



## **JPEG2000 for broadcast contribution applications**

WBU-ISOG FORUM, Oct 2011

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# **T·NIPS**

# *Outline*

- T-VIPS introduction
- Benefits of JPEG2000 for contribution
- JPEG2000 multiple generation performance
- T-VIPS TVG450 JPEG2000 Gateway
- Next steps and standardization activities



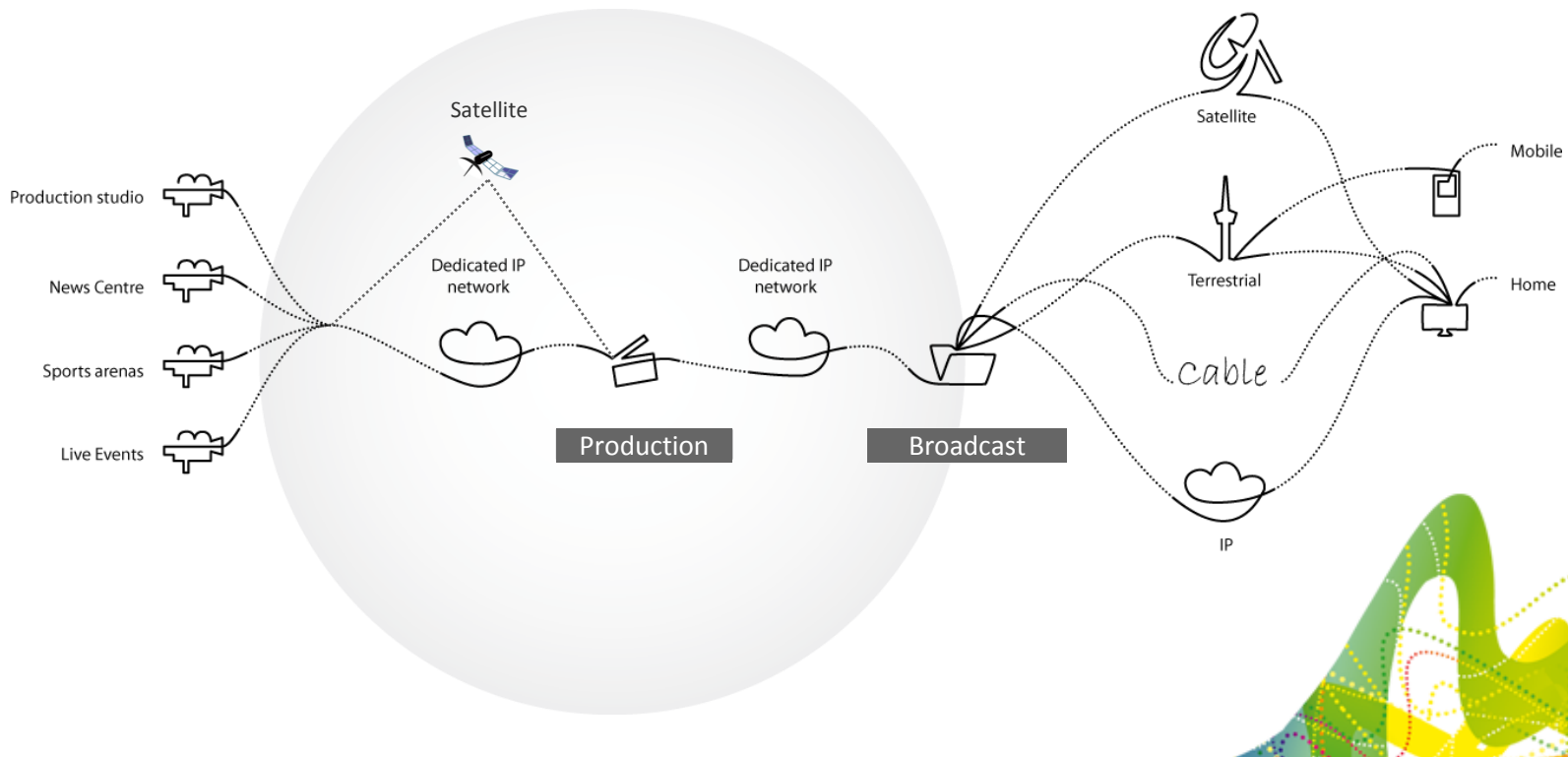
# T-VIPS solutions for broadcasters

## Contribution and Distribution

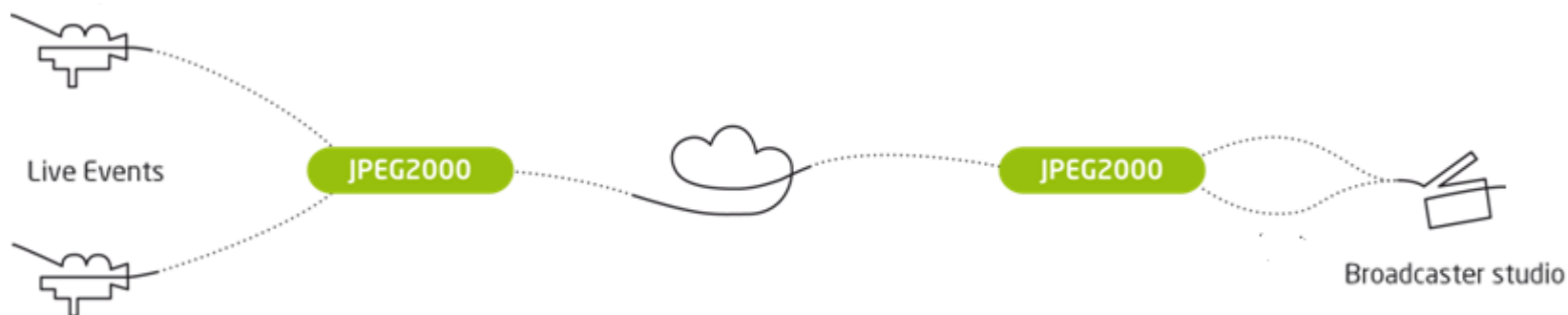
- Live sports production (stadium to studio)
