



4:4:4 Screen Content Coding using Dual-coder Mixed Chroma- sampling-rate (DMC) Techniques

JCTVC-I0272

27 April – 7 May 2012

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Fast Growing Interest in SCC

- **Driven by two major applications:**
 - ✓ **The new generation cloud-mobile computing**
 - ❖ **Separating Users from Computing Units at Screen**
 - ❖ **Examples: Virtualized Screen, Cloudlet-screen Computing, Remote Desktop, Virtual Desktop Infrastructure, Zero Client, PCoIP, etc.**
 - ✓ **Wireless external, second, or mirror display for mobile devices at office or home**

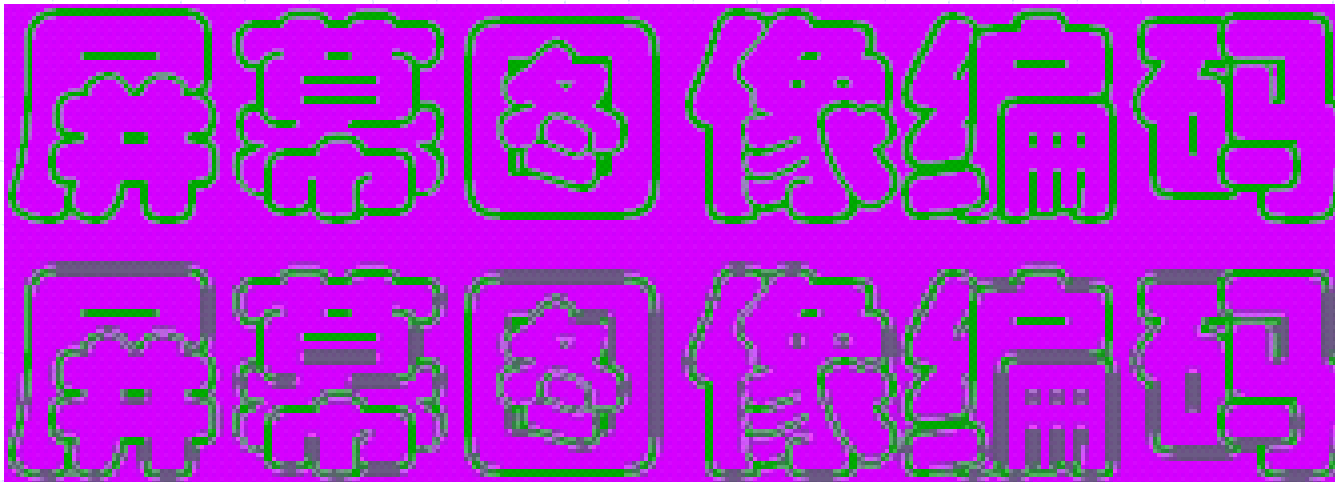


Motivation

➤ 420 chroma-subsampling degrades picture quality



Chroma-subsampling causes severe color artifact such as black pixels in the YUV420 picture.

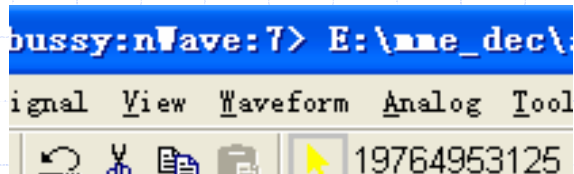


Artifact is more obvious after scaling-up (200% in the example) of the screen content .



