



# IP Workflow Development with ST2110 and VC2 Compression

Tae-Han Kim  
CEO @ IML Co. Ltd.



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## IP Workflow Testbed Design with ST2110 & VC2

1. Introduction to the Testbed
2. SDI-ST2110 Converter
3. VC2 Codec for IP Workflow
4. Audio over IP ( treated as Ancillary data)
5. Discussion



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## ST2110 & VC2 : Introduction

- Where is the Testbed studio ?
  - KBS Laboratory Building, IP Workflow Testbed (Panoramic view)



- Miniature Studio



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## ST2110 & VC2 : Introduction

- Who built the workflow ? (Consortium Organization)

- KBS (Korean Broadcasting System)
  - Architecture Developer, Testbed holder
  - ST2110-20/30 supporting media server developer



- Lumantek
  - ST2110-20 supporting video switcher developer
  - Web-based workflow manager developer



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## ST2110 & VC2 : Introduction

- Who built the workflow ? (Consortium Organization)

- Atto-research

- SDN OpenFlow switch & network structure developer



- IML

- ST2110-22 VC-2(ST2042/2047) compression supporting SDI-IP converter developer
- Stand-alone workflow manager developer



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## ST2110 & VC2 : Introduction

- Why IP Workflow ?

- Study New Technology

- KBS is already operating an IP Studio with Grass Valley-Cisco solution
- Test ST2110 interoperability with legacy UHD equipment

- IP-enabled Video Switcher Development

- Lumantek extends product line with IP capability
- ST2110-20 supporting modular video switcher



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## ST2110 & VC2 : Introduction

- Why IP Workflow ?
  - UHD Video Compression for 10G Network
    - ST2042/2047 VC-2, the only open & released low latency codec
    - Long-distance source with limited communication bandwidth
  - Network Infrastructure
    - Broadcasting Company-wide IP network connectivity
    - All hardware & media assets are managed with IP connection



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## ST2110 & VC2 : Introduction

- How to build ?
  - Use new IP standard
    - SMPTE ST2110 for media transport
    - AMWA NMOS for workflow management
  - Target Media
    - Video : UHD (3,840x2,160) @59.94p
    - Audio : only embedded 16ch audio is supported, yet to be extended to ST2110-30



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## ST2110 & VC2 : Introduction

- How to build ?

- Network

- 1G/10G/25G/40G/100G ethernet switches mixed in spine-leaf design
    - Non-proprietary SDN(OpenFlow) with legacy IGMP support

- Video Coding

- ST2110-20 uncompressed and ST2110-22 compressed with VC2 co-existing design
    - draft-ietf-payload-rtp-vc2hq-03 for VC2 transport



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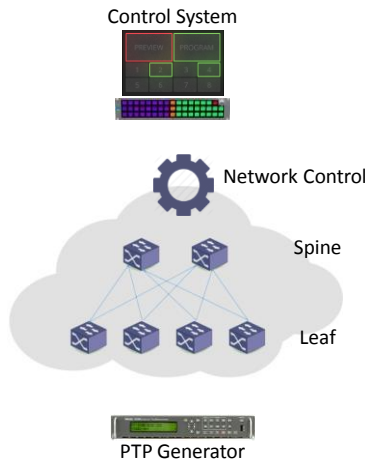


## ST2110 & VC2 : Introduction

- How to build ? (Components)



