MPEG-4 AVC Enables the HD-SNG Revolution

Akira Nakagawa, Dan Dalton, John L. Pittas
Fujitsu Limited

MPEG-4 AVC for Contribution Applications

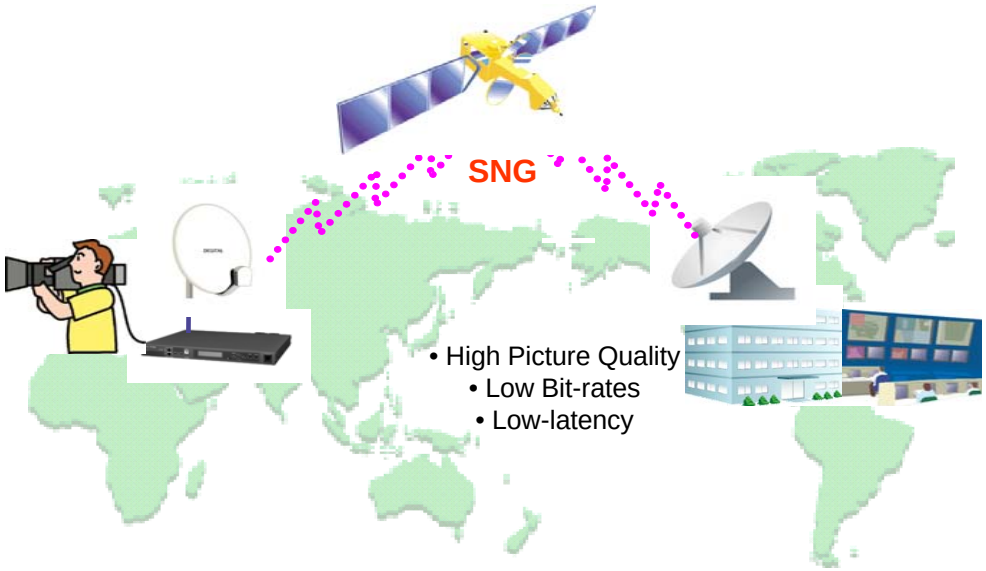
FUJITSU

How MPEG-4 AVC enables the transition to HD

- Technical issues
  - Are MPEG-4 AVC HD codecs ready for E/SNG?
  - What about other live events?
    - Entertainment

Video Codec Requirements for HD-SNG

- **High Picture Quality**
  - Drives viewer acceptance
- **Low Bit-rates**
  - Drives affordability
- **Low-latency**
  - Drives practicality



Video Codec Requirements for HD-SNG

FUJITSU

High Picture Quality

- Drives viewer transition to HD services
  - Entire 16:9 HD camera-to-audience path
  - Avoids up-conversion compromises
    - Lower spatial resolution
    - 4:3 to 16:9 fitting
- For AVC, subjective picture quality is more important than PSNR
  - Human Visual System optimization produces better pictures but lower PSNRs
- Concatenation: don’t forget the effects of multiple downstream codecs!
  - For “live” local E/SNG content, absolute minimum of three:
    - Camera codec
    - E/SNG codec
    - Transmitter codec
  - For “live” network E/SNG content, add a distribution codec
  - For NLE-based content, add another one or two NLE codecs
  - Average number of downstream codecs is five

Video Codec Requirements for HD-SNG

FUJITSU

Low Bit-rates

- Drives affordability by minimizing payload bandwidths

Select MPEG-4 AVC HD Codec Operating Points			
Video	Audio	TS Mux	Total Payload
5Mbps	64Kbps (1-AES)	+	~5.7Mbps
6Mbps	64Kbps (1-AES)	+	~6.7Mbps
7Mbps	64Kbps (1-AES)	+	~7.7Mbps
8Mbps	128Kbps (2-AES)	+	~8.8Mbps
9Mbps	128Kbps (2-AES)	+	~9.8Mbps
10Mbps	128Kbps (2-AES)	+	~10.8Mbps
11Mbps	384Kbps	+	~12.1Mbps
12Mbps	384Kbps	+	~13.1Mbps
14Mbps	384Kbps	+	~15.1Mbps
16Mbps	384Kbps	+	~17.1Mbps
18Mbps	384Kbps	+	~19.1Mbps

Video Codec Requirements for HD-SNG

FUJITSU

- Allowing use of existing transponder channels
- With new or established modulation and channel coding methods

Select Operating Points for 4.5MHz Transponder Segment		
Skies	DVB-S2	DVB-S/DSNG
Heavy	8PSK 2/3: ~7.4Mbps Info Rate (6.7Mbps Payload)	QPSK 7/8: ~5.8Mbps Info Rate (5.7Mbps Payload)
Clear	8PSK 8/9: ~9.9Mbps Info Rate (9.8Mbps Payload)	QPSK 7/8: ~5.8Mbps Info Rate (5.7Mbps Payload)
Select Operating Points for 6.0MHz Transponder Segment		
Heavy	8PSK 2/3: ~9.9Mbps Info Rate (9.8Mbps Payload)	QPSK 7/8: ~7.8Mbps Info Rate (7.7Mbps Payload)
Clear	8PSK 8/9: ~13.2Mbps Info Rate (13.1Mbps Payload)	QPSK 7/8: ~7.8Mbps Info Rate (7.7Mbps Payload)
Select Operating Points for 9.0MHz Transponder Segment		
Heavy	8PSK 2/3: ~14.8Mbps Info Rate (13.1Mbps Payload)	QPSK 7/8: ~11.6Mbps Info Rate (10.8Mbps Payload)
Clear	8PSK 8/9: ~19.8Mbps Info Rate (19.1Mbps Payload)	QPSK 7/8: ~11.6Mbps Info Rate (10.8Mbps Payload)

