Presentation Formatting

COS 460/540

End to End Data

- Data Formats
- eXtensible Markup Language
- Multimedia Data

Data Formats

- Basic data types
- Complex types and data
    - “records”, audio, video, ...
- Sequences

Complex Types

- Compression
  - ...to reduce bandwidth needs
- Error Correction
  - ...to increase reliability

Transmitting Data

- Encoding
  - ...from model to network
- Decoding
  - ...from network to model

XML

eXtensible Markup Language

- Human readable
- Open Standard
- Data and Tags/Markup (XML)
- Schema description of documents (XSD)

```
<?xml version="1.0"?>
<catalog>
  <book id="bk101">
    <author>Gambardella, Matthew</author>
    <title>XML Developer's Guide</title>
    <genre>Computer</genre>
    <price>44.95</price>
    <publish_date>2000-10-01</publish_date>
    <description>An in-depth look at applications
    with XML.</description>
  </book>
  <book id="bk102">
    <author>Ralls, Kim</auth
```

XML

- Based on Web Technologies
- Data and Markup are TEXT
- XML is a “framework”
- Nested tags/values
- Sequences of tags/values

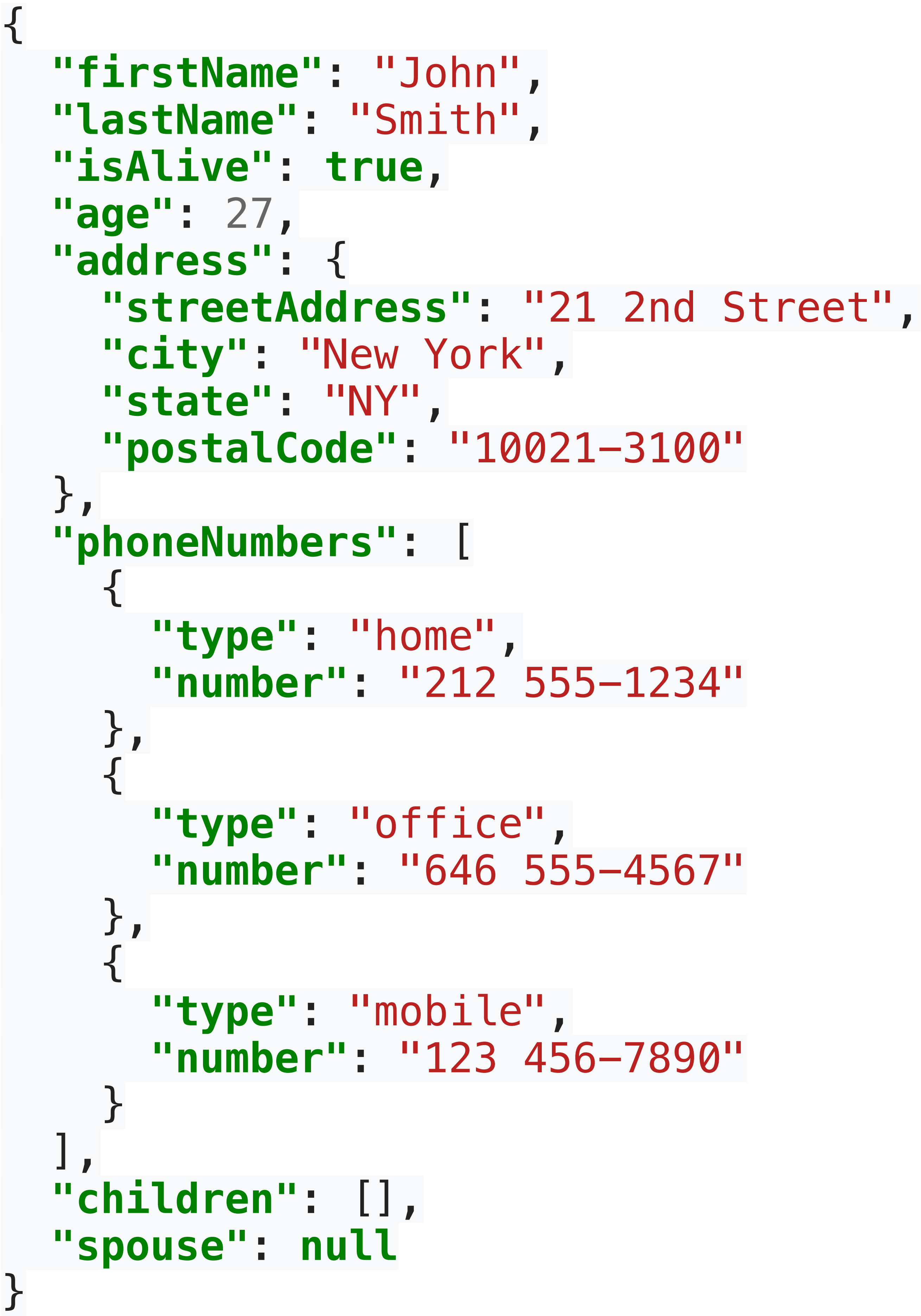
```
<xsd:schema xmlns:xsd="http://www.w3....XMLSchema"
      targetNamespace="urn:books"
      xmlns:bks="urn:books">
 <xsd:element name="books" type="bks:BooksForm"/>
 <xsd:complexType name="BooksForm">
  <xsd:sequence>
   <xsd:element name="book"
         type="bks:BookForm"
         minOccurs="0"
         maxOccurs="unbounded"/>
   </xsd:sequence>
 </xsd:complexType>

 <xsd:complexType name="BookForm">
  <xsd:sequence>
   <xsd:element name="author"   type="xsd:string"/>
```

XSD

- Defines valid XML Documents
- Written in XML
- Basic types: integer, string, boolean
- Complex types: nesting, sequences
- Namespaces to avoid name conflicts

JSON

- JavaScript Object Notation
- Primarily intended to reflect JavaScript objects as textual representation.
- Language independent
- Open Standard
- Human readable



```
{
  "firstName": "John",
  "lastName": "Smith",
  "isAlive": true,
  "age": 27,
  "address": {
    "streetAddress": "21 2nd Street",
    "city": "New York",
    "state": "NY",
    "postalCode": "10021-3100"
  },
  "phoneNumbers": [
    {
      "type": "home",
      "number": "212 555-1234"
    },
    {
      "type": "office",
      "number": "646 555-4567"
    },
    {
      "type": "mobile",
      "number": "123 456-7890"
    }
  ],
  "children": [],
  "spouse": null
}
```