Miniature Studio

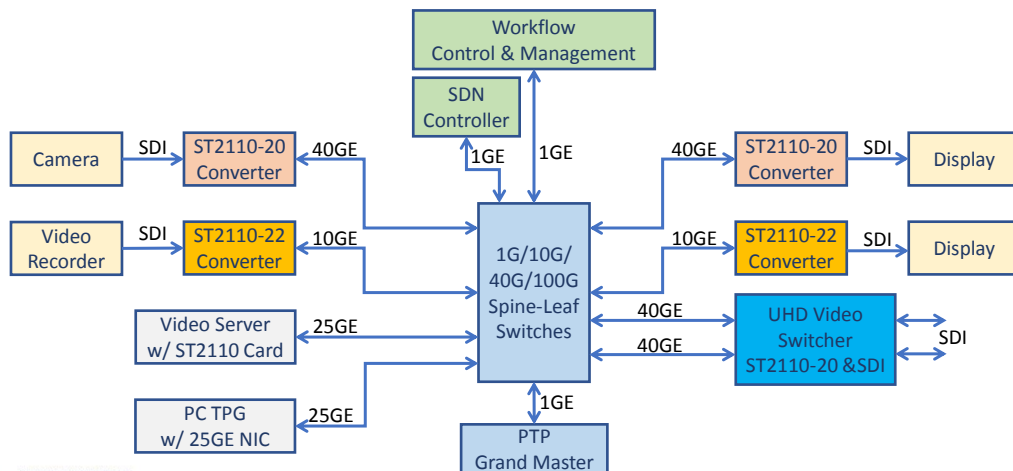


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## ST2110 & VC2 : Introduction

- How to build ? (Block design; Simplified)

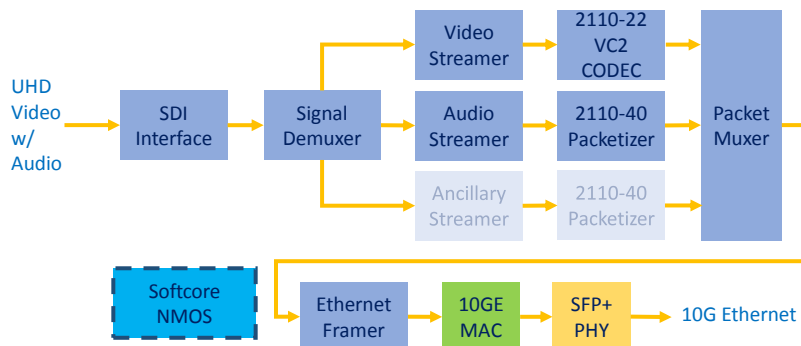


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## ST2110 & VC2 : SDI-IP Converter

- What is developed ?
  - VC2 Encoder

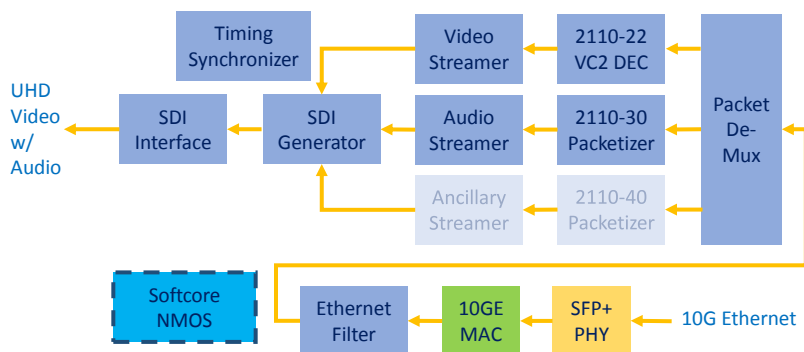


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## ST2110 & VC2 : SDI-IP Converter

- What is developed ?
  - VC2 Decoder

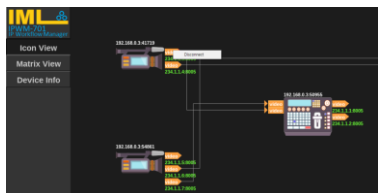


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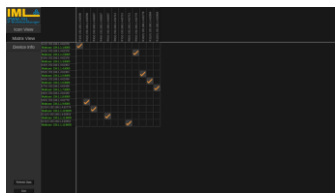


## ST2110 & VC2 : SDI-IP Converter

- What is developed ?
  - NMOS Manager
    - IS-04, IS-05 support
    - Built-in registration server
    - Connection control user interface



Icon View



Matrix View



Device View



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## ST2110 & VC2 : VC2 Codec

- VC2 Video Compression

- Input SDI
  - 12G-SDI 3,840x2,160 UHD 60p,59.94p, 50p
- Wavelet Slice & Filter
  - SMPTE [ST2042-1-2017](#) slice 64x2 Luma Wavelet Slice
  - Legal53 filter ( Haar0, Haar1 )
- Compression Ratio
  - 4:1~10:1 Run-time Programmable,
  - **slice to slice exact CBR** for even video quality over a frame
- Latency
  - **200us** for encoding & decoding & **Buffering** @(Legal53, 64x2 slice, slice CBR)
- Implementation
  - IML's own FPGA IP, <https://www.xilinx.com/products/intellectual-property/1-puxmo7.html>