- Low latency news applications (interviews)
- Remote production and unmanned studios
- Studio-to-studio media exchange
- Distribution from playout center to head-end

## Digital Terrestrial TV (DTT)

- DVB-T /T2 and ATSC terrestrial distribution
- Local insertion (remultiplexing, PSI/SI/PSIP)
- Distribution to transmitter sites over IP
- Transport stream monitoring
- Transport stream redundancy switching



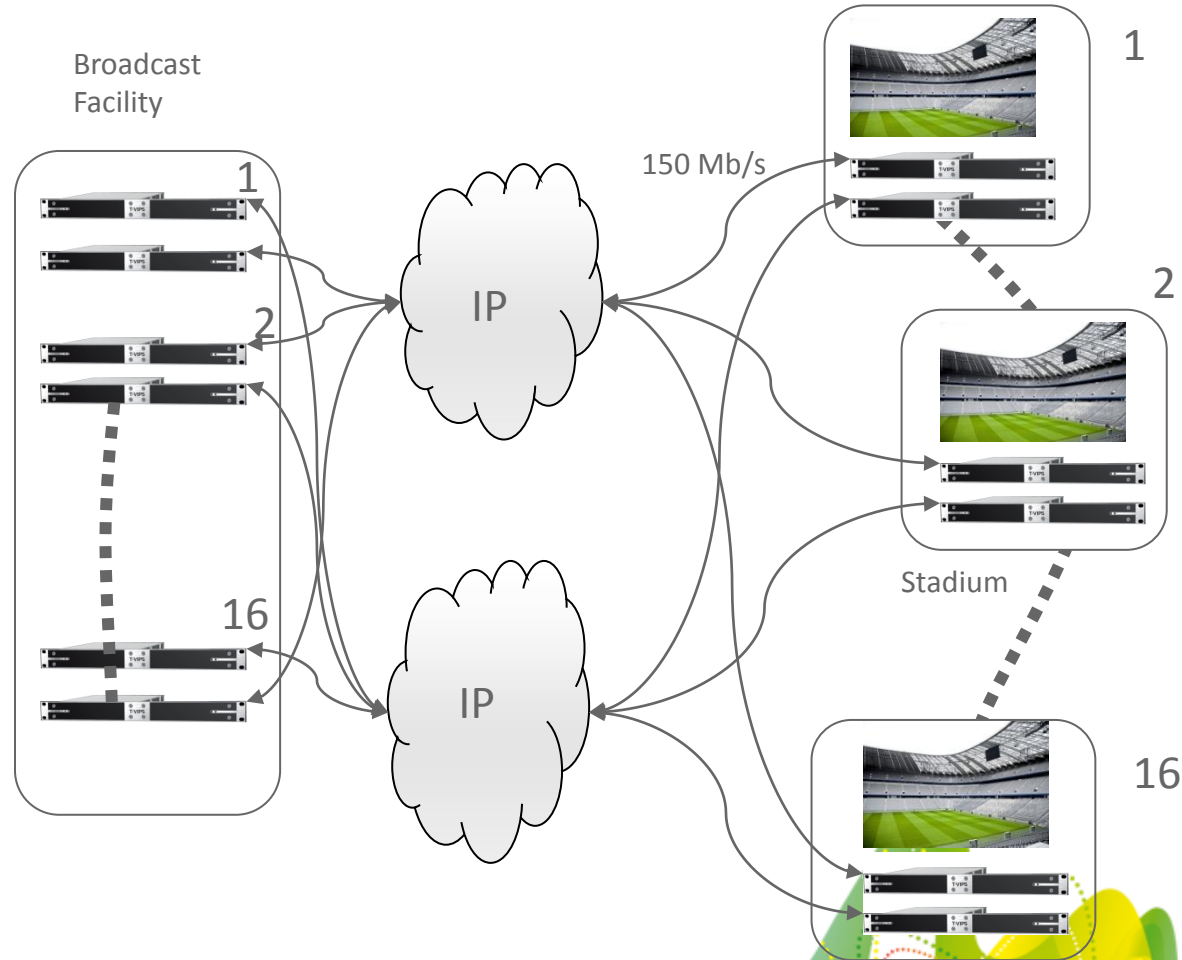
# *Main benefits of JPEG2000 for broadcast contribution*