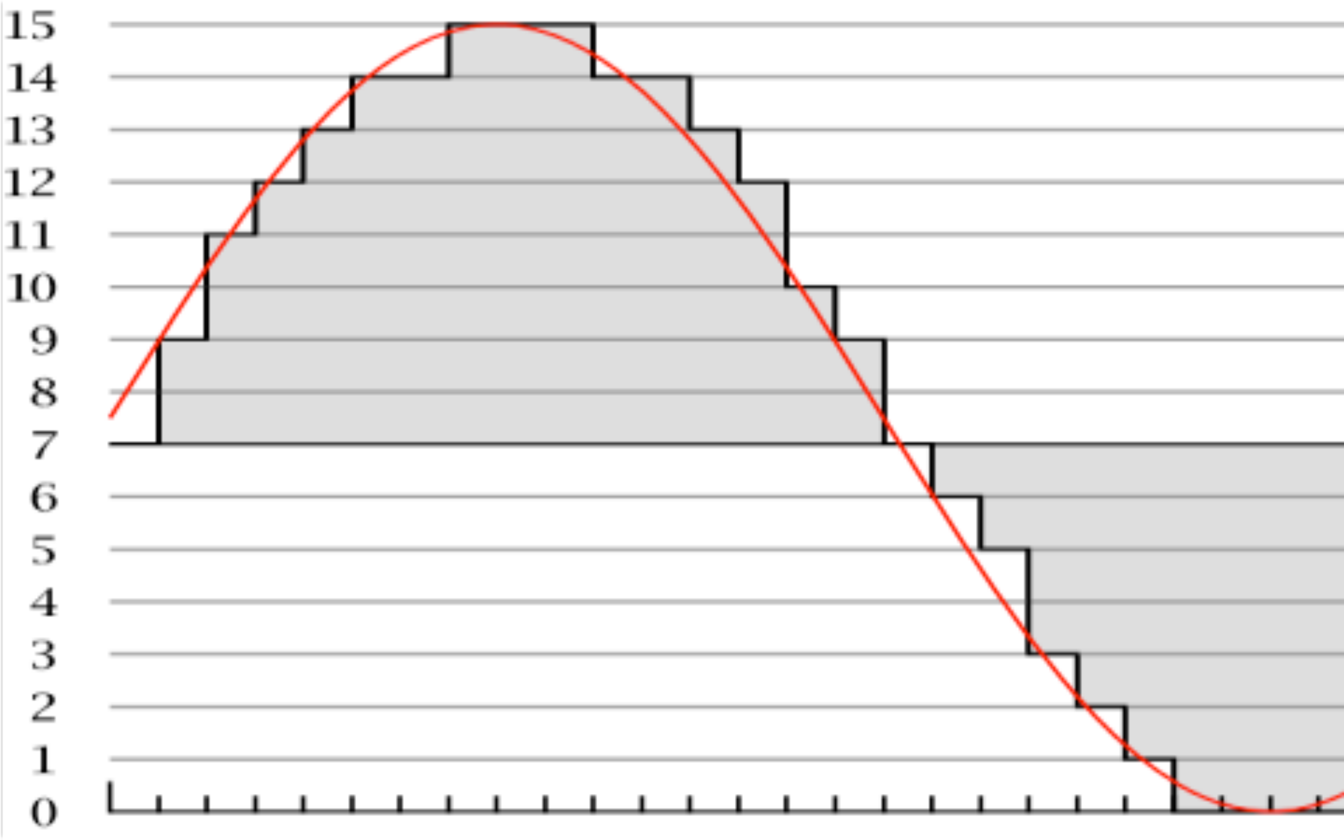
JSON

- Promoted as “low overhead”, compared to XML
- Widespread support and libraries
- Subset of JavaScript, e.g. JSON is valid JavaScript.
  Can thus be a security problem
- Does *not* support object references
  (links to other objects)

Multimedia Data

- The nature of multimedia data
- Compression
    - Lossless (for data)
    - Lossy (for images, video, audio)

Audio

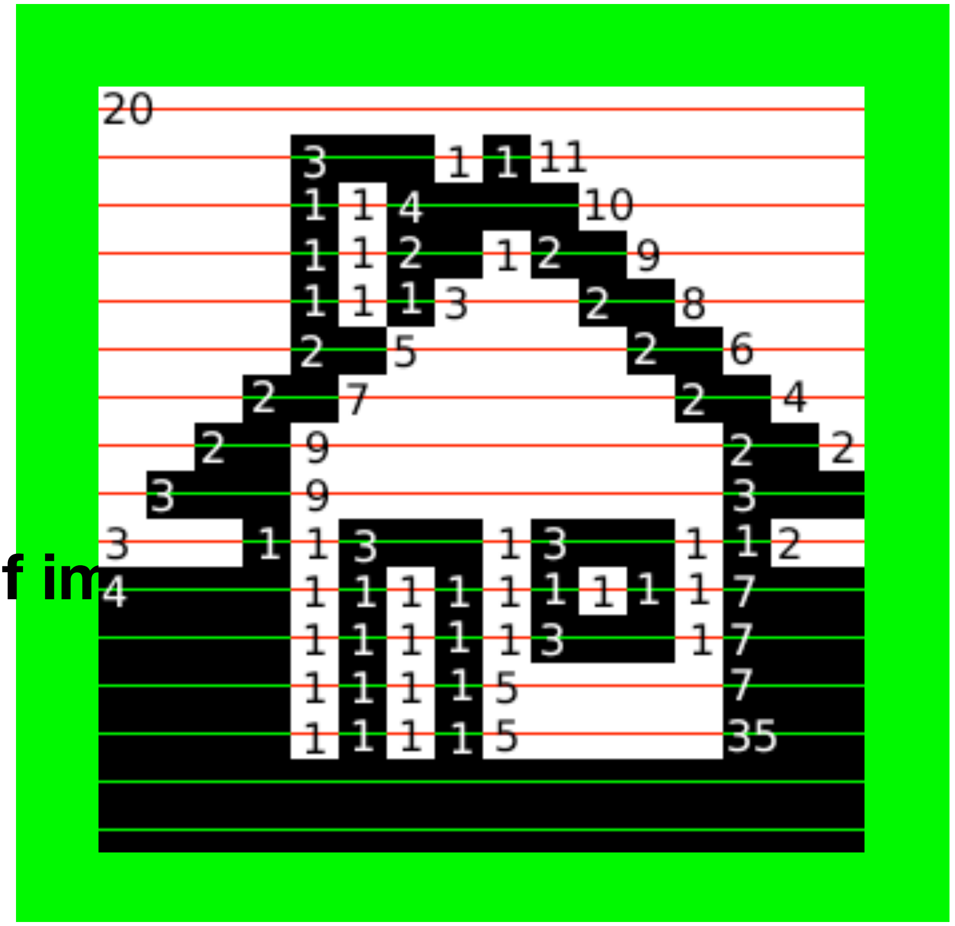


Sampling

- Sampling (time)
- Quantization (quantity, e.g. amplitude)

Images & Video

ence of im



That’s a lot of data!

