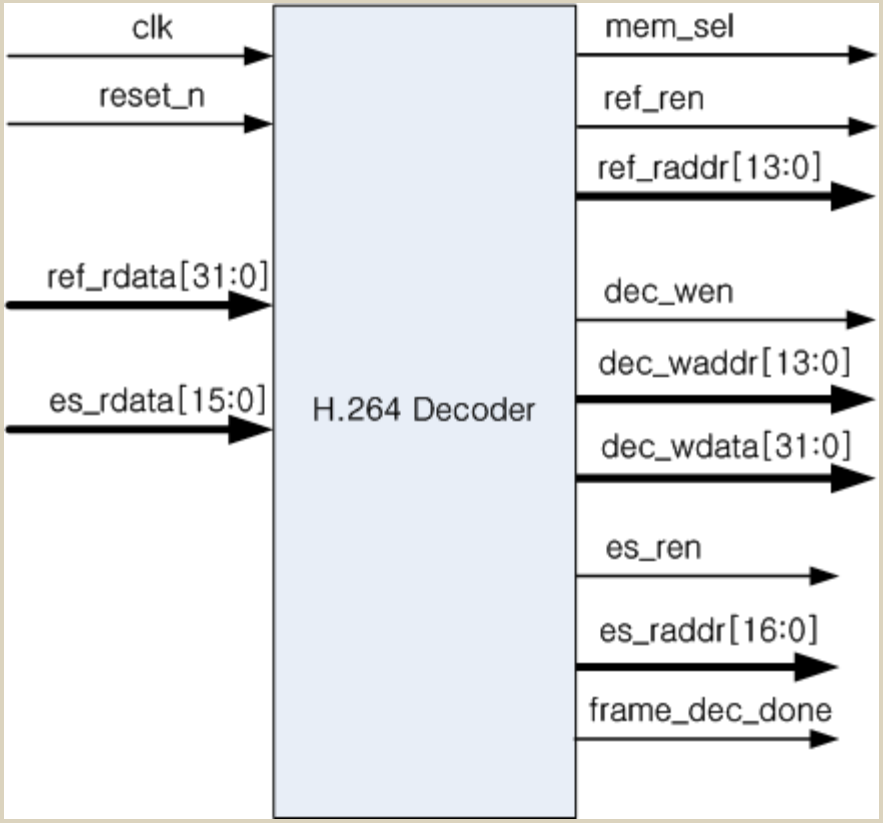
Sample Code: H.264/AVC Decoder Template



H.264/AVC Decoder: Memory Block

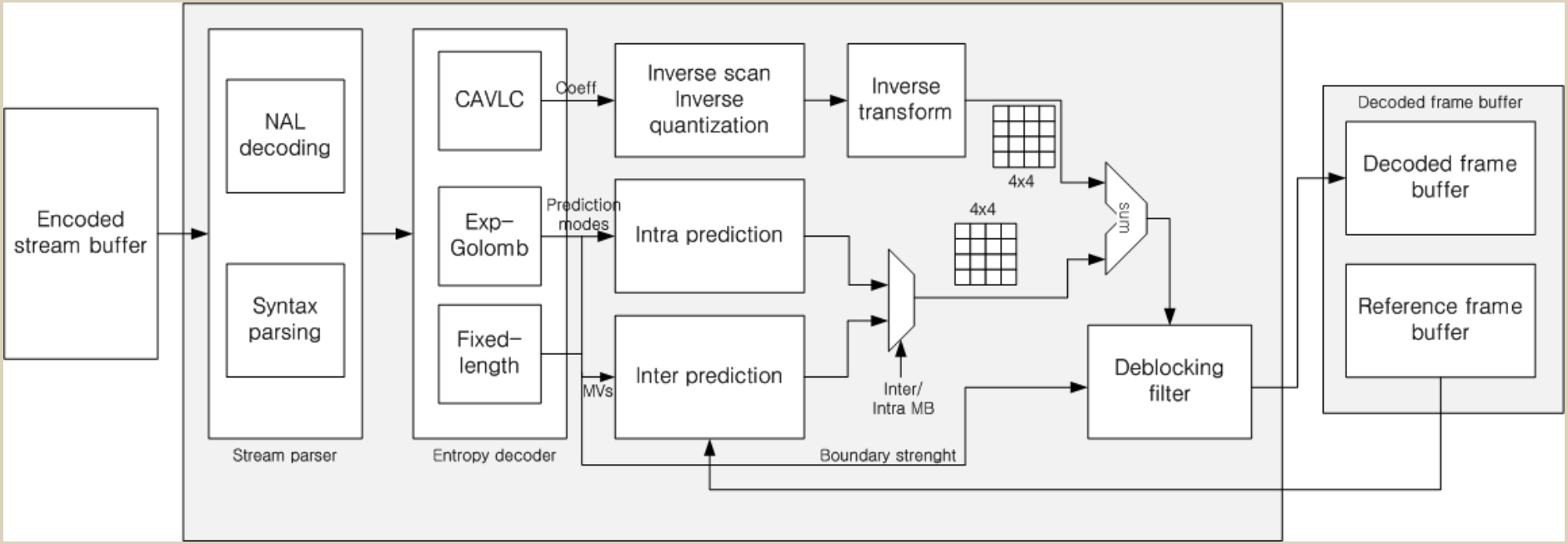