Video Codec Requirements for HD-SNG

FUJITSU

Low-latency

- Drives practical use for live events
  - Each satellite hop ~250ms
  - News
    - Studio-to-field interviews require <1s total round-trip delay
    - 1s – (2 X 250ms) = 500ms (maximum field-to-studio codec delay)
  - Live Entertainment
    - Particularly music and dance events
    - Require higher bit-rates to preserve fast motion and dynamic lighting changes
    - Strobe lights, flash bulbs and smoke are especially stressful to encoders

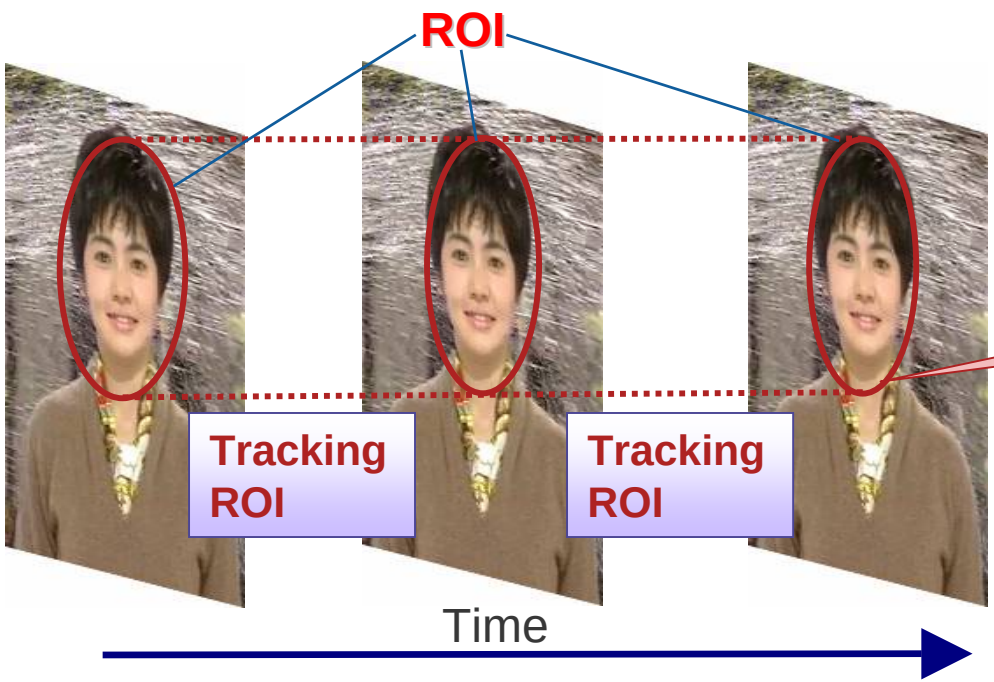
Fujitsu's IP-9500 MPEG-4 AVC HD Codec

FUJITSU

		Rev. 3.0
Video	Input	1 x HD/SD-SDI 1 x HDMI
	Output	1 x HD/SD-SDI 1 x HDMI 1 x NTSC/PAL (down-converted)
Audio	Input / Output	4 x AES pair HD-SDI embedded 1 x HDMI 1 x Analog Stereo pair (balanced)
Network		DVB-ASI 10BASE-T/100BASE-TX/1000BASE-T
Video	Format	1920/1440/960 x 1080i @ 59.94/50Hz 1280/960/640 x 720p @ 59.94/50Hz 720 x 484i @ 59.94Hz 720 x 576i @ 50Hz
	Coding	HD: H.264 HP @ L4 CBR SD: H.264 MP @ L3 CBR
	Bit Rate	HD: 4Mb/s to 20Mb/s SD: 3Mb/s, 4Mb/s
Latency (Typical)		Low: 300ms over DVB 500ms over IP Standard: 1.4s over DVB 1.6s over IP
Decoder Compatibility		Fujitsu Sencore (over DVB)
Audio Coding		MPEG-1 L2 (128, 256, 384 Kbps per pair) MPEG-2 AAC (64, 128, 256 Kbps per pair) SMPTE-302M uncompressed
Network Error Correction		Fujitsu FEC and ARQ Pro-MPEG FEC

High Picture Quality Coding

- Based on behavior of the Human Visual System
- Algorithm maintains overall subjective picture quality
  - Region of Interest (ROI) is detected and tracked in the input video
  - Optimal bit distribution is performed by considering the ROIs