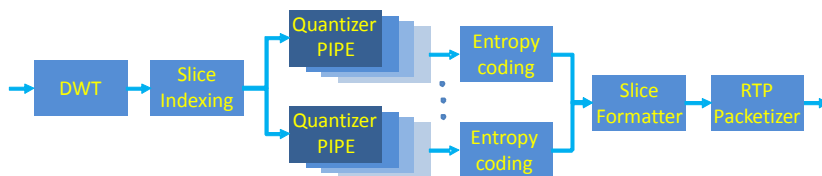
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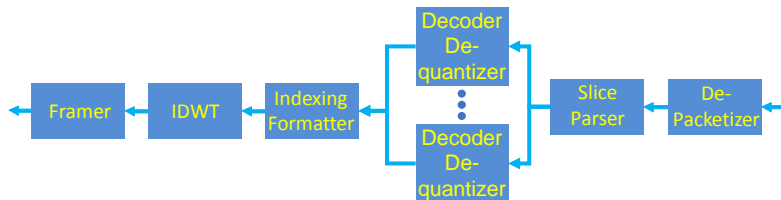
## ST2110 & VC2 : VC2 Codec

- VC2 Codec Structure

- Encoder



- Decoder



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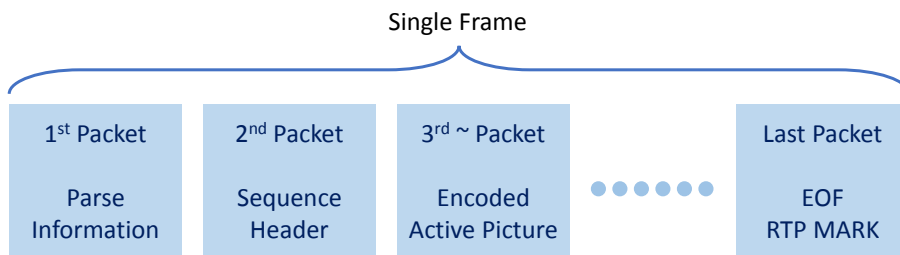
## ST2110 & VC2 : VC2 Codec

- Transmission of VC2-compressed Video
  - RTP packet structure
    - IETF draft-ietf-payload-rtp-vc2hq-03 is followed
    - Fixed number of compressed slices are packed in the payload → RTP packet size varies
    - VC2 frame header packet is generated at each start of a frame
      - Compression ratio, filter type can be dynamically changed



## ST2110 & VC2 : VC2 Codec

- Transmission of VC2-compressed Video
  - RTP packet sequence





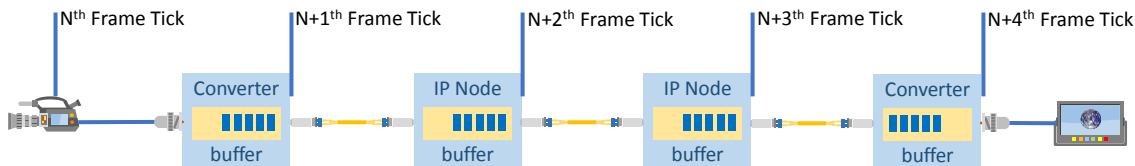
## ST2110 & VC2 : VC2 Codec

- Transmission of VC2-compressed Video
  - Time Synchronization
    - No PTP timing information is used in encoder’s RTP frame generation
    - **Minimal latency from pixel input to RTP packet** → No frame timing sync for RTP stream
    - Decoder generates video timing with input RTP packet data speed
  - Identification of Stream Type
    - SDP file “a=rtpmap:99 VC2/90000” for NMOS connecting managements
    - Detailed parameters in the first packet of a frame