Motivation

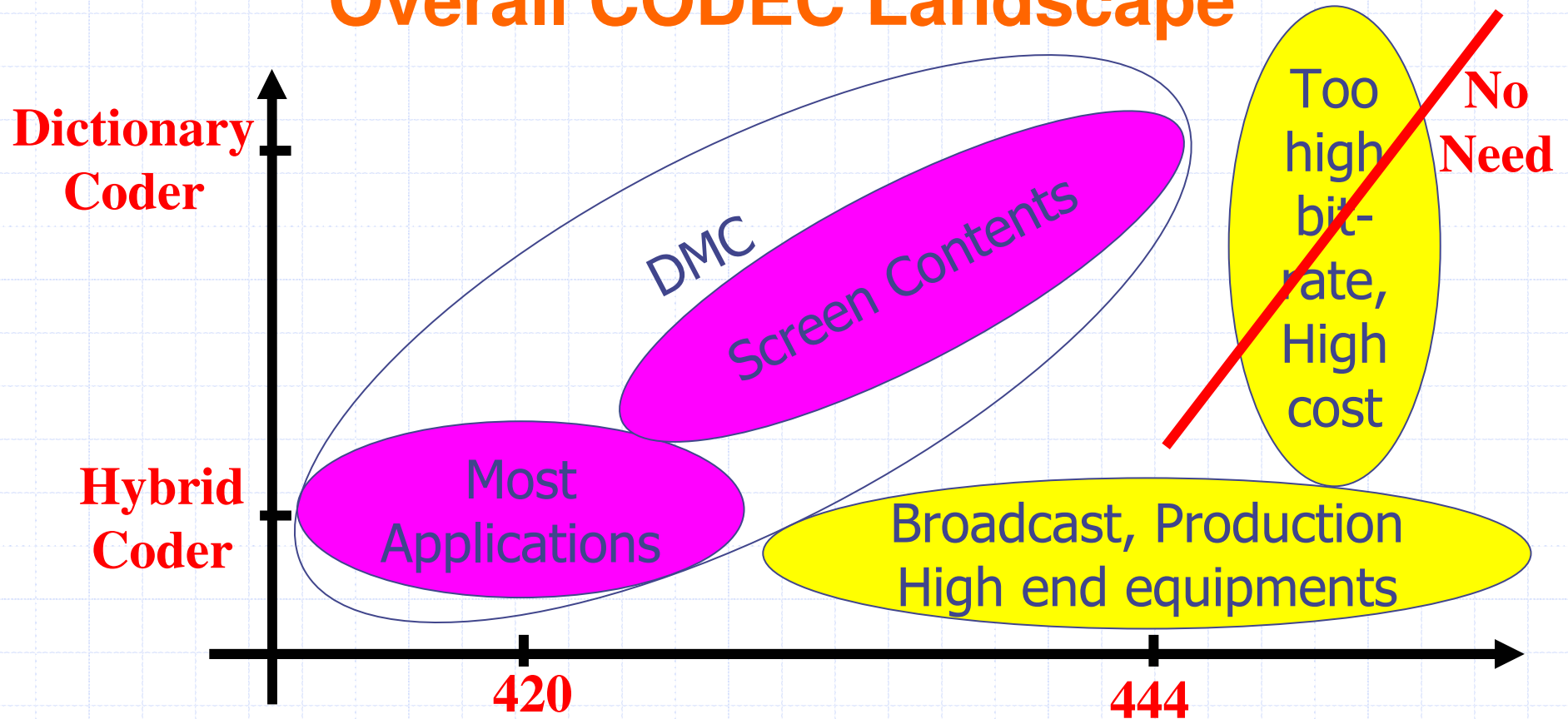
- ◆ Screen picture has two types of content
 - ◆ Continuous-tone content + Discontinuous-tone content
- ◆ Hybrid coding is not discontinuous-tone oriented
 - ◆ Even 444 hybrid coding has problem at very low bit-rate
- ◆ Non-hybrid coder can do a much better job
 - ◆ Skipping Transform/Quantization is one solution
 - ◆ Even Better: using a super-large predictor set (dictionary)



← hash table based quick intra-frame search
can code the picture at lower bitrate



Overall CODEC Landscape



◆ Dual-coder Mixed Chroma-sampling-rate (DMC)

- ◆ An extension of HEVC 420 hybrid coding (used AS IS)
- ◆ Add 444 Dictionary coding (three new syntax elements)



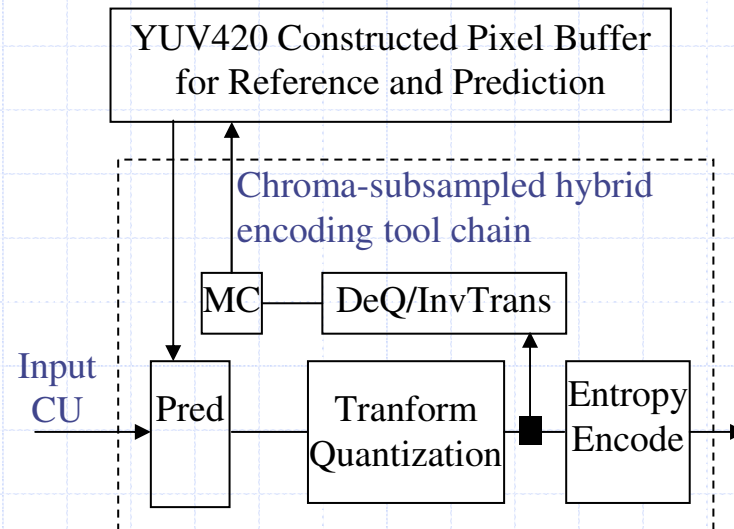
coding_unit() {	Descriptor
if(dmc_enable == 0) //dmc_enable flag is defined in SPS	
{the current YUV420 HEVC hybrid coder syntax is used AS IS}	
else {	
coder_type_flag	ae(v)
if(coder_type_flag == 0) //HYBRID_CODER	
{the current YUV420 HEVC hybrid coder syntax is used AS IS}	
else //DICTIONARY_ENTROPY_CODER	
dictionary_entropy_coder()	
}	
}	