- Quality: JPEG2000 provides improved quality head-room in production with exceptional multi-generation performance
- Latency: very low end-to-end latency makes production easier to manage and enables distributed productions
- Cost: Lower capital investment for JPEG2000 and IP/Ethernet access network infrastructure (also more flexible because of multi-service capability)

# JPEG2000-based general contribution networks

- Typically replacement of old ATM links & satellite due to limited capacity or high cost of maintenance
- Contribution between broadcast facilities, and common media POPs
- Contribution from sports stadiums back to studios
- Mobile production units with fixed infrastructure (network, encoders)



# *Multiple generation encoding*

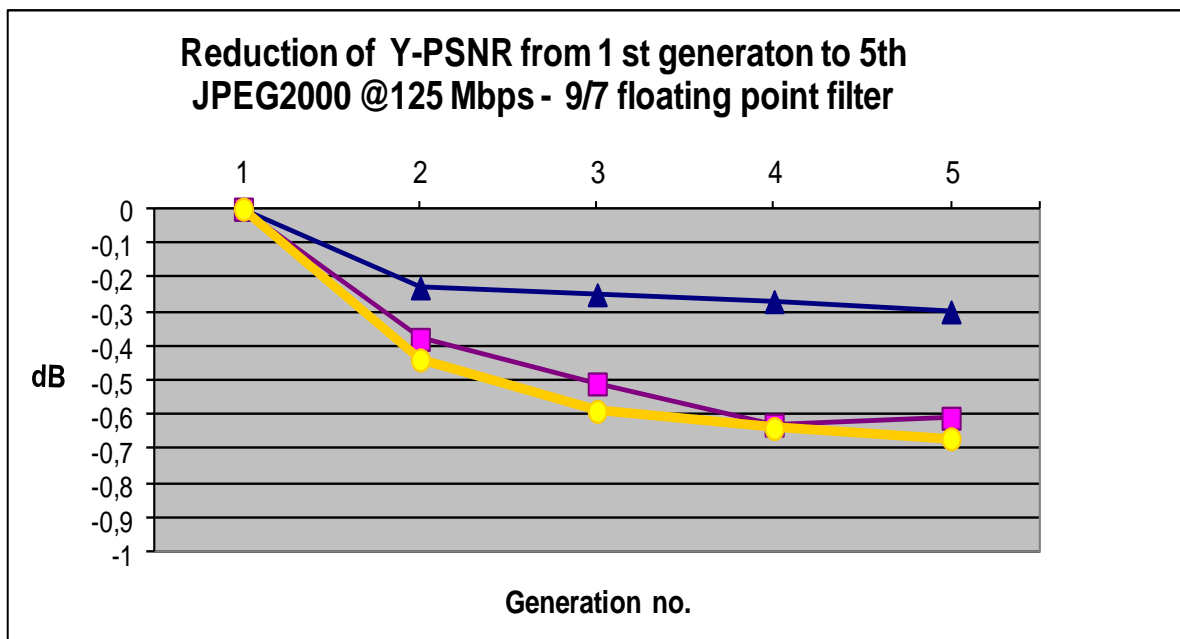
- EBU recommends:
  - A studio compression system should provide BT.500 "grade 4.5" image quality after 7th multi generation compression, including pixel shift.