Tracking ROI for HVS
→ **Keeping ROI for the Highest Video Quality**

Improving Overall Subjective Quality

Comparison of JVT and Fujitsu's Algorithms

FUJITSU

- 1440x1080i @ 7Mbps -

H.264 Reference Software from Joint Video Team (JVT)

HVS Based Control

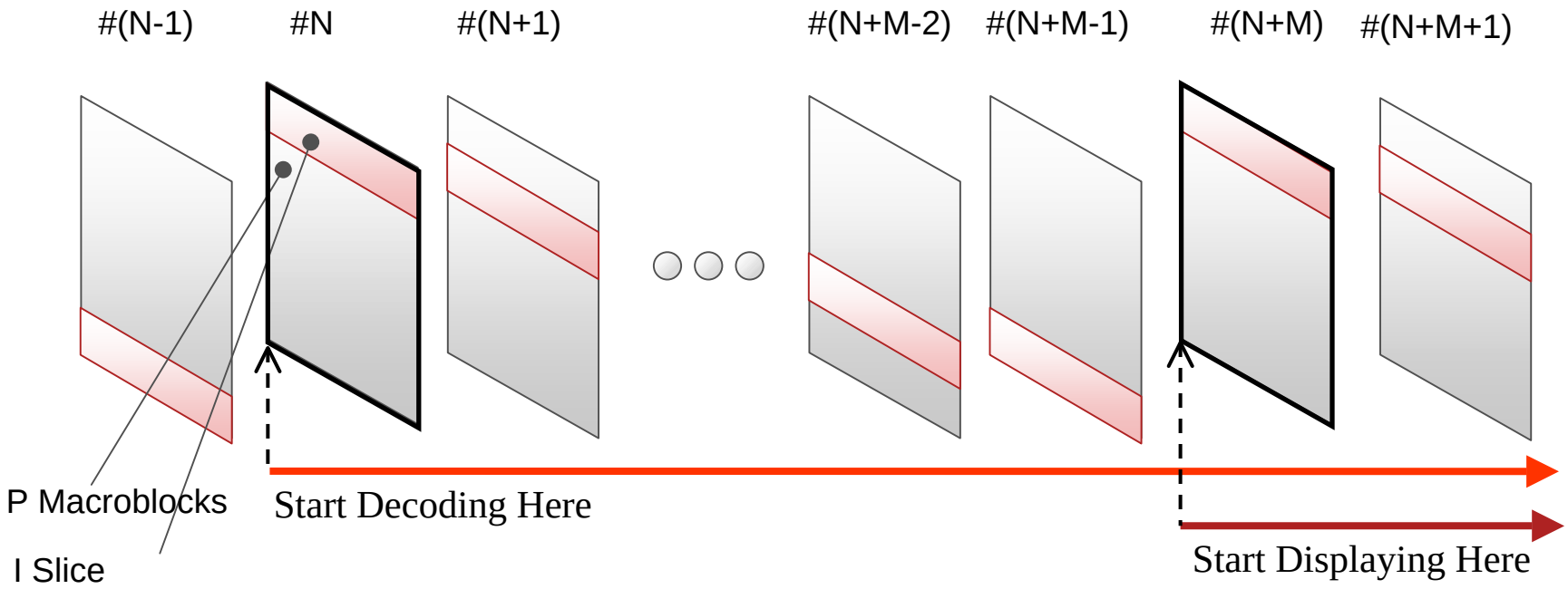
*ITE Test Chart "Splinkling"

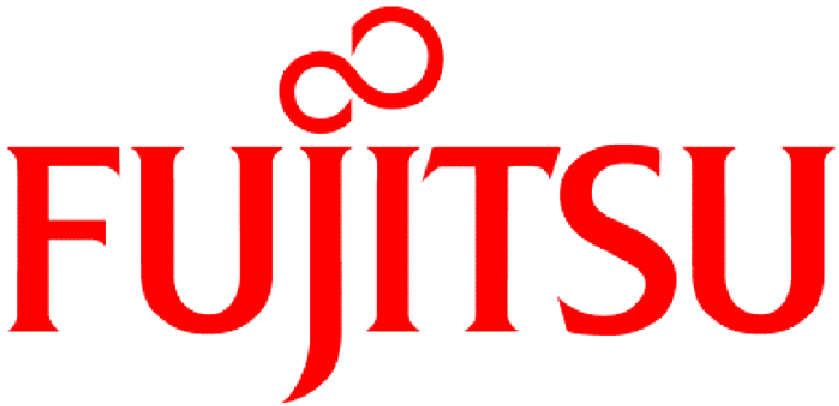
Fujitsu's Low-latency Method

FUJITSU

Gradual Decoding Refresh (GDR)

- Similar to conventional Intra Slice schemes
  - A frame is composed mostly of P Slices
  - An I Slice "walks down" the frame across a sequence of frames
    - Allows recovery from scene changes
- GDR can average the number of bits for each picture and reduce Video Buffer Verifier delay





THE POSSIBILITIES ARE INFINITE