dictionary_entropy_coder {	Descriptor
decoded_sample_count = 0	
while(decoded_sample_count < NumSamplesInCU) {	
matching_string_flag	ae(v)
if(matching_string_flag == 1) {	
distance	ae(v)
length	ae(v)
decoded_sample_count += length	
}	
else {	
literal	ae(v)
decoded_sample_count += 1	
}	
}	



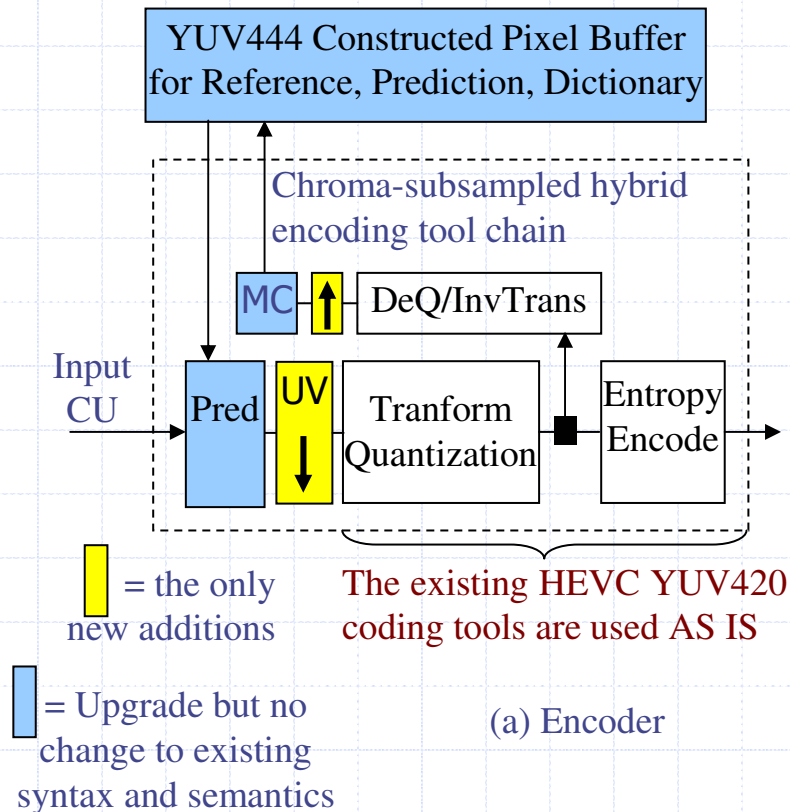
➤ Starting Point: the existing HEVC 420 hybrid coder



(a) Encoder



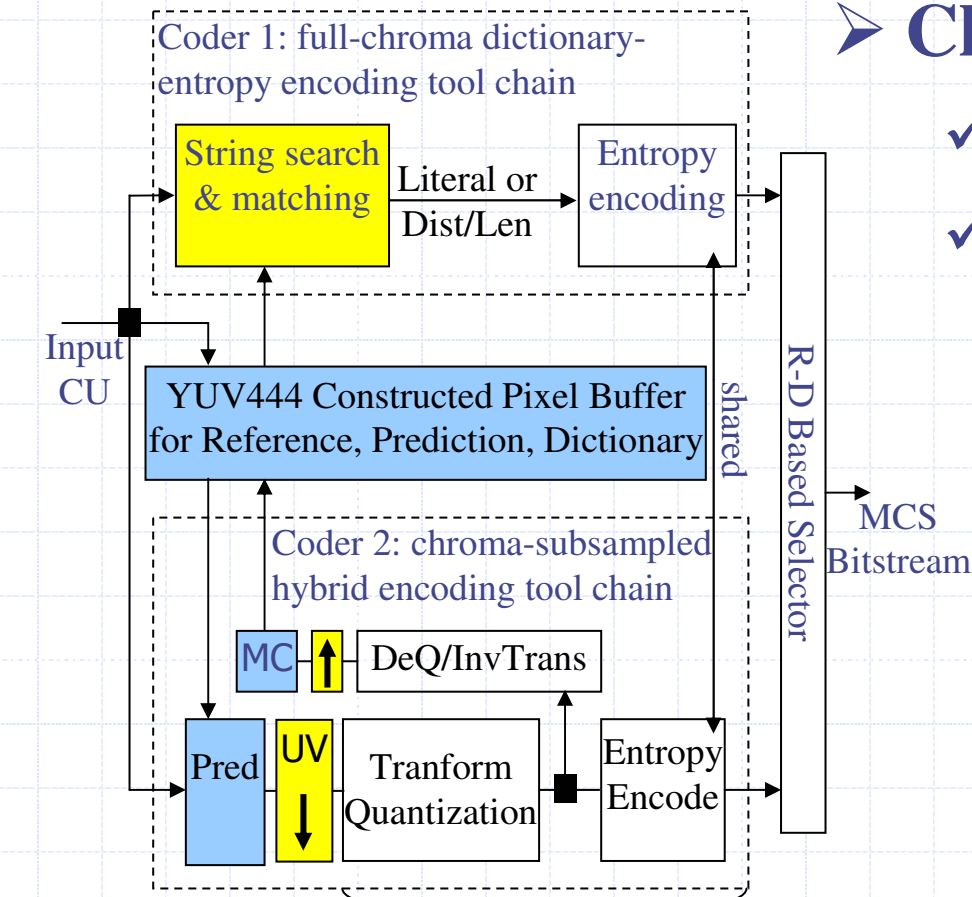
- **Change #1: Upgrading Pred/MC/CPB from 420 to 444**
 - ✓ Extend calculation formula from 420 to 444 → one hour job
 - ✓ Add UV prediction residual subsampler and upsampler