BT.500 subjective quality scale:

5=Excellent 4=Good 3=Fair 2=Poor 1=Bad



# Multiple Generation Performance: 5th generation JPEG2000 has nearly no noise!

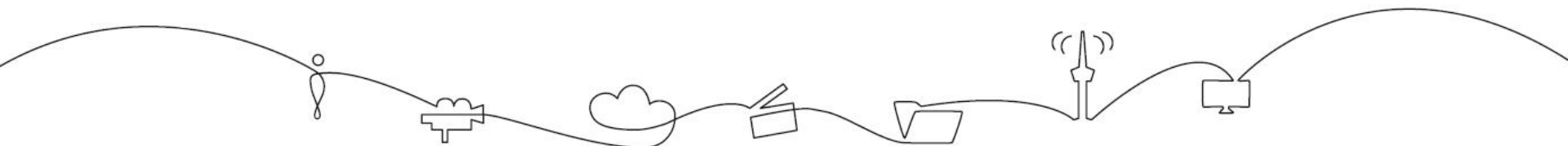


Degradation:

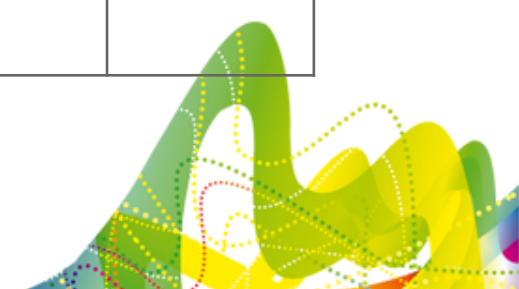
- 125 Mbps: < 0.7 dB for 5<sup>th</sup> generation
- Impairments < 1 LSB (in 10 bits range) from generation 1 to 5
- Blue – High PSNR
- Purple – Average PSNR
- Yellow – Low PSNR



# T-VIPS Video Gateways



Product line	Product	Functionality	C&D	DTT/DTH
Video Gateways	TVG410	Uncompressed SDI over IP w/FEC	✓	
	TVG420	Up to 8 ASI over IP/Ethernet w/FEC	✓	✓
	TVG420i	FEC insertion for IPTV, up to 20 SPTS		✓
	TVG425	Up to 8 ASI/TS over IP, FEC, dual GE	✓	✓
	TVG415	SD JPEG2000 over IP and ASI	✓	
	TVG430	HD/SD JPEG2000 over IP and ASI	✓	
	TVG450	3D/3G/HD/SD JPEG2000 over IP	✓	
	TVG480	3G/3D/HD/2K JPEG2000 over IP	✓	
	TVG610	HD/SD MPEG-4 AVC/MPEG-2 IRD with DVB-S/S2, ASI and IP interfaces	✓	
	TVG650	HD/SD MPEG-4 AVC 4:2:2 10-bit Encoder with ASI and IP output	✓	