1080 x 1920 x 24 = 50Mb

24fps = 1.2Gbps

Lossless Compression

All the data are important

- Run Length Encoding
- Differential Pulse Code Modulation

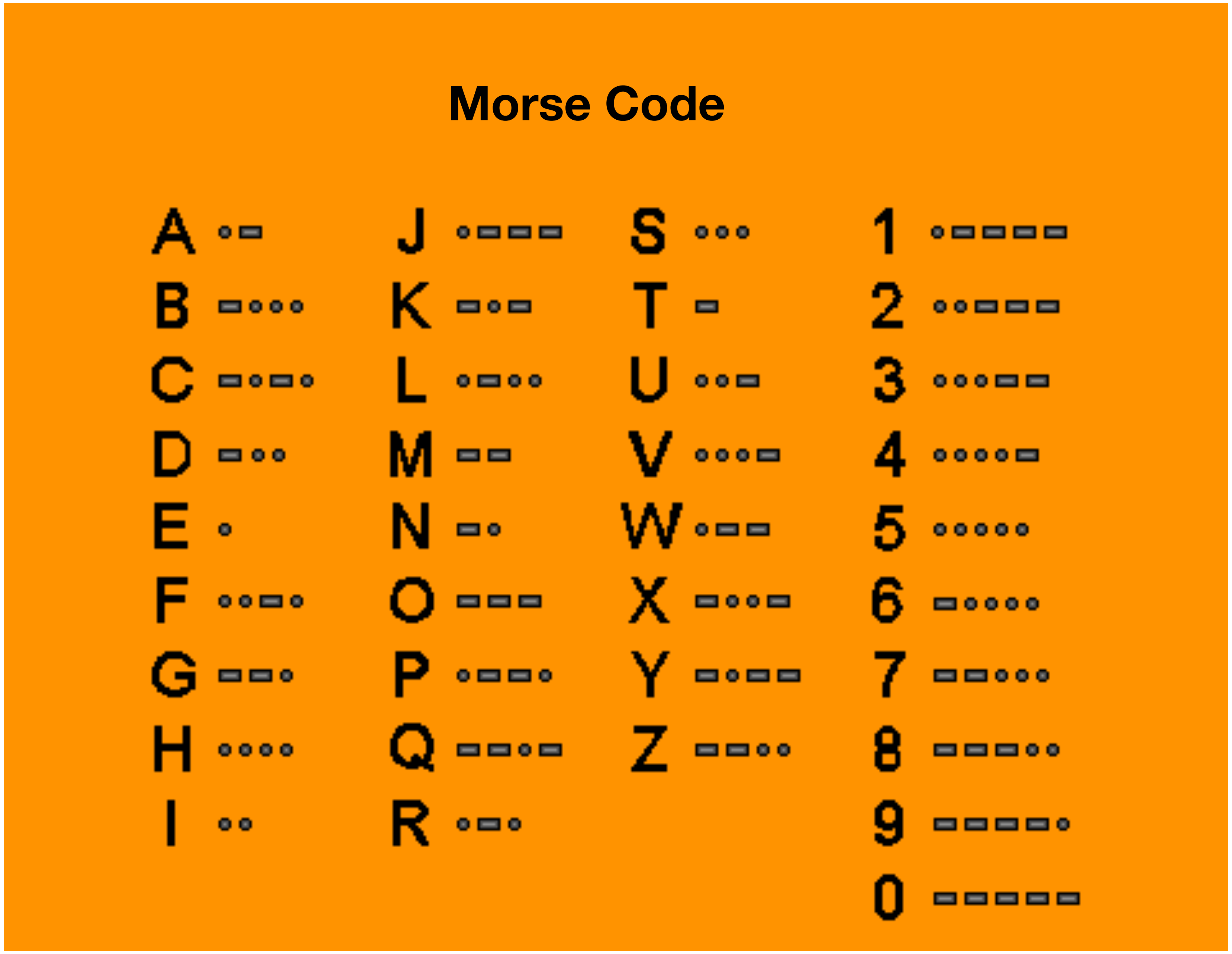
Run Length Encoding

AAABBCDDDDDDAAAAABCCC **21B**

DPCM

AAABBCDDDDDDAAAAABCCC 21B

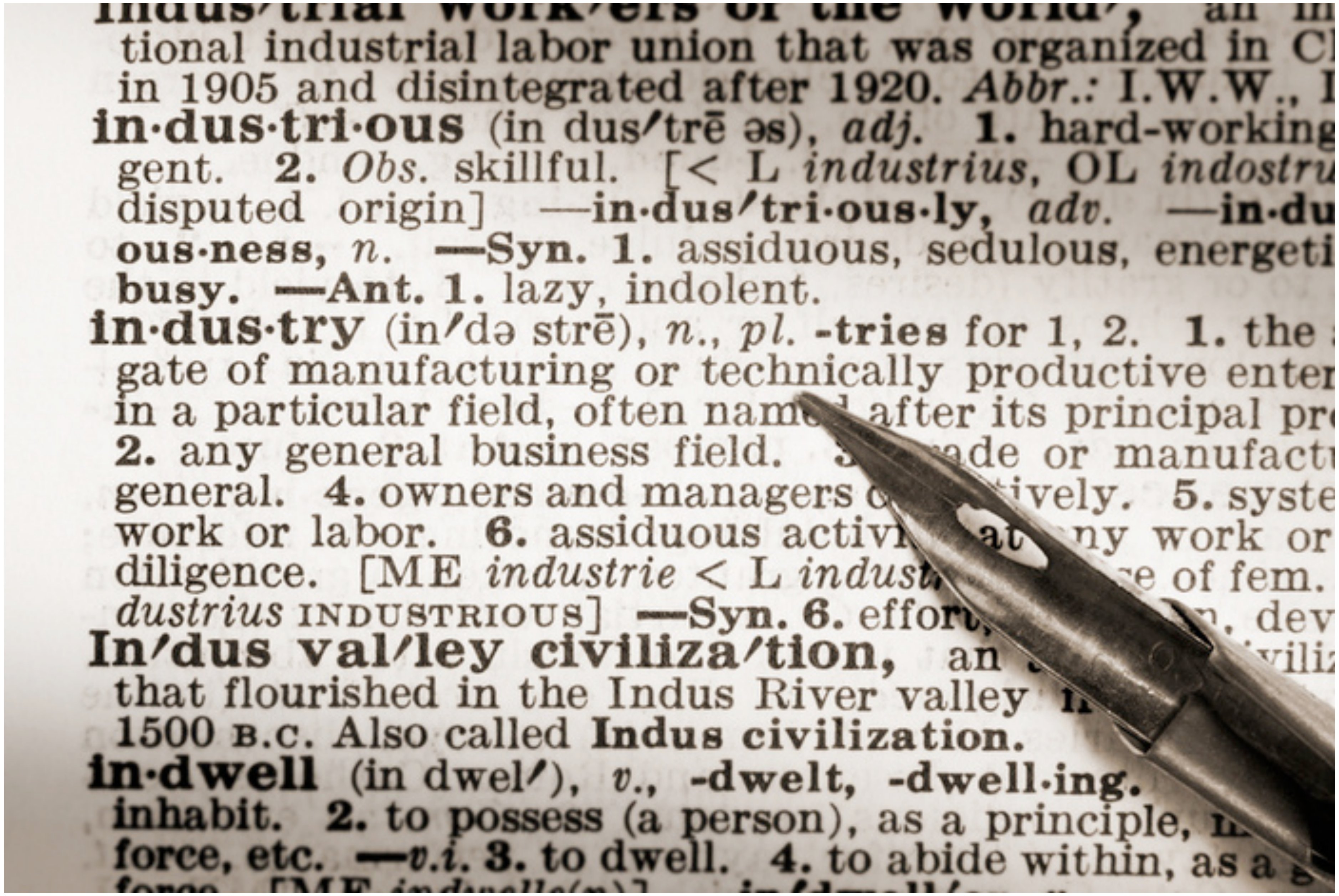
Huffman Code



Morse Code

A	·–	J	·–––	S	···	1	·––––
B	–···	K	–·–	T	–	2	··–––
C	–·–·	L	·–··	U	··–	3	···––
D	–··	M	––	V	···–	4	····–
E	·	N	–·	W	·––	5	·····
F	··–·	O	–––	X	–··–	6	–····
G	––·	P	·––·	Y	–·––	7	––···
H	····	Q	––·–	Z	––··	8	–––··
I	··	R	·–·			9	––––·
						0	–––––

LZW - Dictionary



In′dus′trial Work′ers of the World′, an in
tional industrial labor union that was organized in Cl
in 1905 and disintegrated after 1920. *Abbr.:* I.W.W., I
in·dus·tri·ous (in dus′trē əs), *adj.* **1.** hard-working
gent. **2.** *Obs.* skillful. [< L *industrius,* OL *indostru*
disputed origin] **—in·dus′tri·ous·ly,** *adv.* **—in·du**
ous·ness, *n.* **—Syn. 1.** assiduous, sedulous, energeti
busy. **—Ant. 1.** lazy, indolent.
in·dus·try (in′də strē), *n., pl.* **-tries** for 1, 2. **1.** the
gate of manufacturing or technically productive enter
in a particular field, often nam after its principal pr
2. any general business field. **3** ade or manufactu
general. **4.** owners and managers o tively. **5.** syste
work or labor. **6.** assiduous activi at ny work or
diligence. [ME *industrie* < L *industr* e of fem.
dustrius INDUSTRIOUS] **—Syn. 6.** effor n, dev
In′dus val′ley civiliza′tion, an iviliz
that flourished in the Indus River valley
1500 B.C. Also called **Indus civilization.**
in·dwell (in dwel′), *v.,* **-dwelt, -dwell·ing.**
inhabit. **2.** to possess (a person), as a principle,
force, etc. **—***v.i.* **3.** to dwell. **4.** to abide within, as a