➤ Change #2:

- ✓ String search
- ✓ Select one of dual-coder CU-by-CU



= the only new additions

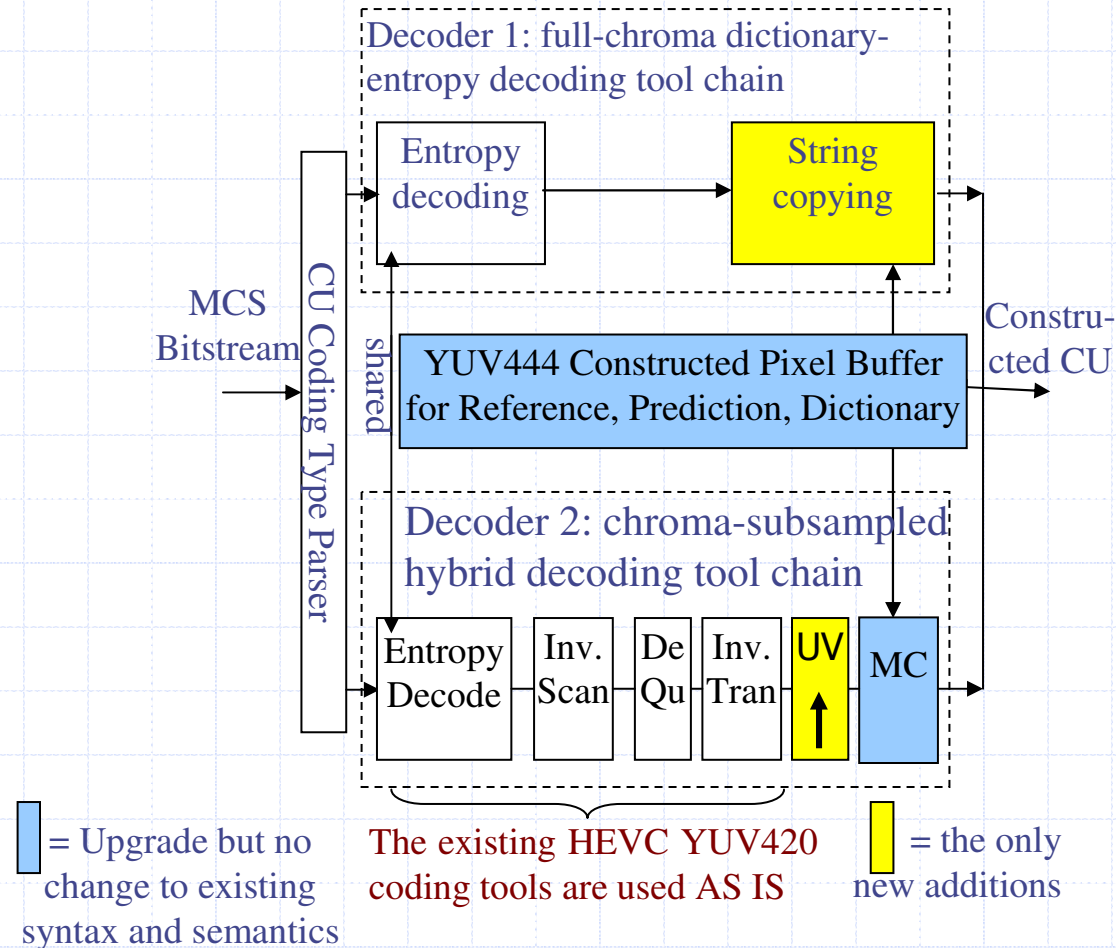
The existing HEVC YUV420 coding tools are used AS IS