H.264/AVC Decoder: Decoder Main Block



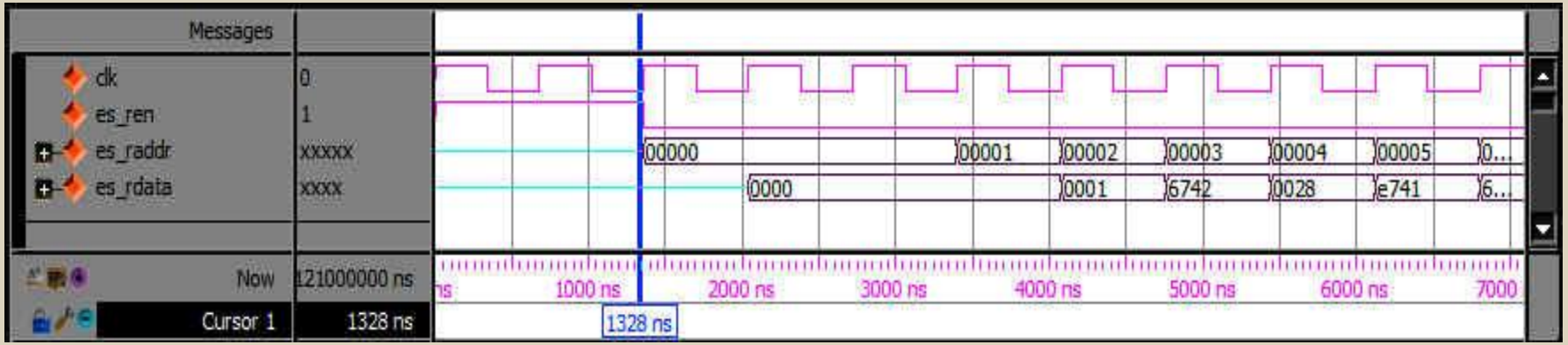
H.264/AVC Decoder: Decoder Top Block Diagram