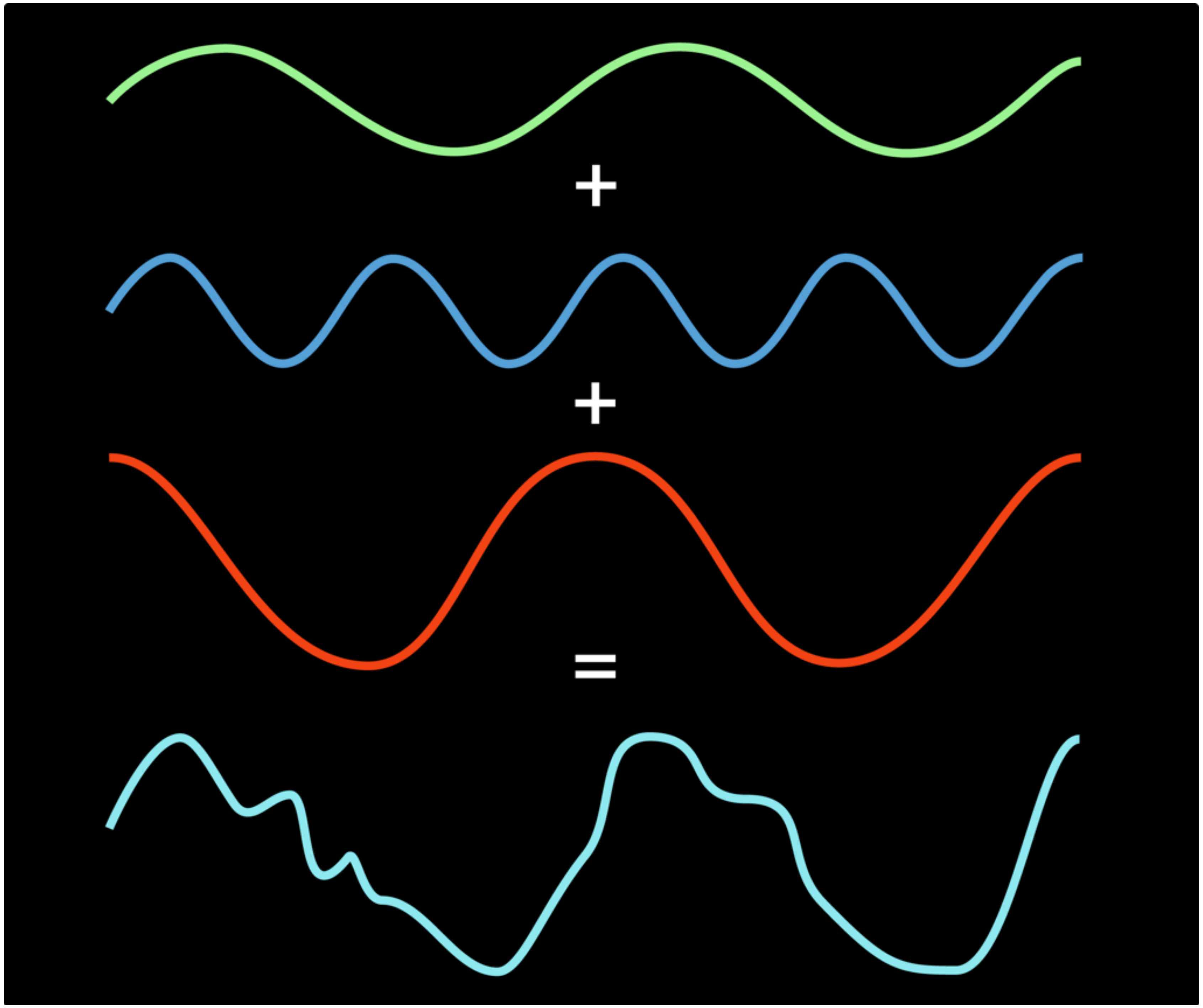
Lossy Compression

All the data are

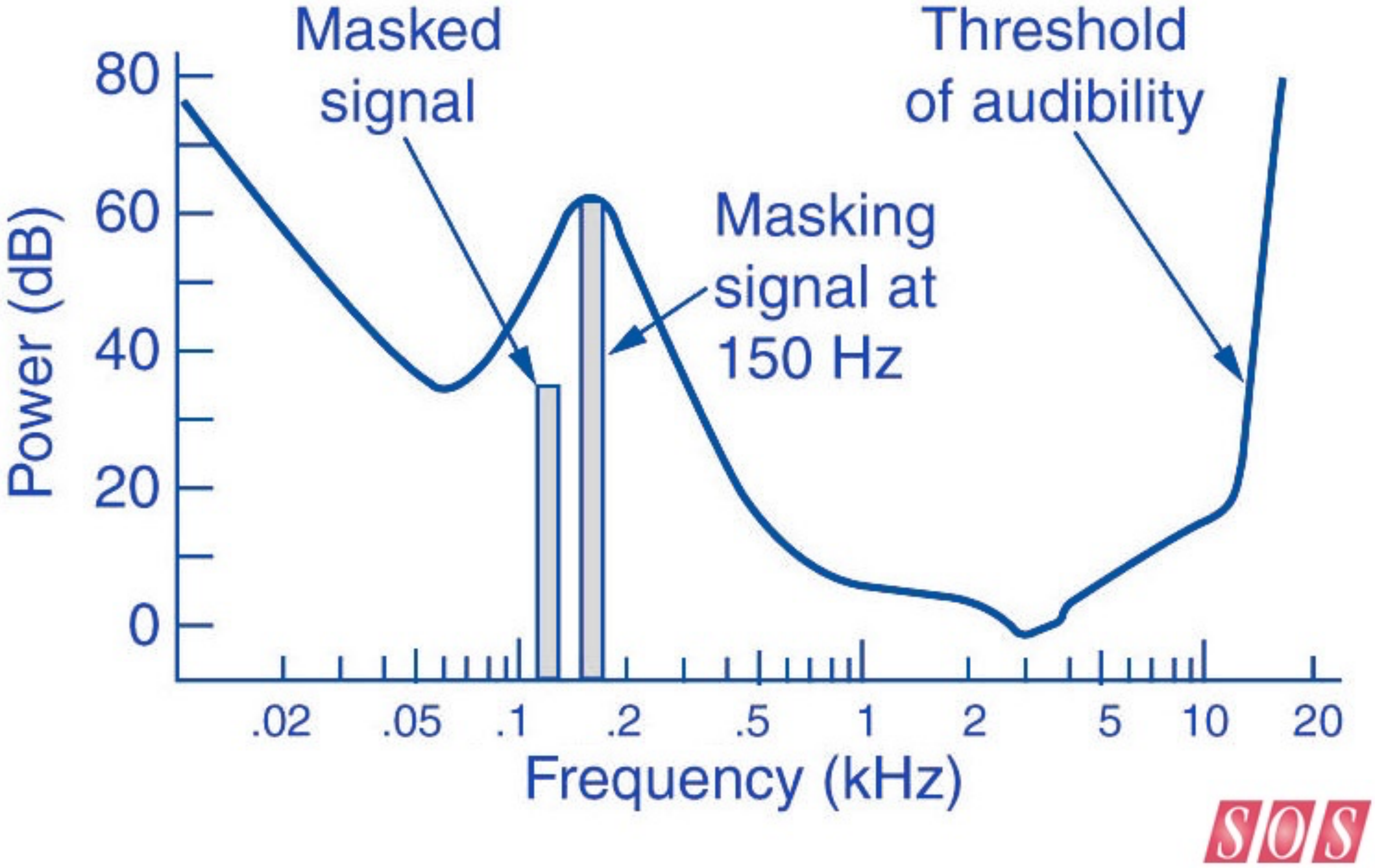
NOT important

- Single image compression
- Stream compression

MP3 (audio)



Signal Reduction (masking)



Bitrate?