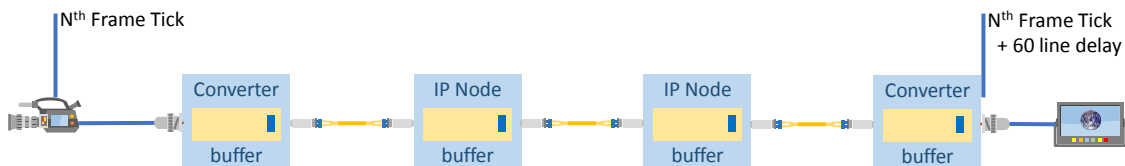


## ST2110 & VC2 : VC2 Codec

- Transmission of VC2-compressed Video
  - Phase Synchronized Transmission → Multi-frame delay



- Minimum Latency Transmission





## ST2110 & VC2 : Audio as ANC data

- Audio Over IP
  - Input SDI
    - 12G-SDI 16ch PCM audio
  - Transport
    - SMPTE ST2110-40 (NOT 30)
    - SMPTE ST272M, ST2082-10 Audio packet (16ch, 48kHz) treated as ANC data
  - Time Sync
    - The audio packet in SDI is regenerated in the original position in the SDI frame



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## ST2110 & VC2 : Audio as ANC data

- Audio Over IP
  - Stream Management
    - Automatic port mapping with the video NMOS connection
    - Independent audio stream can also be generated
  - Usage
    - SDI audio embedded/de-embedded can be used

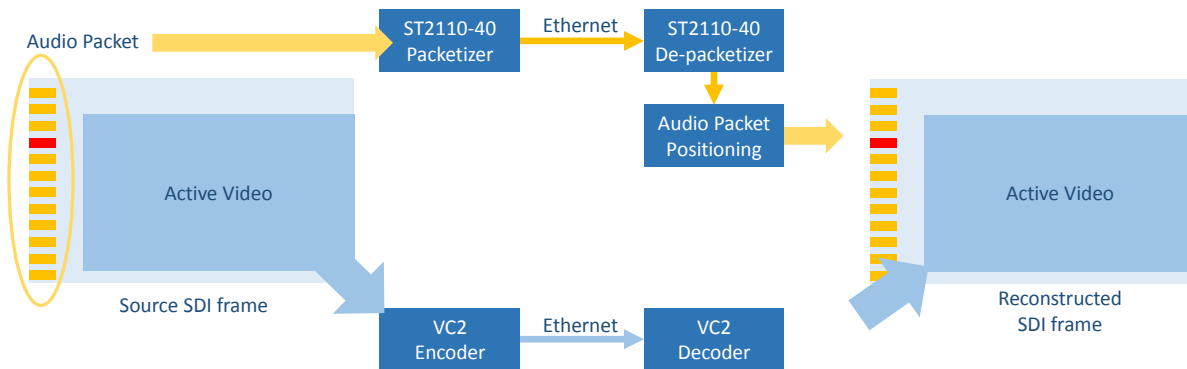


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## ST2110 & VC2 : Audio as ANC data

- Audio Over IP
  - Audio packets are regenerated in the original position
    - Possible from VC2 Encoding/Decoding delay



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## ST2110 & VC2 : Discussion

- What we got from the testbed
  - Interoperability of legacy(12G-SDI) equipment & ST2110 devices
    - Working fine
    - Unified management is required
    - IP-converter should “NMOS” for legacy equipment
    - Ethernet based configuration & management of legacy equipment may be used for generating NMOS data



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## ST2110 & VC2 : Discussion

- What we got from the testbed
  - Timing Synchronization
    - All devices may not require PTP connection
    - Time synchronization is really done in contribution/distribution encoder
    - Frequency synchronization is required in video/audio creator
    - Video mixers should have frame buffer for mixed ST2110 WIDE, Gapped/Linear devices
      - ← Phase synchronization
    - The other devices can follow the source timing with minimum latency



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## ST2110 & VC2 : Discussion

- Future Works
  - Application of the Latest & New AMWA Standards
    - IS-04/05 update
    - IS-06/07/08/09/10 ...
    - Full-stack by VSF
  - VC2 Codec +
    - Add envelop coding in wavelet coefficients → better PSNR
    - Better quantization factor guess algorithm for reduced logic size
  - Workflow Manager
    - Open source project for easily integrated IP workflow



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For Further Discussion, Visit [IML@2.A31](#)

**Thank you**

Tae-Han Kim, IML Co. Ltd.  
[ceo@iml.co.kr](mailto:ceo@iml.co.kr) +82-2-830-5173

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