JPEG Syntax and Data Organization

EC	D	MPS	CX	Qe (hexadecimal)	A (hexadecimal)	C (hexadecimal)	CT	ST	B
1	0	0		5A1D	0000	00000000	11	0	
2	0	0	CE	5A1D	A5E3	00000000	11	0	
3	0	0		2586	B43A	0000978C	10	0	
4	0	0		2586	8EB4	0000978C	10	0	
5	0	0		1114	D25C	00012F18	9	0	
							9	0	
							9	0	
							9	0	
							9	0	
							8	0	
							8	0	
							8	0	
							8	0	
							8	0	
							8	0	
							4	0	

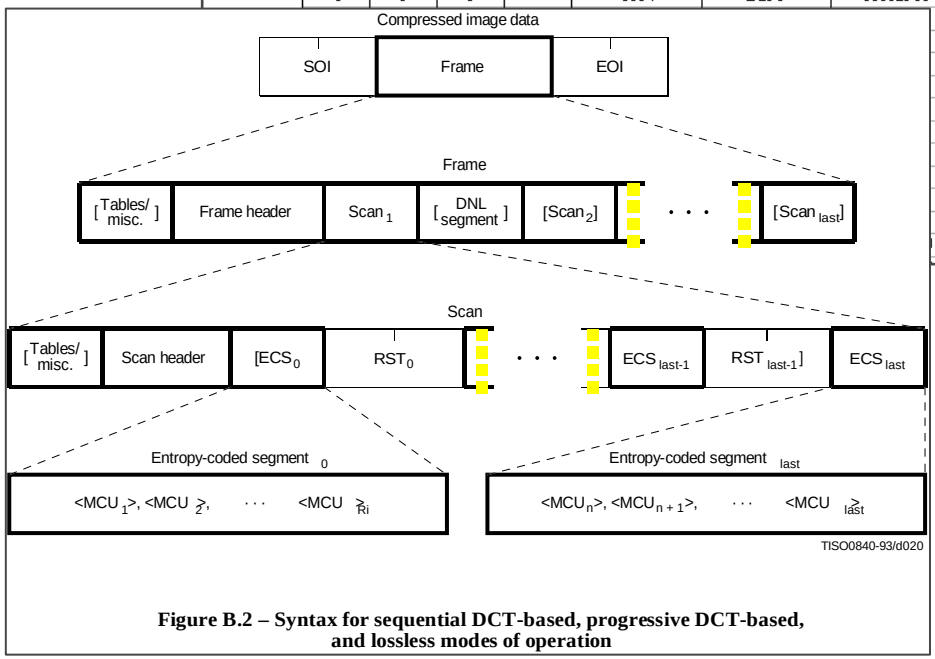

Figure B.2 – Syntax for sequential DCT-based, progressive DCT-based, and lossless modes of operation