- 24Kbps = Spoken word (telephone)
- 48-64Kbps = AM Radio
- 128Kbps = reasonable for car-radio, falls off over 16KHz (cymbals)
- 192KBps = ‘near CD quality’
- >= 256Kbps = identical to original up to about 18KHz

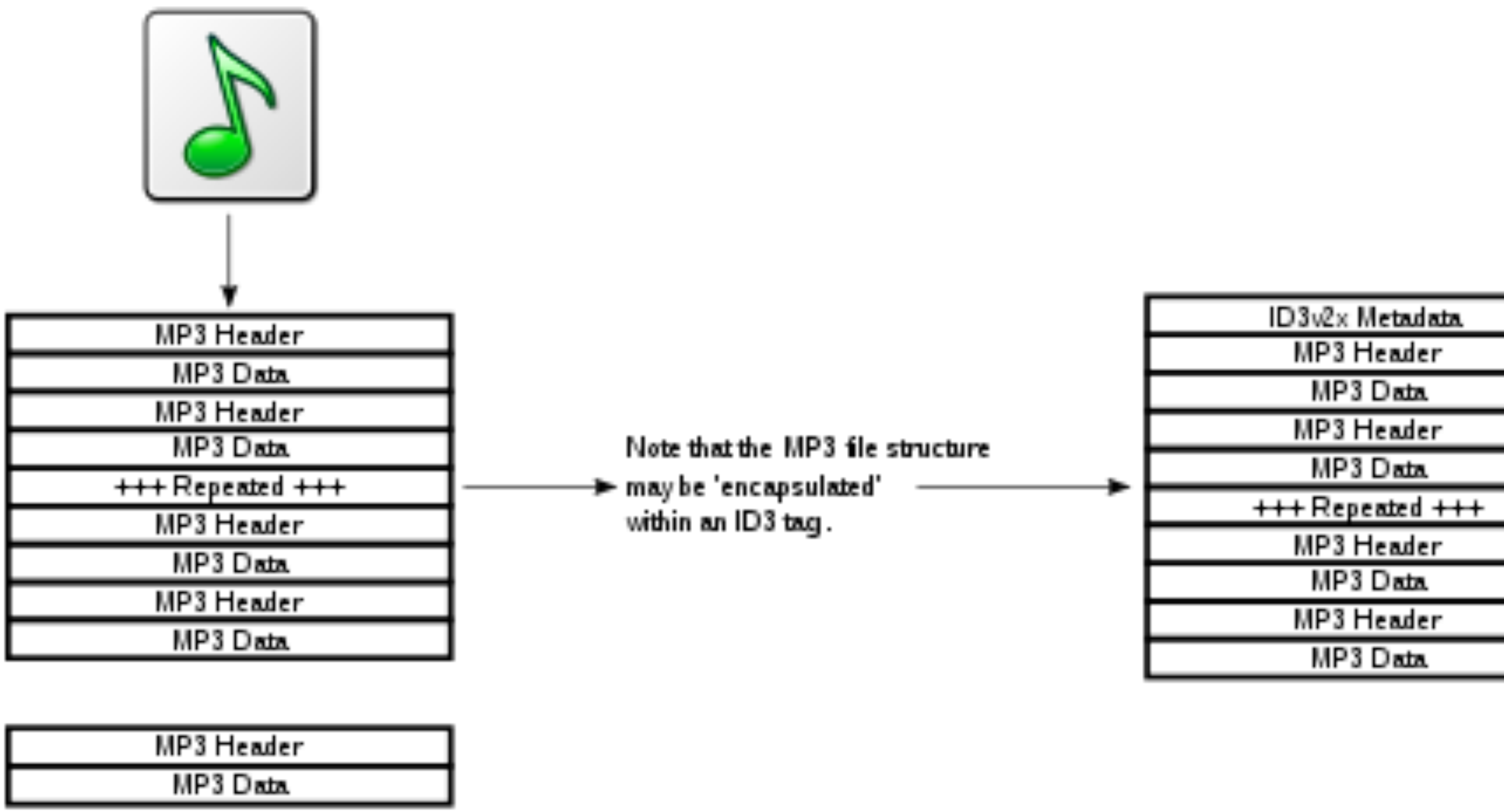
CBR vs VBR

- Constant
  - Same bitrate throughout the stream
- Variable
  - bitrate changes based on content analysis

An MP3 File

Internal Structure of an MP3 File

An MP3 Frame



Note that the MP3 file structure may be 'encapsulated' within an ID3 tag.