= Upgrade but no change to existing syntax and semantics

(a) Encoder



◆ Decoder has negligible complexity and cost increment

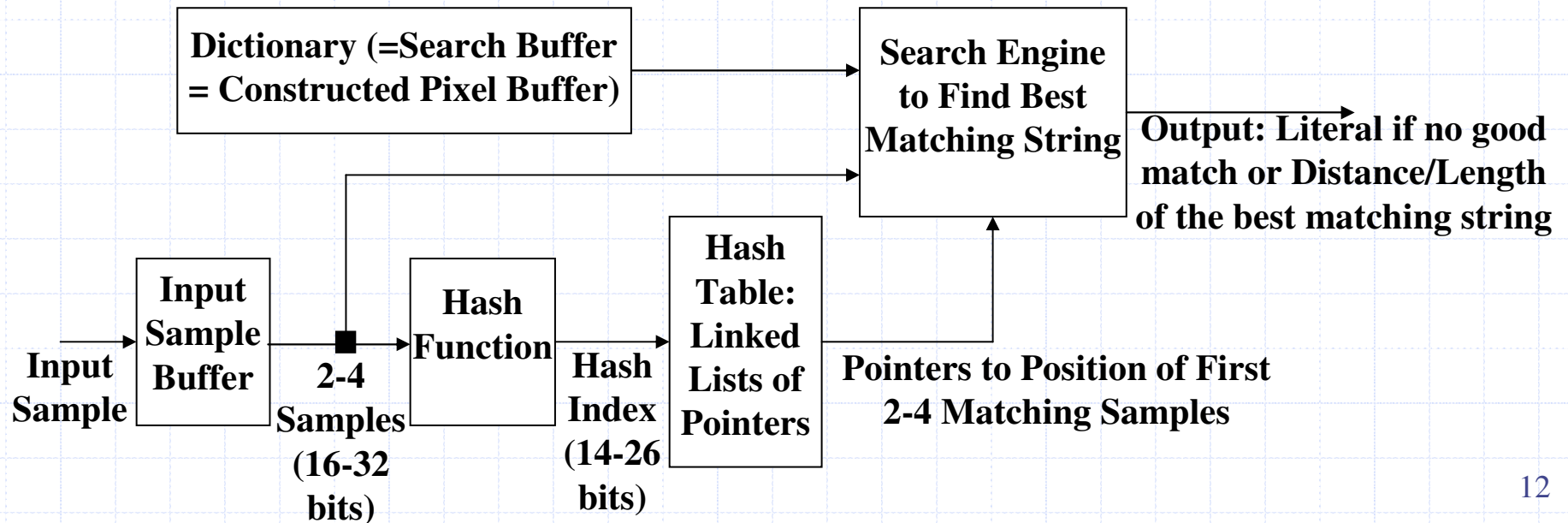


(b) Decoder

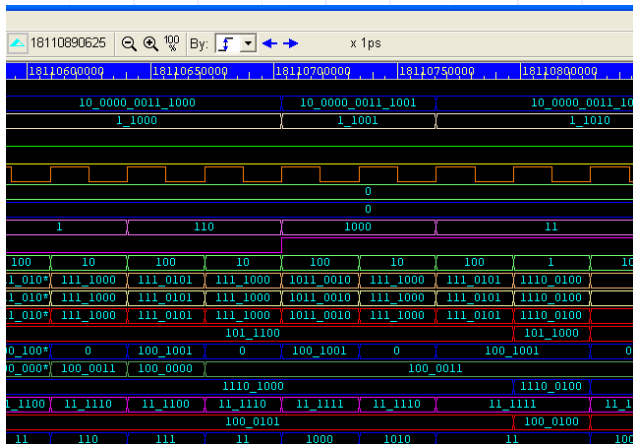


Why Dictionary Coding

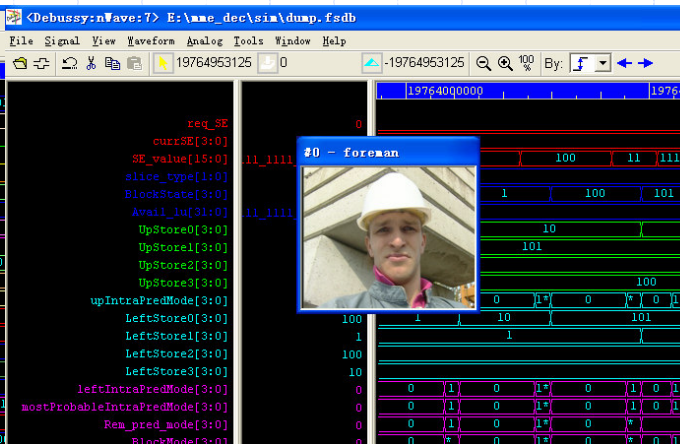
- ◆ Very effective for discontinuous-tone contents
 - ◆ An extension of intra prediction with a super-predictor-set