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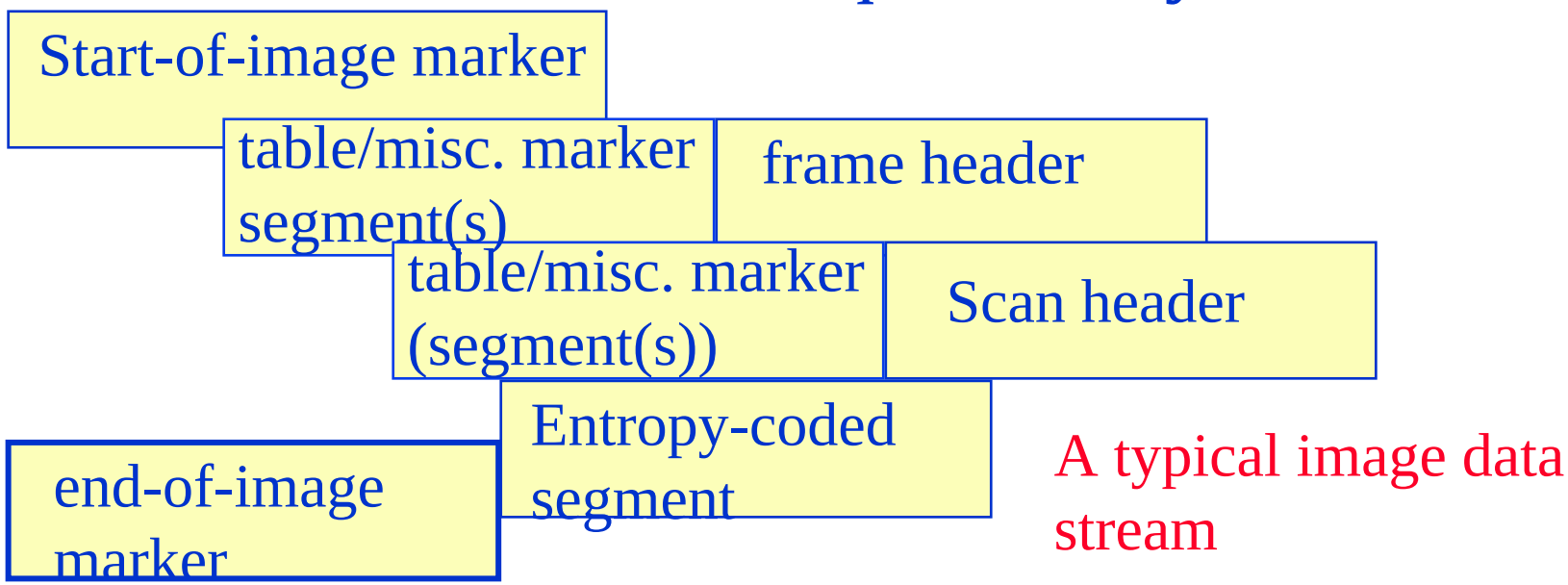
Control and Data Structure

- Two classes of segments:
  - Entropy coded segments: data
  - Marker segments: headers, tables and other general information
- Markers start with a unique two-byte code.



A typical image data stream

Interchange/Abbreviated Data Formats

3 formats for JPEG compressed data:

- Interchange format for compressed data: includes all required tables (for the decoder)
- abbreviated format for compressed data: may omit some or all tables (decoder must have them some other way)
- abbreviated format for table specification: only tables are sent (no frames, entropy coded data etc.)