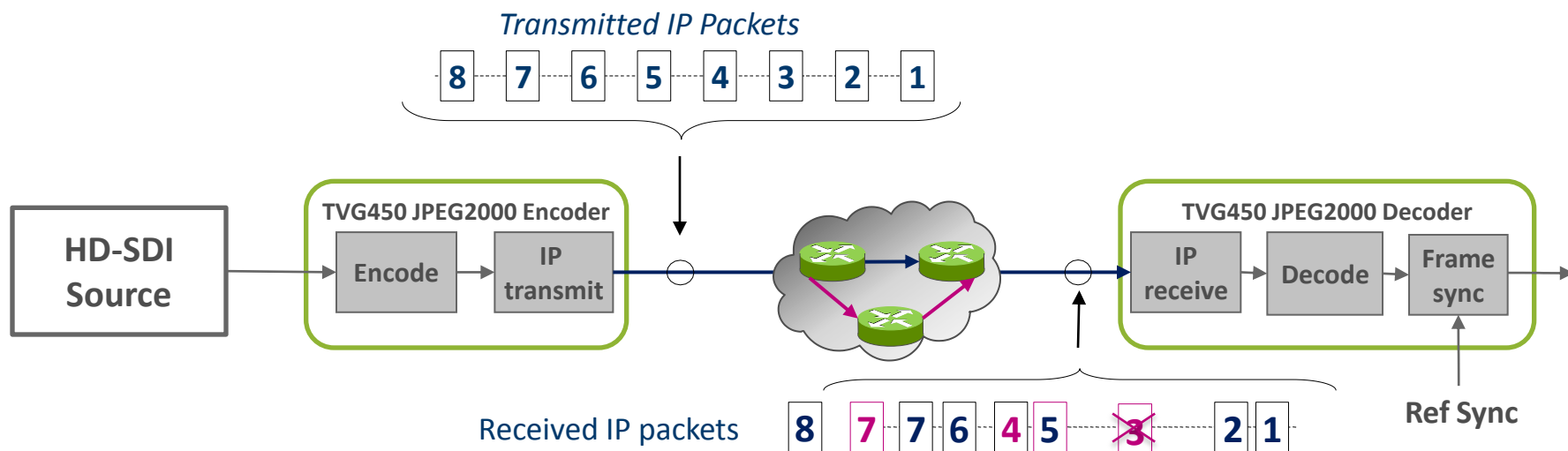


# *TVG450 JPEG2000 Gateway*

- TVG450 - SD/HD/3D/3G JPEG2000 over IP
  - ✓ Multi-channel encoding and decoding (4 SD, 2 HD, 1 3D/3G)
  - ✓ Full bidirectional operation for SD and HD
  - ✓ Metro Ethernet, IP/MPLS, SDH/SONET transport
- Gateway features
  - ✓ Visually lossless JPEG2000 compression (SD@20-50, HD@80-160)
  - ✓ Transparent handling of audio and ancillary data
  - ✓ MXF-based frame-aligned wrapping of all components
  - ✓ Built-in SDI monitoring and frame store on encoder
  - ✓ Built-in RTP/IP monitoring and frame store on decoder
  - ✓ Built-in frame synchronizer for direct-to-studio connections



# Reliable contribution over IP

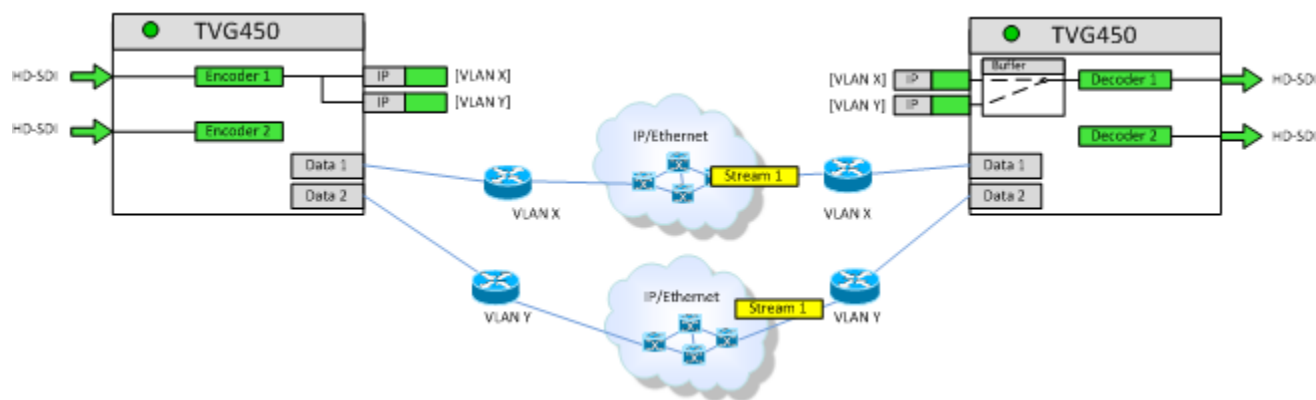


- IP networks are reliable but not perfect
- We need intelligent mechanisms to handle:
  - ✓ Out of order and duplicated packets -> RTP Seq. Nr.
  - ✓ Packet loss -> Forward Error Correction (FEC)
  - ✓ Burst loss, re-routing -> FEC, error concealment, dual path
  - ✓ Jitter (packet delay variation) -> IP buffer on RX
  - ✓ Long term drift in TX/RX timing reference -> frame skip and repeat (handled in frame synchronizer)