 - ◆ Exact matching and hash-table to accelerate prediction
- ◆ Very flexible encoder implementation



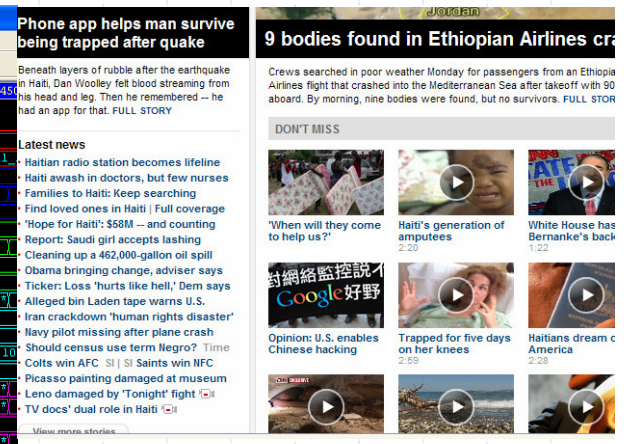
◆ DMC Intra coding



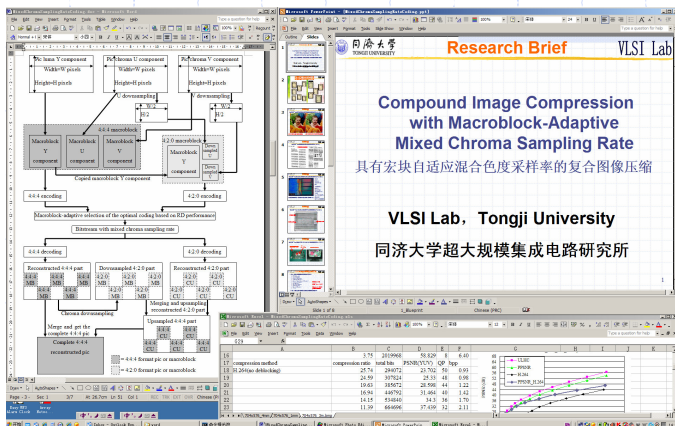
(a) Integrated-circuit design debug waveform.



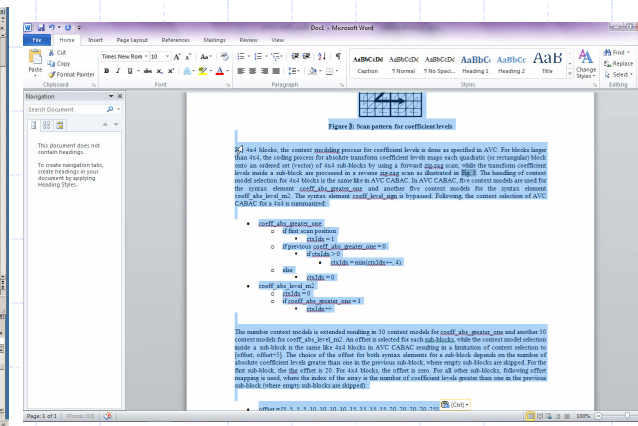
(b) IC design debug waveform plus nature picture.



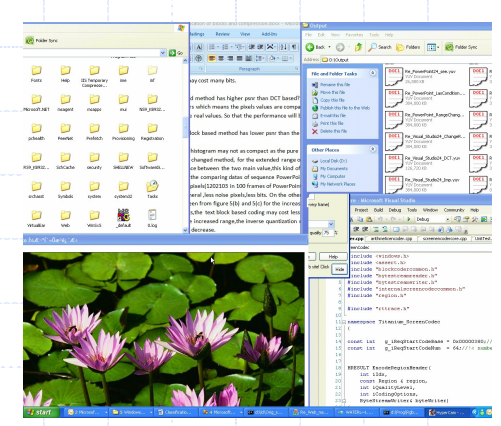
(c) Web page.