Example MP3 Header

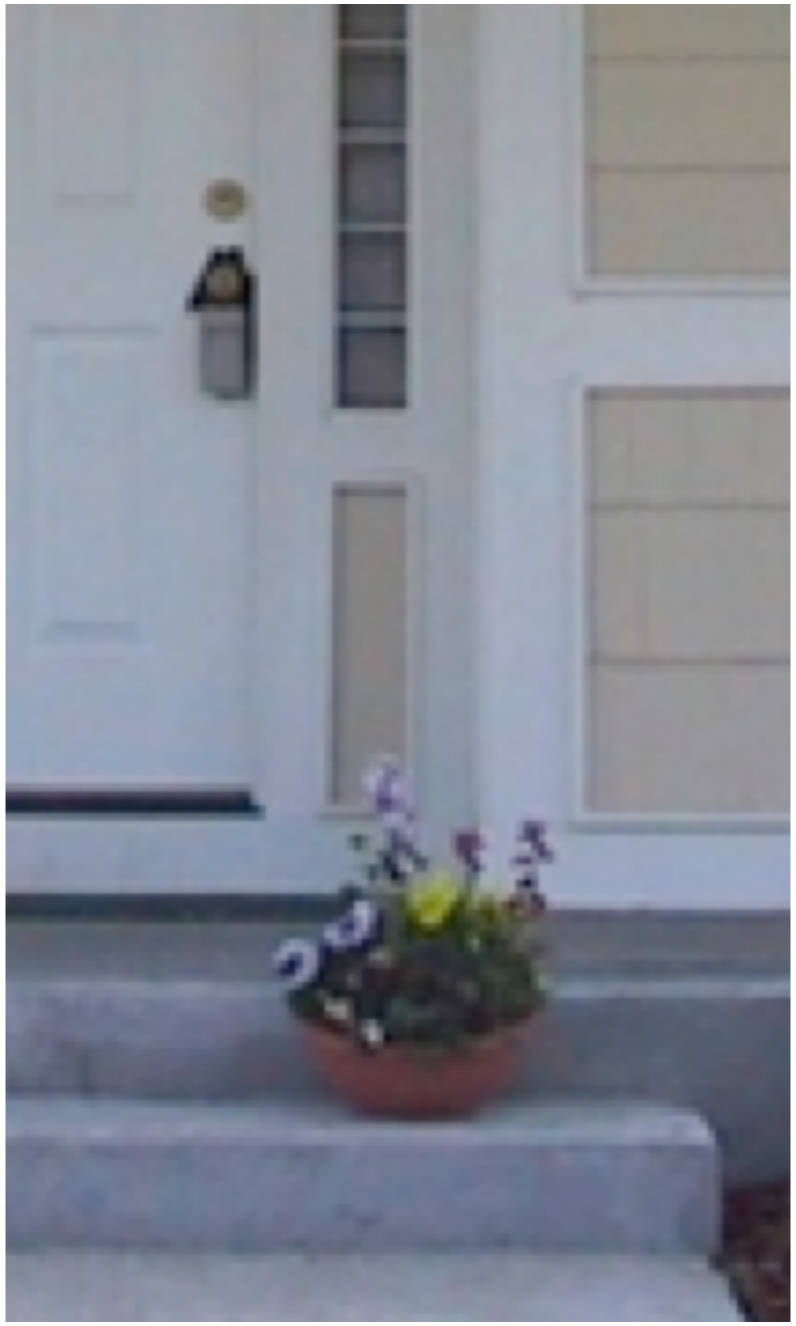
F	F	F	B	A	0	4	0

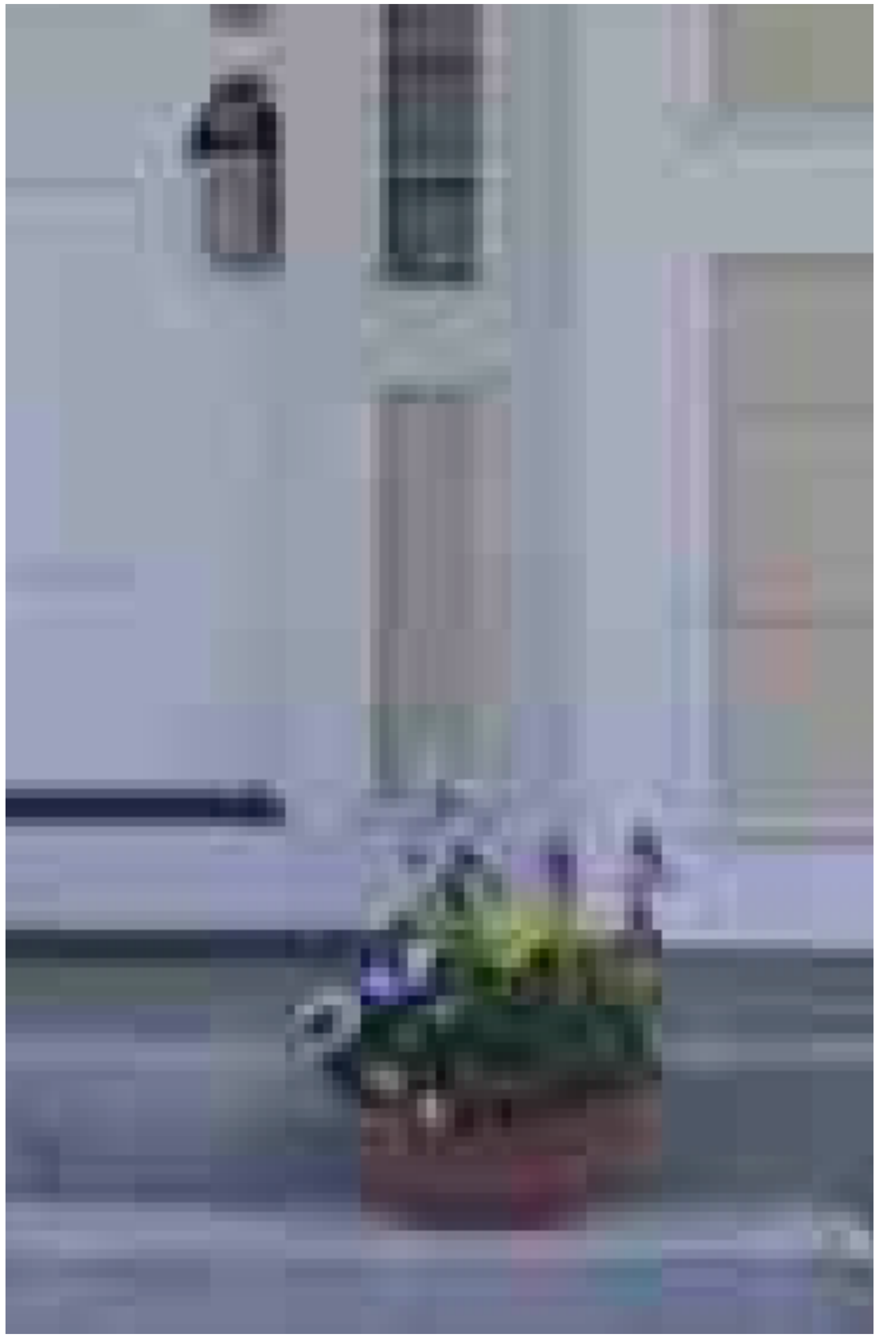
Colour-coding shows binary bit mapping to hex values below

Detail of an MP3 Header

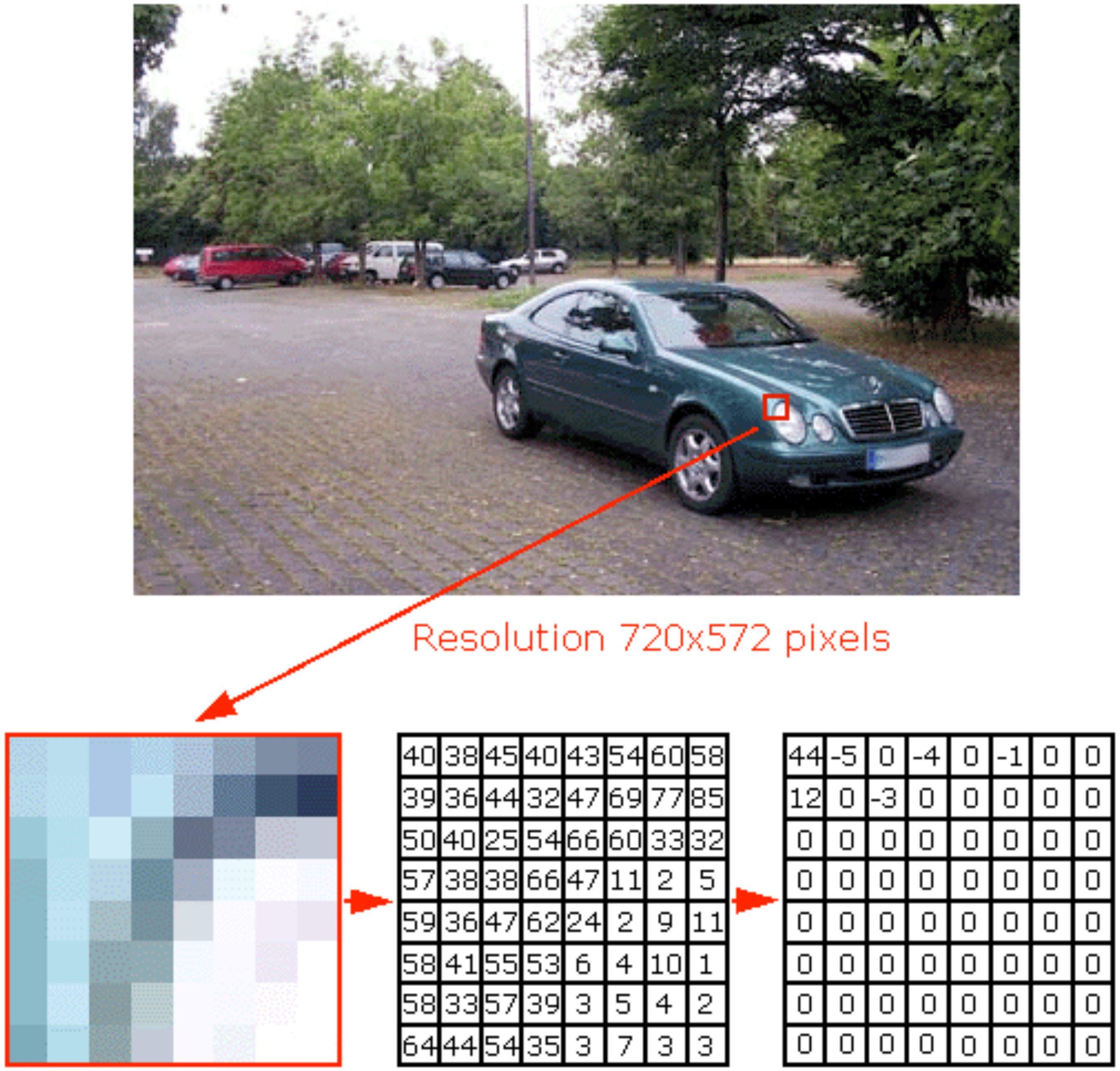
Bits	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Binary	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	0	0	0
Hex	F				F				F				B				A					
Meaning	MP3 Sync Word												Version	Layer		Error Protection	Bit Rate				Frequency	
Value	Sync Word												1 = MPEG	01 = Layer 3		1 = No	1010 = 160				00 = 44100 Hz	