- Duplicated packets
- Out of order packets
- Jitter / delay variation
- Lost packets



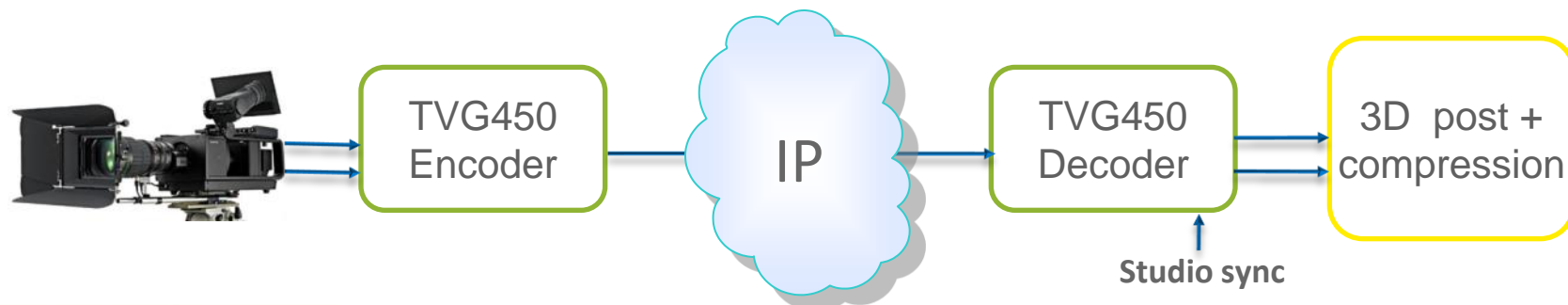
# Dual path network redundancy



- IP smallcast: encoder transmits RTP stream on two IP links
- Input diversity reception: decoder receives packets from main and spare link simultaneously
- Enables hitless protection on packet loss and link failures
- Provides high reliability transmission over error-prone links



# 3D Sports Contribution



- Stereoscopic 3D video transport
- Dual channel JPEG2000 encoding @ 200-250 Mb/s
- Full resolution on L/R channels – and perfect sync
- Maintain quality and resolution of the 3D signal to improve end-user QoE and allow for centralized post-processing
- Conversion to SbS/TaB is irreversible and should not be done until the final emission encoding stage

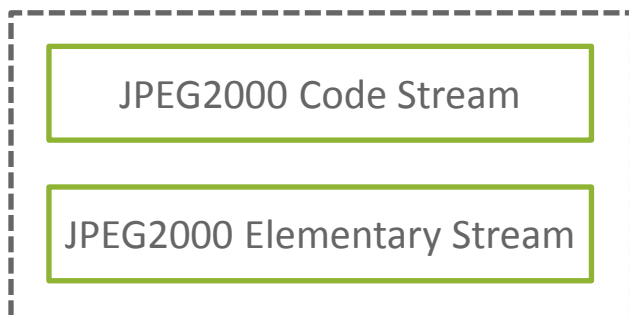


## *Standardization activities*

- The use of JPEG2000 for contribution is now well-accepted and wide-spread in the industry
- Currently there is no vendor interoperability
- Standards have been developed in JPEG and MPEG for carriage of JPEG2000 in MPEG-2 TS
- Interoperability efforts underway in VSF and DVB
- DVB AVC is adding implementation guidelines in revision of contribution specification TS 102 154
- VSF is planning interoperability tests for 2012