(d) PowerPoint, Word, and Excel file windows.



(e) Document editing.

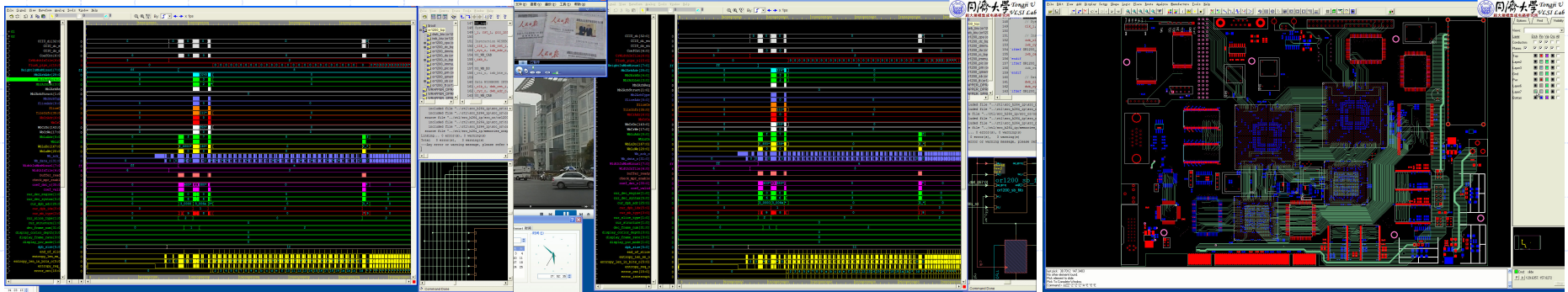


(f) Various windows mix.



◆ DMC Inter coding

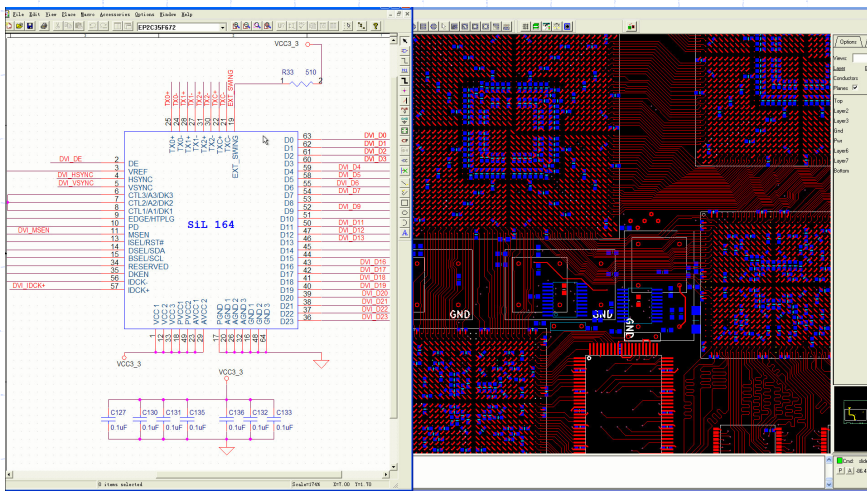
◆ See JCTVC-H0294 for details of the test sequences



