PDF/R: future revision & high efficiency compressed images for PDF

the state of research for adding new,
highly efficient image codes to future PDF versions
for up to ~5x smaller PDF, faster cloud scanning

Why new image compression?

- JPEG from 1992, Discrete Cosine Transform (DCT) based ~10:1 compression
- 8x8 block bad for non-photographs, synthetic images, sharp edges
- JPEG 2000, Discrete Wavelet Transform (DWT) based mostly improved multi resolution, progressive transmission, but slow, and dated, too

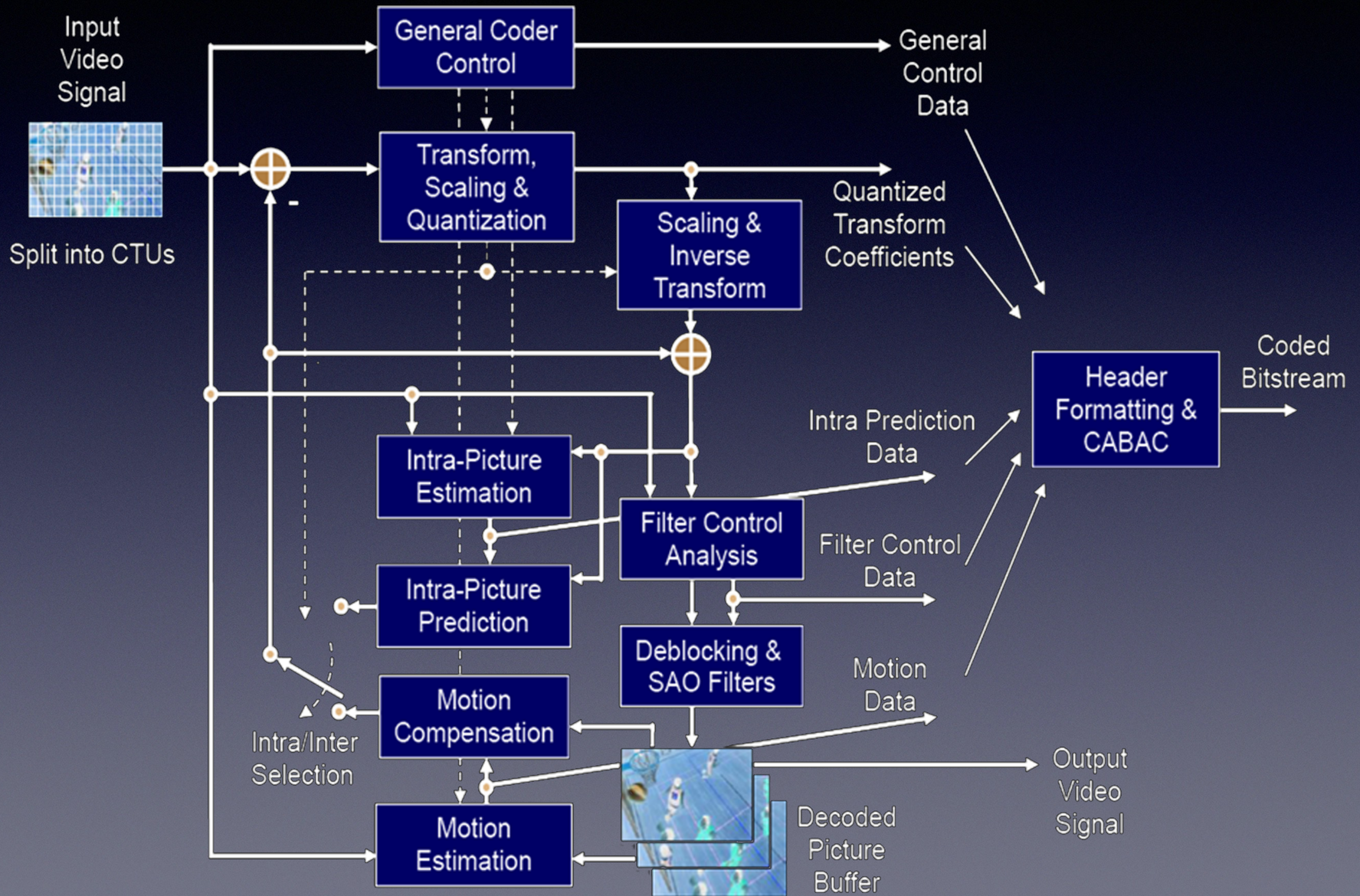
How does JPEG work?