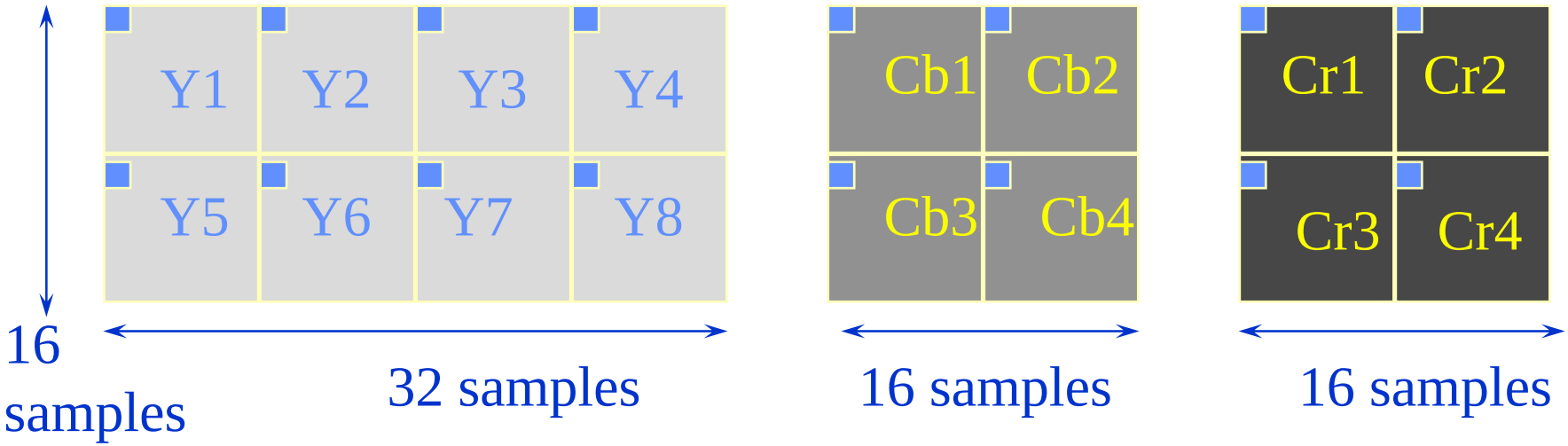
Image Data Ordering

- Internal representation:
  - Upto 255 unique components for each image
  - Each component is represented as a rectangular array of samples
  - All processing of those rectangulars are from left to right, top to bottom
- Those are merely convenience, except the rectangular array which must be.

Data Units

- For lossless modes: arrays are processed sample at a time, left-to-right, top-to-bottom
- For DCT modes: a block of 8x8 samples is a basic unit
- Minimum Coded Units (MCU), are groups containing interleaved/non-interleaved data from different components (if more than one).

MCU Example



- Each block is 8x8 samples
- The preceding DC value is always the predictor for the current one (first is 0)

Data units ordering example:

Non-Interleaved data units			Horizontally Interleaved		
	Component block	MCU		Component block	MCU
Scan 1:	Y1	1	Scan 1:	Y1	1
	Y2	2		Y2	1
	.			Cb1	1
	Y8	8		Cr1	1
				.	
Scan 2:	Cb1	1		.	
	.			.	
	Cb4	4		Y7	4
				Y8	4
Scan 3:	Cr1	1		Cb4	4
	.			Cr4	4
	Cr4	4			

Marker Definitions

- Each marker segment begins with X'FF and a non-zero one byte 'marker code' to identify its function.
- An occasionally created X'FF (in the entropy coded data) is followed by a stuffed zero byte.
- All marker segments and entropy coded segments contain an integer number of bytes, so in Huffman coding one-bits used to pad data to achieve byte alignment for the next marker.

Start-of-Frame (SOF) Markers

For example: Huffman coded frames:

SOF_0	X'FFC0	Baseline DCT
SOF_1	X'FFC1	Extended Sequential DCT
SOF_2	X'FFC2	Progressive DCT
SOF_3	X'FFC3	Lossless (Sequential)
....		
SOF_{15}	X'FFCF	Differential Lossless (Arithmetic Coding)