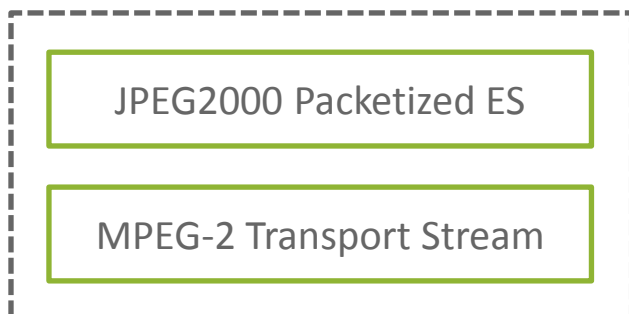


# Potential standards for JPEG2000 over MPEG-2 TS



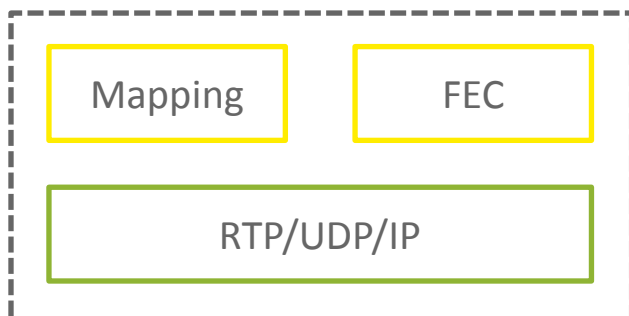
JPEG 2000 Part 1 (ISO/IEC 15441-1)

JPEG 2000 Part 1 Amd 3 – **Profiles for Broadcast Application** (ISO/IEC 15444-1:2004/Amd3)



MPEG-2 Systems Amd 5 – **Transport of JPEG 2000 part 1 video over MPEG-2 TS** (13818-1:2007/AMD5)

MPEG-2 Systems (13818-1:2007)



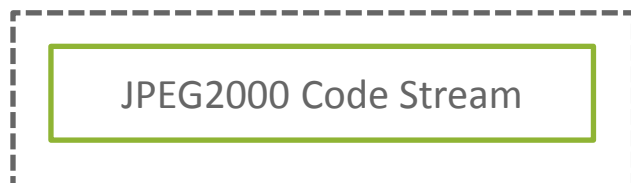
SMPTE 2022-1/2 CBR MPEG-2 TS over IP + FEC

RFC 3550 RTP

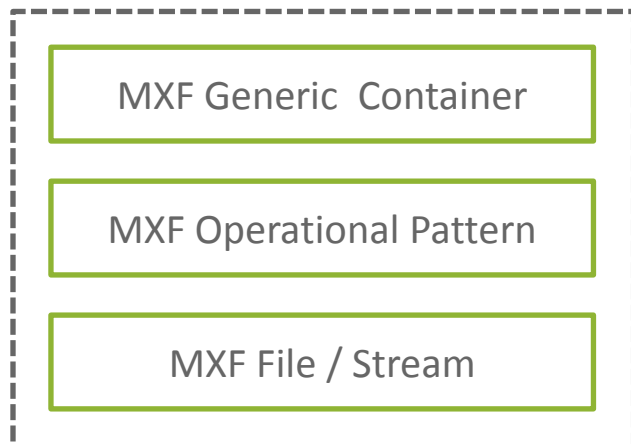
*Preliminary: standardization and interoperability efforts are still in progress*



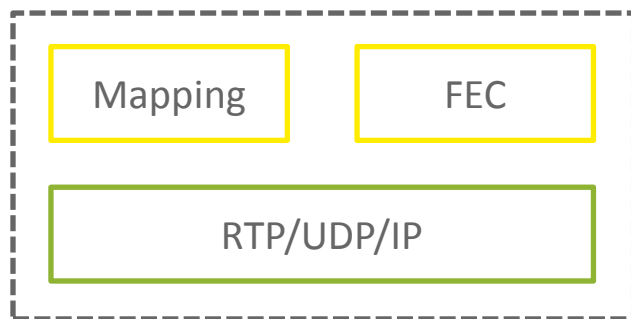
# Potential standards for JPEG2000 over MXF/IP



JPEG 2000 Part 1 (ISO/IEC 15441-1)  
 JPEG 2000 Part 1 Amd 3 – Profiles for Broadcast  
 Application (ISO/IEC 15444-1:2004/Amd3) (Constraints)



SMPTE ST 422 Mapping JPEG 2000 Codestreams into the  
 MXF Generic Container (SMPTE revision in progress)  
 SMPTE ST 379-2-2010, MXF Refined Generic Container  
 Low Latency Streaming MXF (SMPTE work in progress)  
 SMPTE ST 378-2004, Operational pattern 1A



SMPTE ST 377-1-2009, MXF File Format Specification

SMPTE 2022-5/6 High Bit Rate Media Transport over  
 IP Networks (SMPTE work in progress)

RFC 3550 RTP

*Preliminary: standardization and interoperability efforts are still in progress*



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Thanks for your attention

*Just imagine*

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