- Color transform (RGB -> YCbCr)
- 8x8 DCT
- Quantization and DC prediction
- Re-order and Huffman entropy coding

Existing video codec options!

- HEIC, H.265, video compression ~1000:1, heavily patented
- WebP, only 8-bit, obligatory 4:2:0 subsampling
- AVIF, AV1, up to 12 bit, slow
- JPEG-XL, up to 16 bit, supports progressive
- High-Throughput JPEG 2000 (HTJ2K)

New high efficient video codecs



JPEG XL very versatile

- Next Generation Image Compression
- Google Pik + Cloudinary Free Universal Image Format
- Combining ideas from JPEG, lossless WebP, and FLIF
- Responsive / Progressive layered by design
- 20:1 to 50:1 typical compression ratio!
- Backwards compatible w/ JPEG w/o re-quantization, 20% smaller PNG24, PNG8 & GIF, no additional loss, always smaller than input!

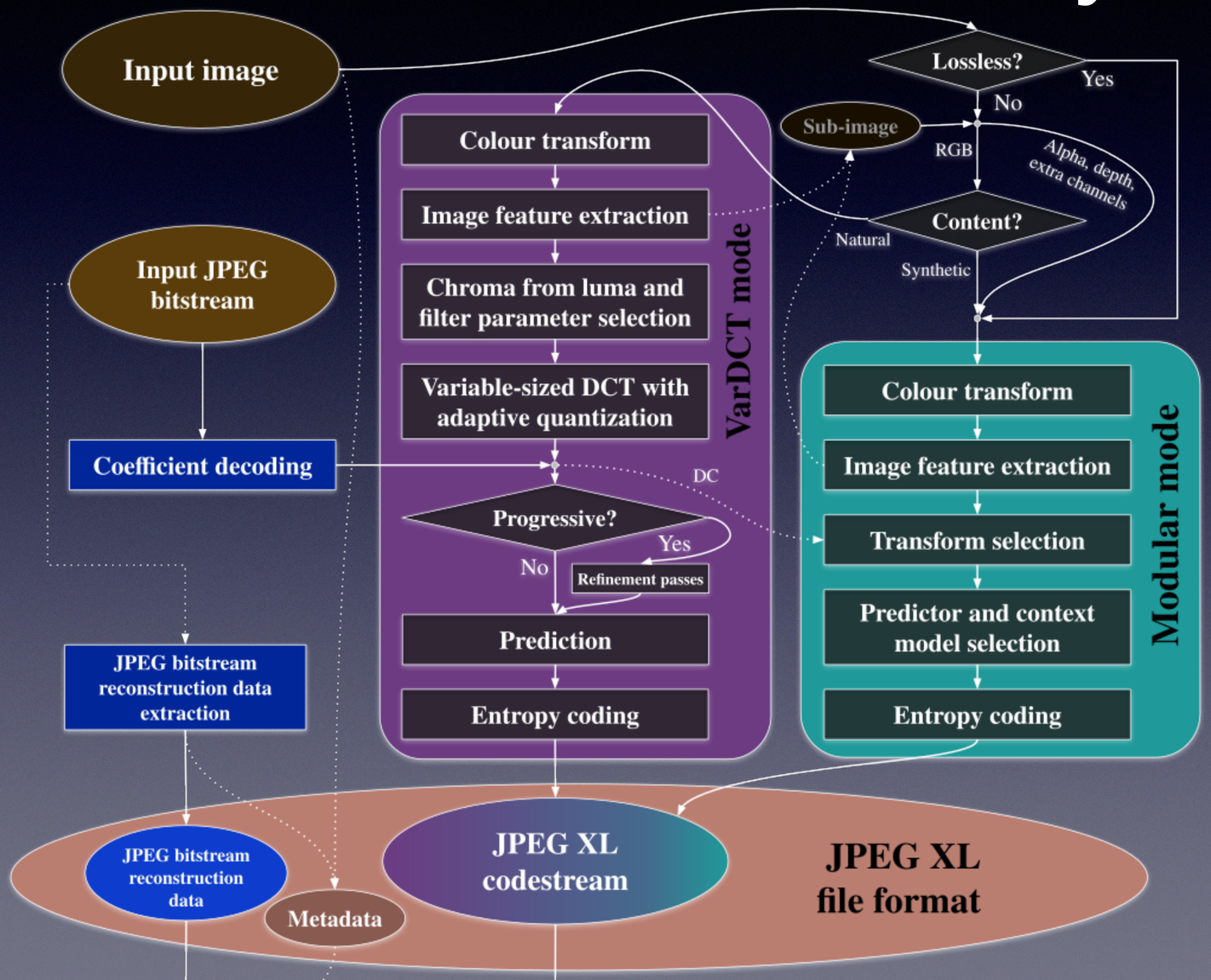
JPEG XL very versatile

- Up to 4100 channels, direct RGB + Alpha + 4096 extra channels
- High maximal resolution: 2^30-1 (1,073,741,823)
- Layered tiles, for HiDPI, responsive Web
- Lossless, Progressive
- Variable, perceptual metric adjusted quality regions
- High bit depth, wide gamut, HDR
- Any kind of content: photos, illustrations, renders, scans, medical

JPEG XL internally

- VARDCT block sizes, from 4×4 to 256×256
- Modular mode for synthetic content
- Image features are rendered on top of the decoded image
- Prediction, restoration filter, adaptive quantization
- Modified nonlinear Haar wavelet, enables efficient and progressive decoding
- High bit depth, wide gamut, HDR
- (Animation support)