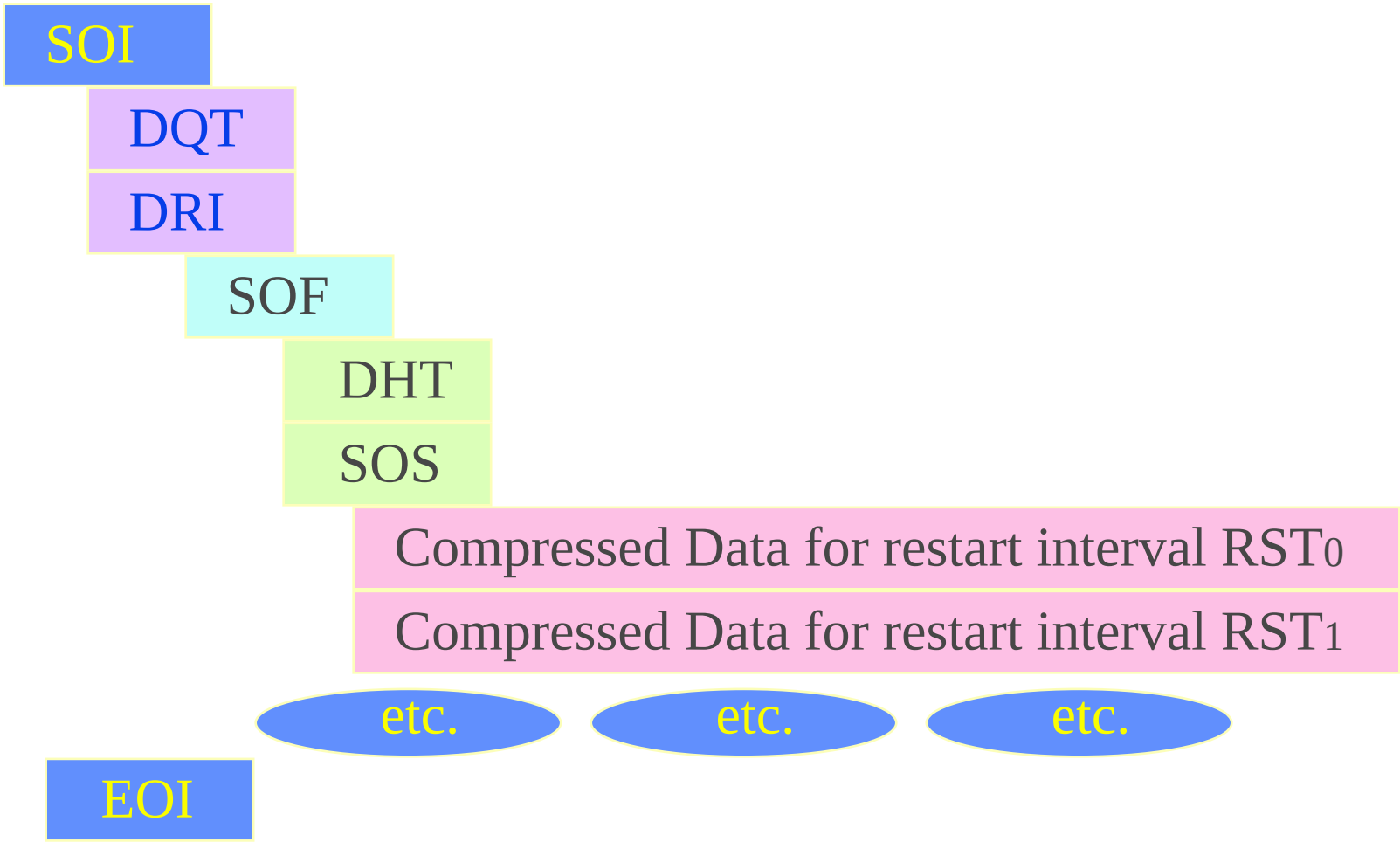
Non-SOF Markers

- APP X’FFE0 - X’FFEF Reserved for application use
- DHT X’FFC4 Define Huffman table
- DQT X’FFD4 Define Quant. table
- SOS X’FFDA Start of Scan

- (About 20 non-SOF markers)

Structure of Compressed Data

- Example of non-hierarchical data:



Frame Header

- *Frame:* Basic attributes of the image

Frame header length	16 bits
Sample precision	8
Number of lines	16
Number of samples/line	16
Number of components	8
Frame component specification	
Identifier	8
Horiz. sampling factor	4
Vertical sampling factor	4
Quantization table	8 (4 optional tables)

Scan Header

- Many scans can occur in a frame
- If scan has only one component than data is non-interleaved (MCU contains one data unit)
- If more than one component - interleaved data
- Components are always coded independently
- Scan parameters are: Number of components, DC and AC entropy coding table, Spectral selection and successive approximation parameters etc.

Number of Data Units in MCU

- Data Unit = Block or samples (in lossless)
- If more than one component in a scan, the total number of data units in the MCU up to 10 units.
- Any combination of components and sampling factors that gives more than 10 is forbidden.

Other Markers

- Define Huffman Table (DHT) segment
- Arithmetic Conditioning table (DAC) segment
- Quantization table (DQT) segment
- Restart interval (DRI) segment

Web sites & Reviews

- Official site of JPEG group:

http://www.jpeg.org/

- JPEG FAQ:

http://www.faqs.org/faqs/jpeg-faq/

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The JPEG Still Picture Compression Standard,
Commun. of the ACM. 34:4, 1991, pp.30–44.
Furht B.
A Survey of Multimedia Compression Techniques and Standards.
Part I: JPEG Standard, Journal of Real-Time Imaging,
vol. 1, no. 1, April 1995, pp. 49-67.