H.264 decoder



Timing Specification: Encoded Stream Buffer

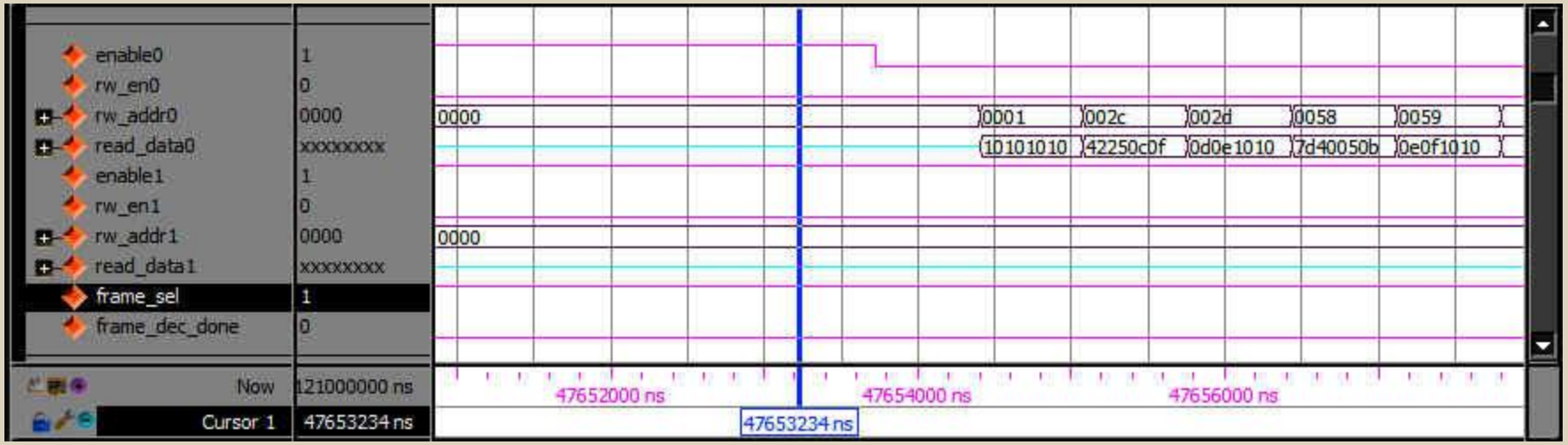
Timing of Encoded stream buffer



Timing Specification: Decoded Frame Buffer

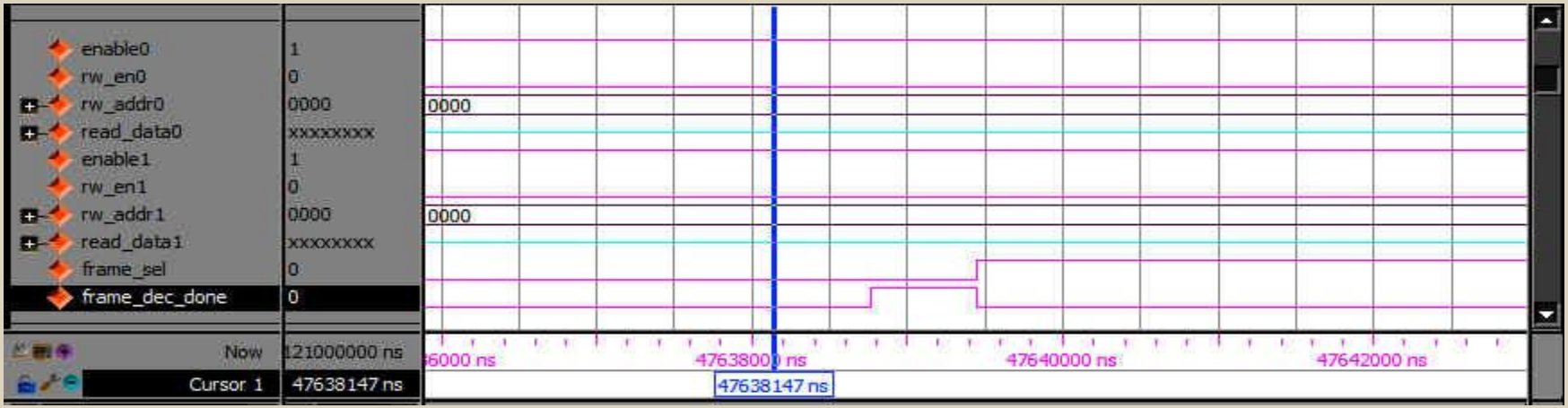
- Frame_sel = 0
  - buffer 0 → storing a decoded frame
  - buffer 1 → reading a reference frame
- Frame_sel = 1
  - buffer 1 → storing a decoded frame
  - buffer 0 → reading a reference frame

Timing of read signals (enable is negative active, frame_sel = 1)



Timing Specification: Decoded Frame Buffer

Generation of frame_sel signal



Timing of write signals (enable is negative active, frame_sel = 0)