JPEG XL internally

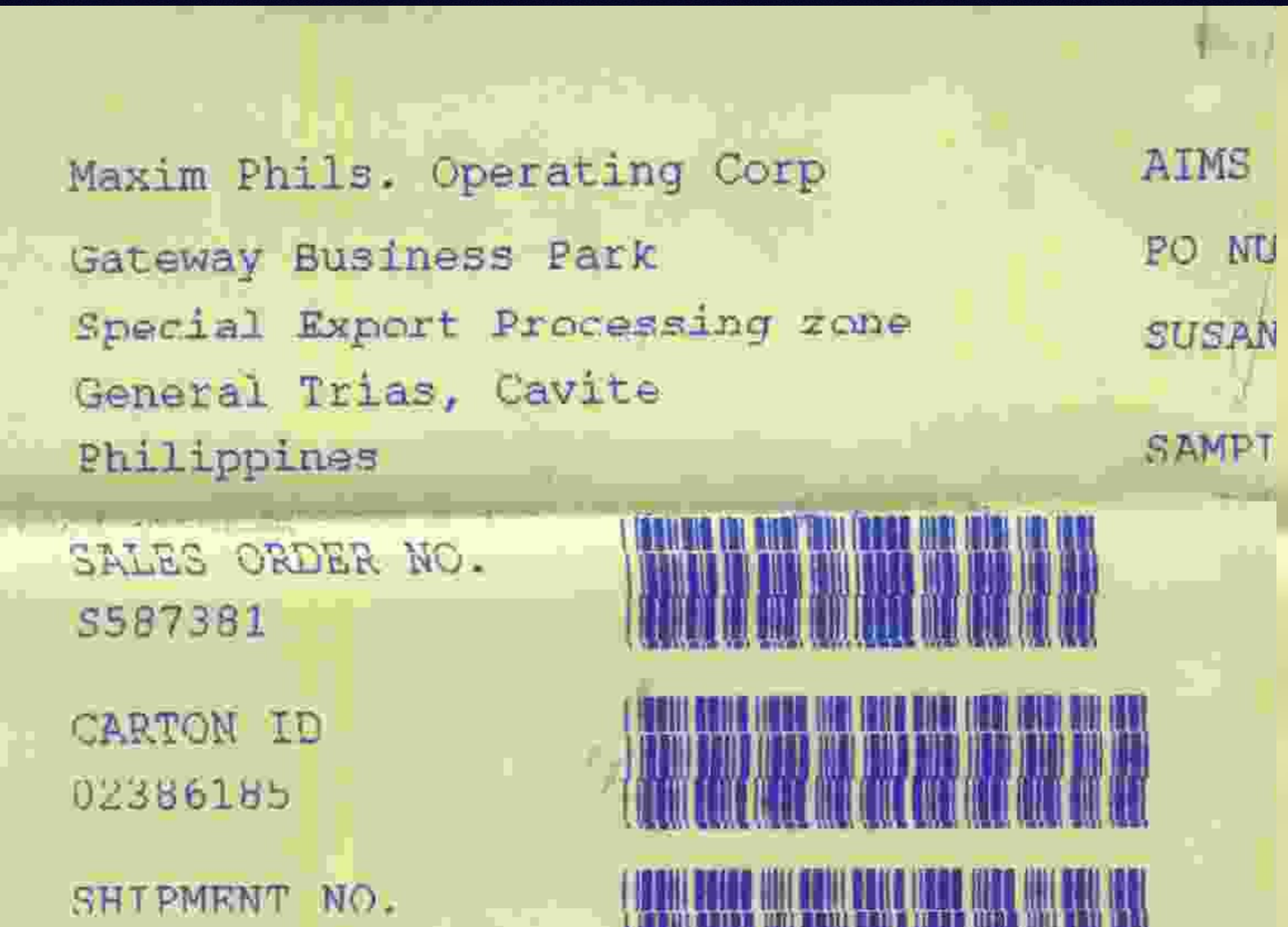


JPEG XL is fast!

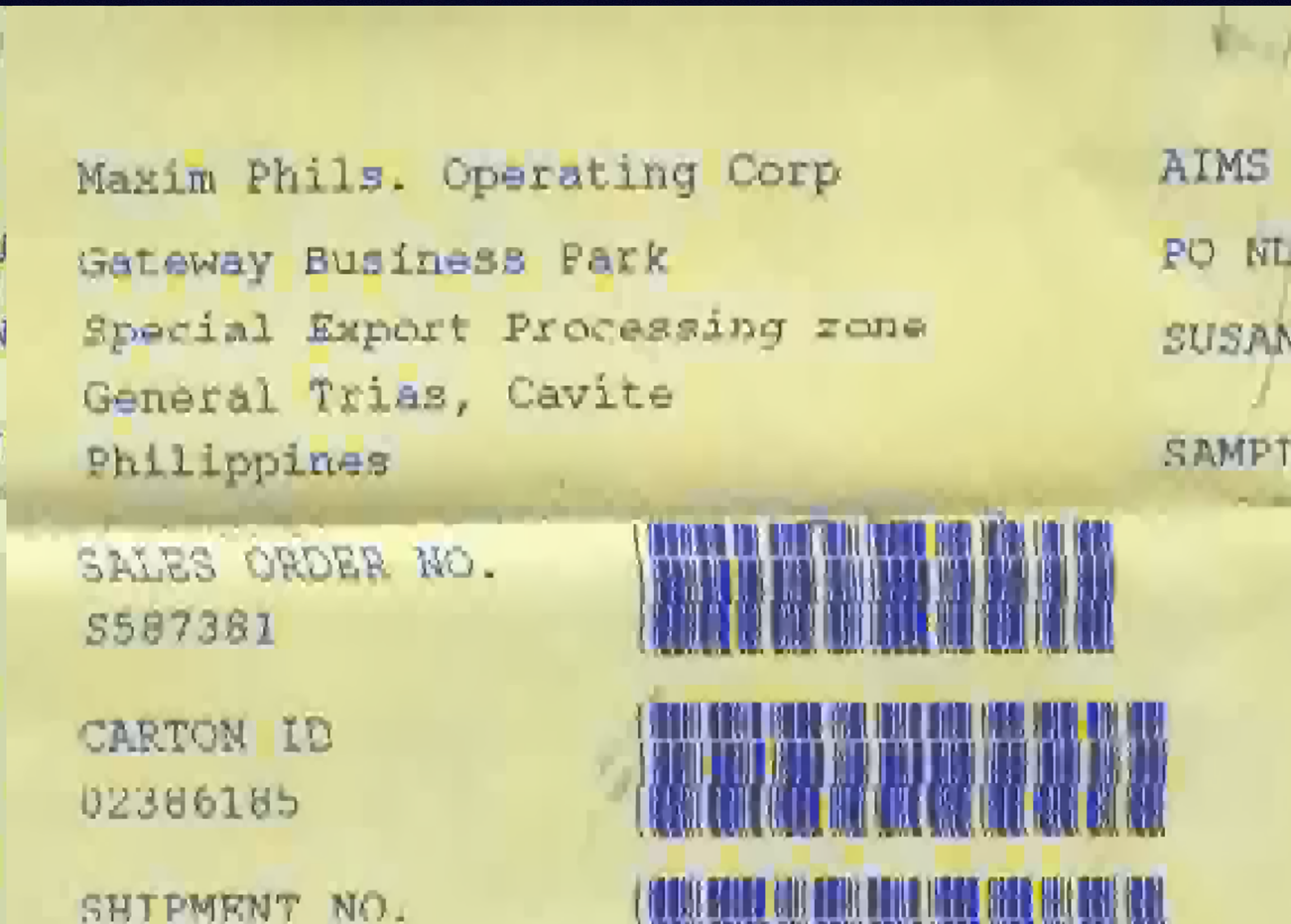
- JPEG XL is about as fast to encode and decode as JPEG using libjpeg-turbo
- an order of magnitude faster to encode and decode compared to HEIC with x265.
- also better parallelizable, thread-parallelism and SIMD