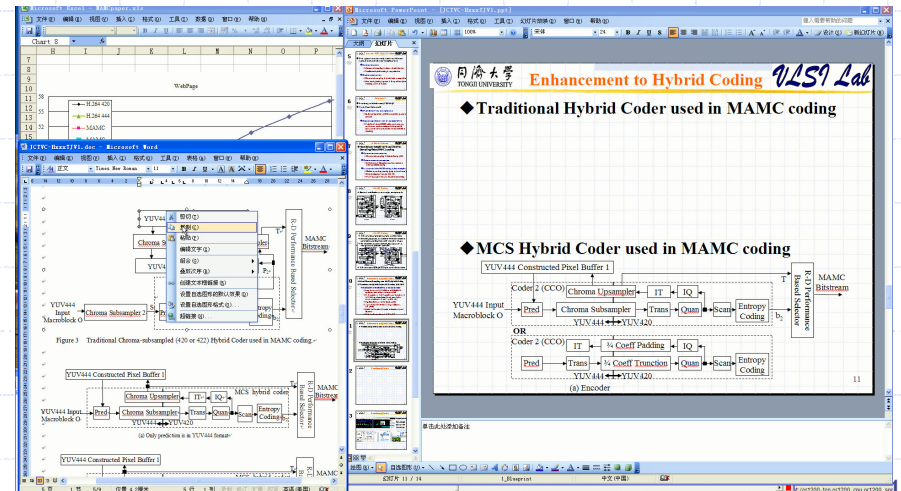
TJU_CAD_waveform.yuv

TJU_CAD_waveform_Street_Campus.yuv

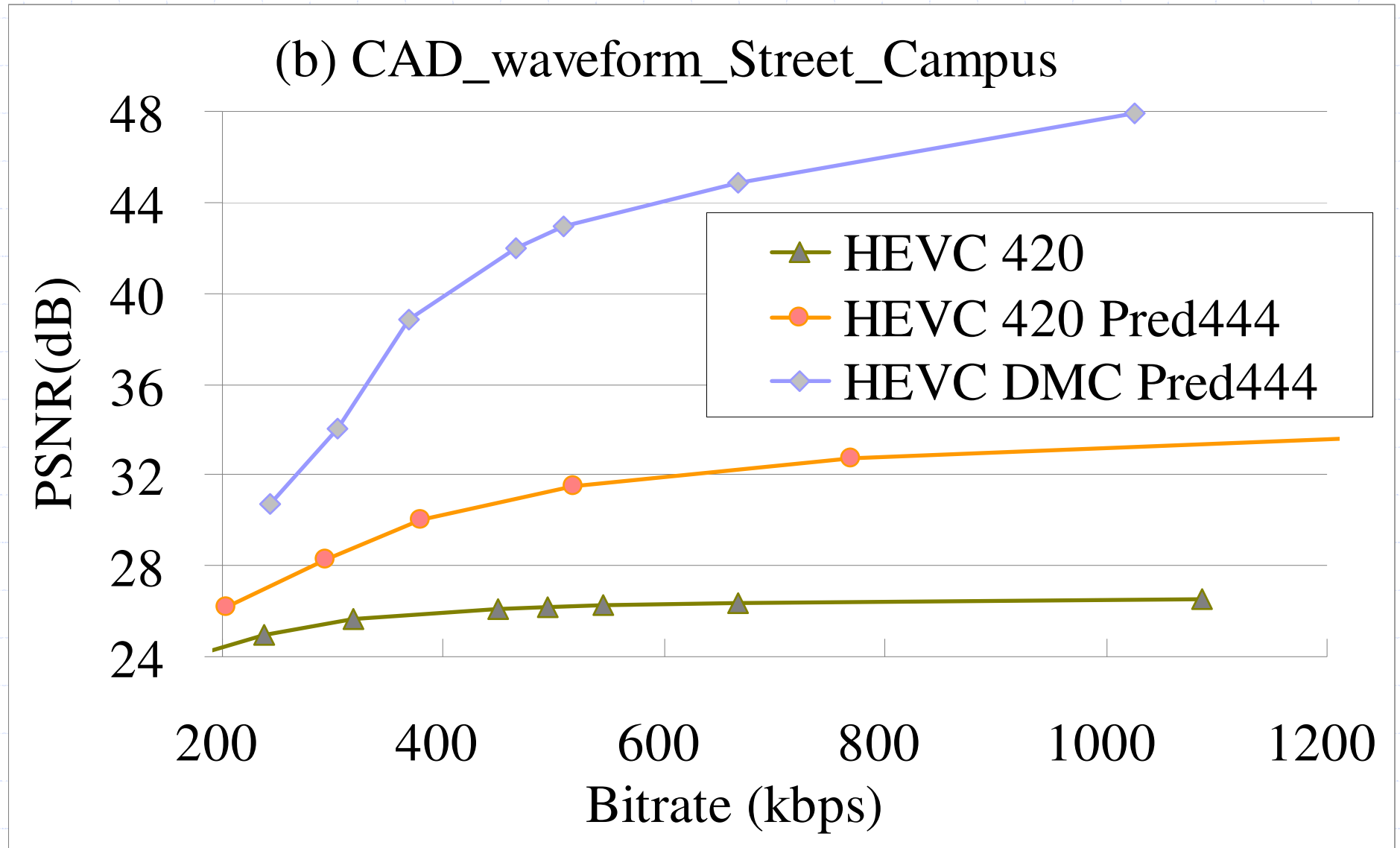
TJU_PCB_layout.yuv



TJU_PCB_schematic.yuv



TJU_ppt_doc_xls.yuv





Conclusions

- **DMC coding is a straightforward yet very effective extension of the state of the art HEVC for SCC**
- **Just adding three new syntax elements**
- **Significant quality improvement at very low bitrate**
- **Call for more participants for further investigation, cross-check and other activities**



THANK YOU