Images & Audio





JPEG



Resolution 720x572 pixels

Block at 8x8 pixels

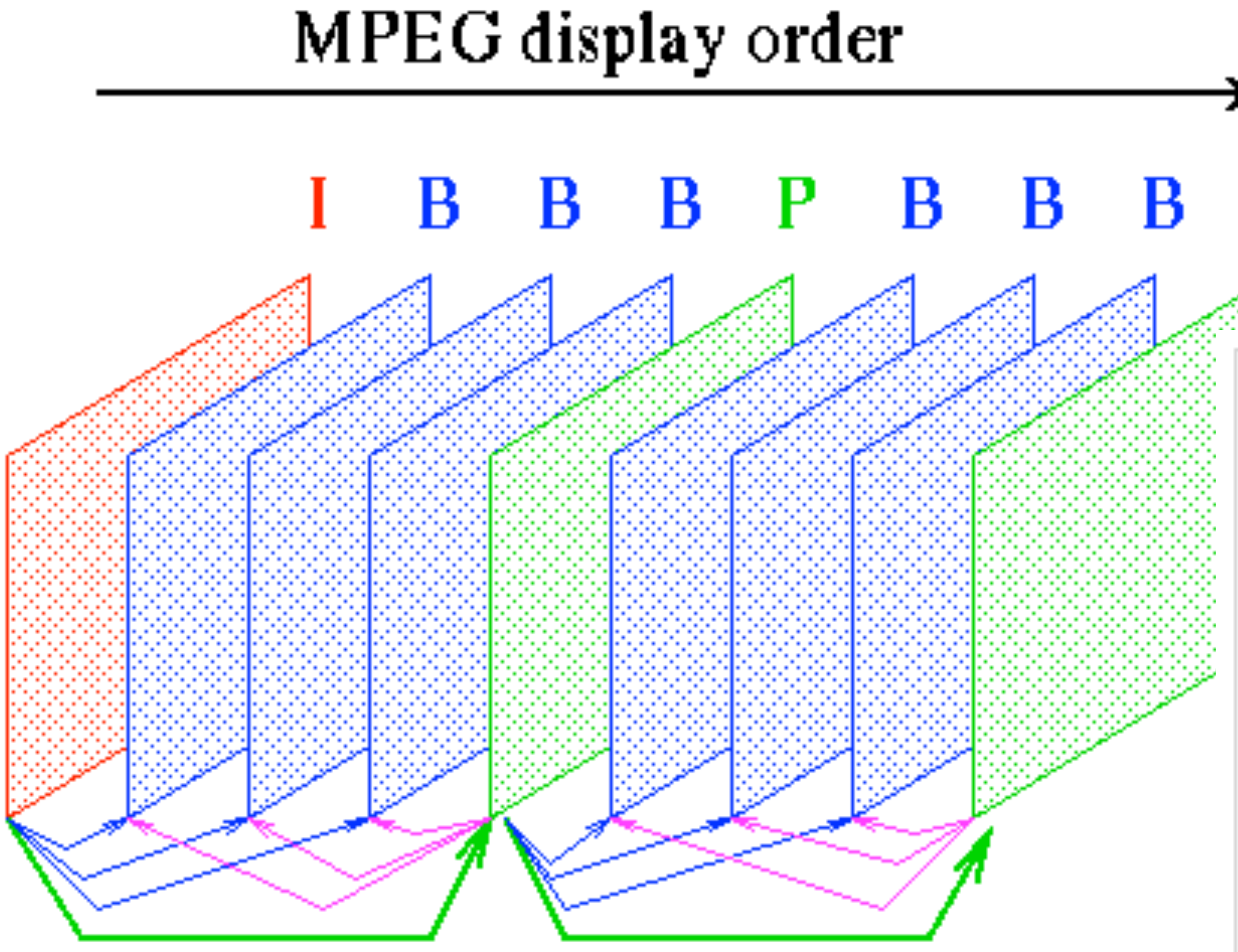
Color value matrix

40	38	45	40	43	54	60	58
39	36	44	32	47	69	77	85
50	40	25	54	66	60	33	32
57	38	38	66	47	11	2	5
59	36	47	62	24	2	9	11
58	41	55	53	6	4	10	1
58	33	57	39	3	5	4	2
64	44	54	35	3	7	3	3

DCT coefficients

44	-5	0	-4	0	-1	0	0
12	0	-3	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