Less visible artifacts

JPEG: 161kb

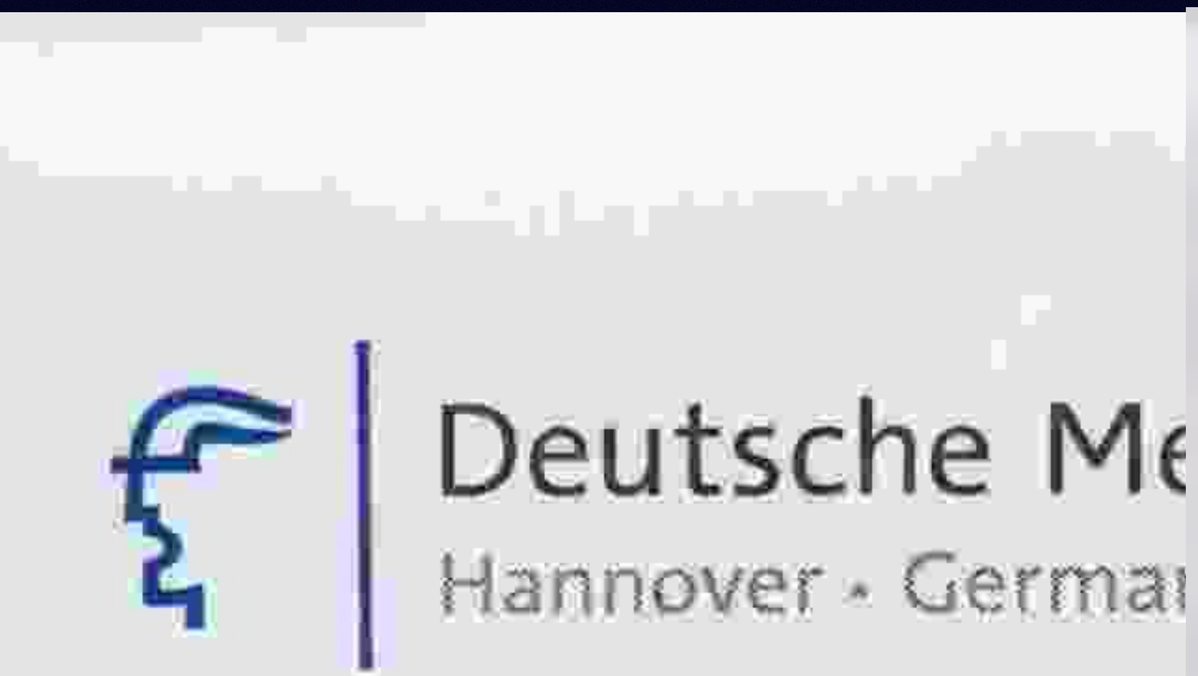


JPEG-XL: 30kb !!

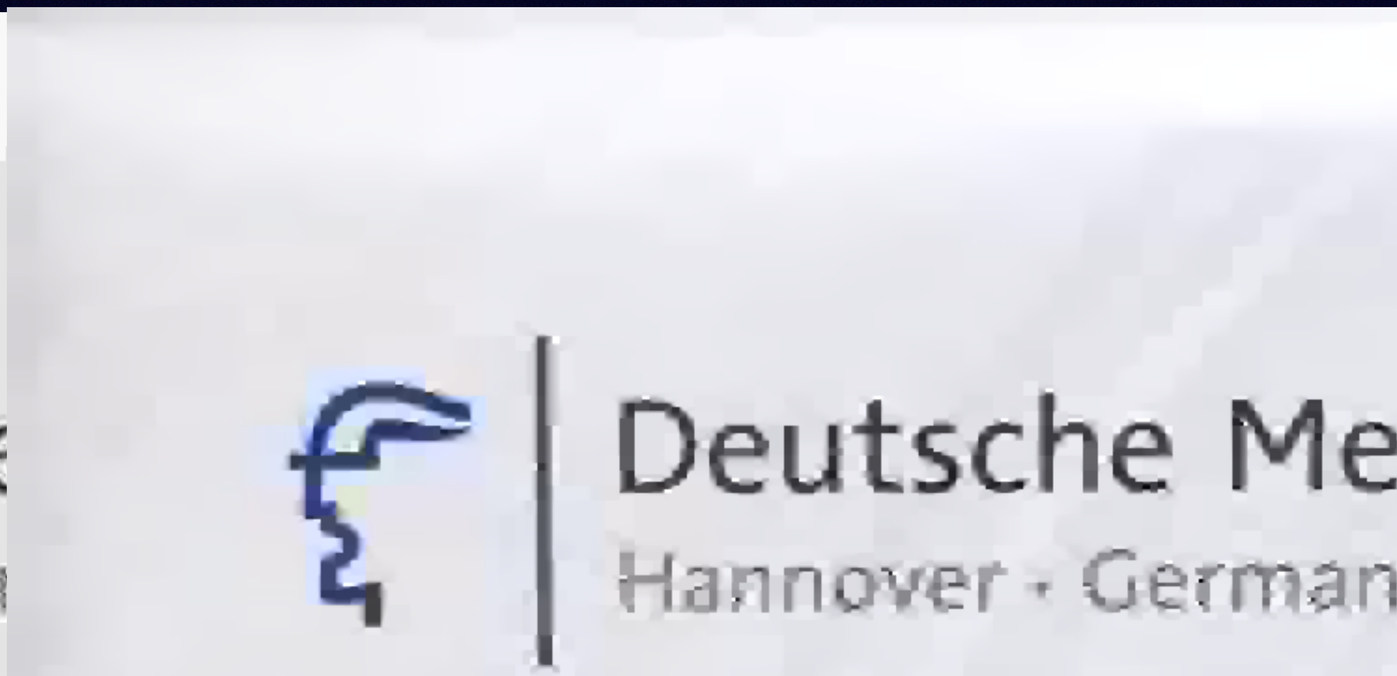


Less visible artifacts

JPEG: 67kb



JPEG-XL: 14kb !!



Feature comparison

	jpeg	jpeg2k	web	heic	avif	jpeg-xl
compr. photo	+	++	+++	++++	++++	++++
compr. synthetic	-	+	+++	+	++	++++
compr. lossless	-	+	++	+	++	++++
encode perf.	++++	++	+++	++	+	++++
decode perf.	++++	++	++++	++	++	++++
HDR	-	✓	-	✓	✓	✓
progressive	+++	++++	-	-	-	++++
size	65,535	2^32	16,383	8193x4320	8193x4320	2^30
precision	8	38	8	10	10	32
channels	4	16,384	4	5	5	4100