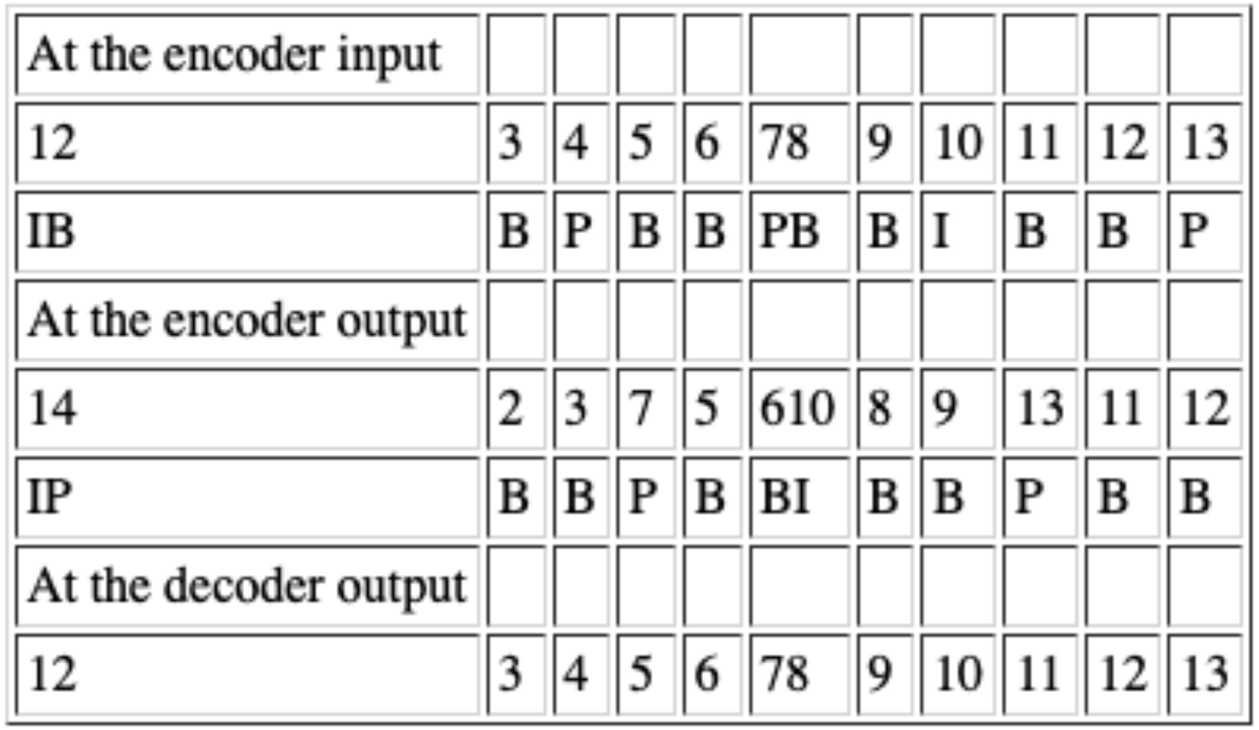
MPEG



forward prediction of P –frames

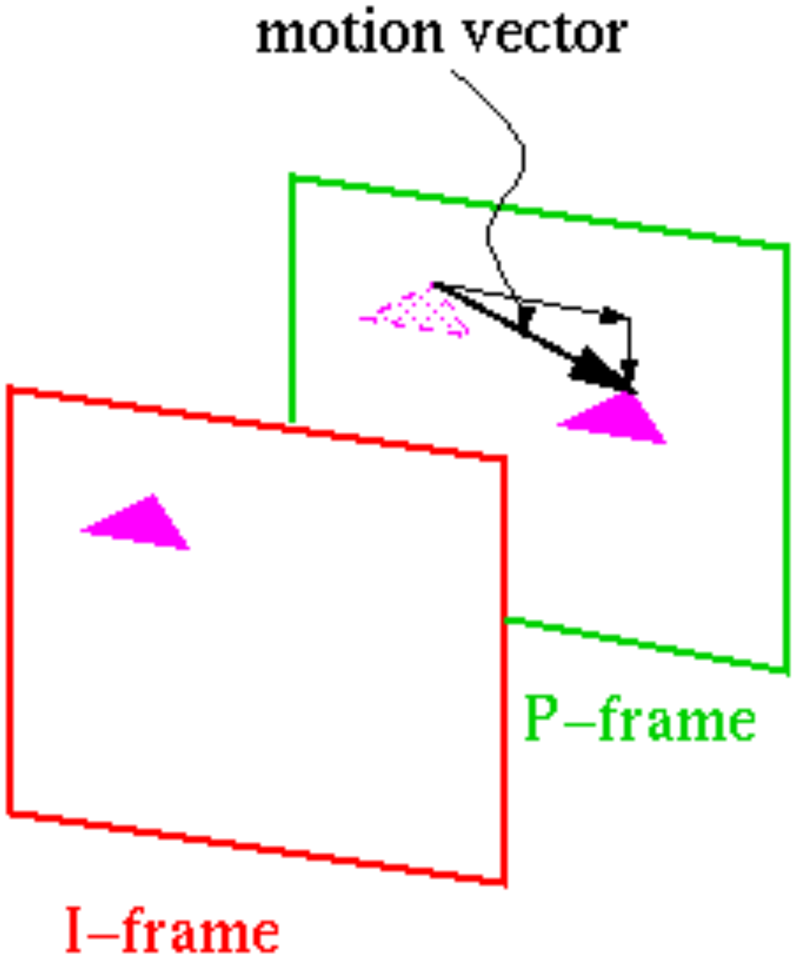
forward prediction of B–frames

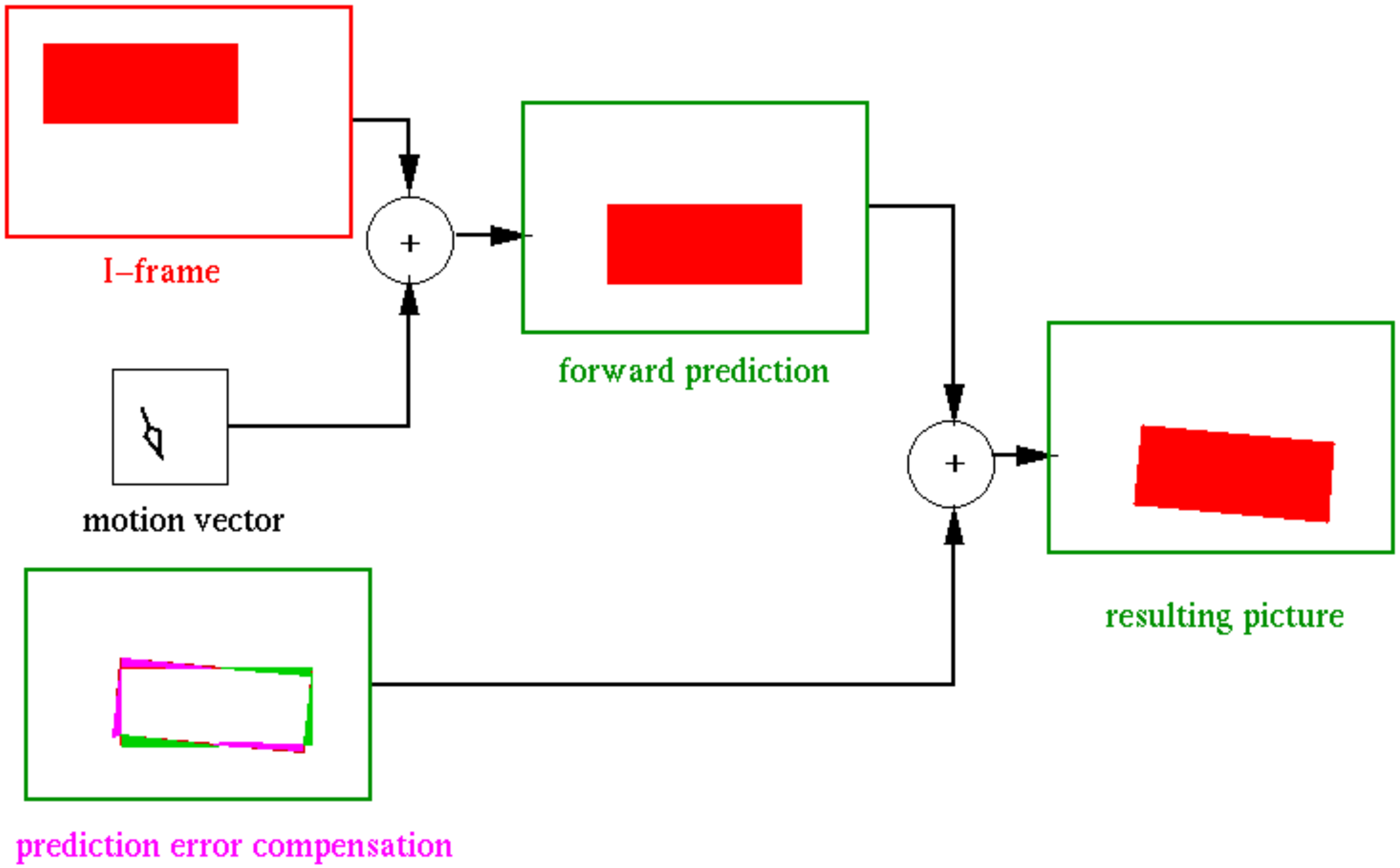
backward prediction of B–frames



At the encoder input										
12	3	4	5	6	78	9	10	11	12	13
IB	B	P	B	B	PB	B	I	B	B	P
At the encoder output										
14	2	3	7	5	610	8	9	13	11	12
IP	B	B	P	B	BI	B	B	P	B	B
At the decoder output										
12	3	4	5	6	78	9	10	11	12	13

Prediction


motion vector
P–frame
I–frame


I–frame
+
forward prediction
motion vector
+
resulting picture
prediction error compensation

End

Presentation Formatting
XML