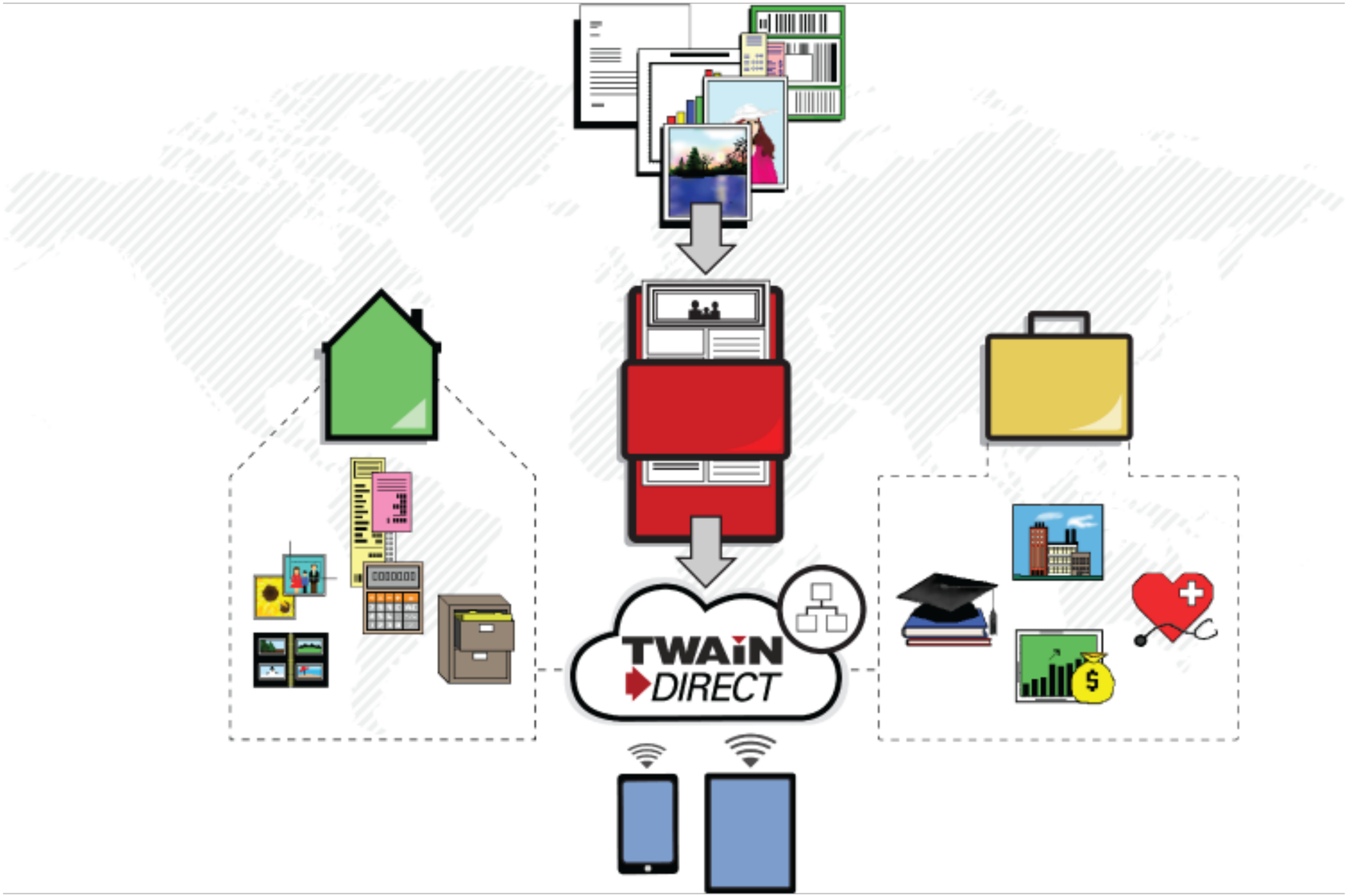
How to add to PDF?

- simply new XObject filters ?
- we had /DCTDecode, /JPXDecode :-/
- /JPXLDecode, /AVIFDecode, /BMFFDecode?
  ISO “Base Media File Format”
- how to handle extra channels, HDR, …?

Benefits

- up to ~5x smaller PDF images
- faster transfers (email, web), smaller archives
- HDR: more than 8, 10 bits per sample
- GPU hardware accelerated
- directly embeddable from some modern smartphones

Use in TWAIN Direct / Cloud



Use in TWAIN Direct

- speed up networked, WiFi and cloud scanning
- directly space efficient long term storage
- hardware compression off-loading in modern SoCs and GPUs

Ongoing WG project

- JPEG-XL and AVIF primary candidates
- details, codecs, channels, HDR to be discussed
- expert feedback and requirements appreciated
- in PDF/R 1.1 likely only one codec, preferring JPEG-XL

Q & A

More information online at:

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