

# Συστήματα και Αλγόριθμοι Πολυμέσων

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Ομιλία #9: Διεθνές στάνταρ  
συμπίεσης MPEG-4  
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# Επανάληψη

- Αρχιτεκτονική Intel Pentium
  - Η πιο δημοφιλής αρχιτεκτονική προσωπικών υπολογιστών
  - “P6” (=Centrino) & “NetBurst” (=Pentium 4)
- MMX/SSE/SSE2
  - Βασίζεται στην τεχνική της παράλληλης εκτέλεσης μιας εντολής σε πολλαπλά δεδομένα (SIMD)

## Επανάληψη (2)

- MMX = 64-bit καταχωρητές (8 bytes/4 words/2 double-words/1 quad-word)
- SSE/SSE2 = 128-bit καταχωρητές (16 bytes/8 words/4 double-word/2 quad-words/1 double-quad-word)
- Προσφέρουν μεγάλη ποικιλία αριθμητικών και λογικών παράλληλων πράξεων
- Προγραμματίζονται με τη βοήθεια intrinsics ή με γλώσσα μηχανής (inline assembly)

# Άσκηση #9

- Να γράψετε την ρουτίνα υπολογισμού του μέσου όρου δύο καρέ βίντεο, ανά κουκίδα.
- Να την υλοποιήσετε σε
  - Αριθμητική κινητής υποδιαστολής, χρησιμοποιώντας γλώσσα προγραμματισμού “C”
  - Ακέραια αριθμητική, χρησιμοποιώντας γλώσσα προγραμματισμού “C”
  - Ακέραια αριθμητική, χρησιμοποιώντας εντολές MMX μέσω intrinsics
  - Ακέραια αριθμητική, χρησιμοποιώντας εντολές MMX μέσω γλώσσας μηχανής

# Άσκηση #9- συνέχεια

- Να υλοποιήσετε τη ρουτίνα σε
  - Ακέραια αριθμητική, χρησιμοποιώντας εντολές SSE2 μέσω intrinsics/γλώσσας μηχανής
- Να χρησιμοποιήσετε το εργαλείο Vtune και να υπολογίσετε την επιτάχυνση της εκτέλεσης των διαφόρων μορφών του προγράμματος

# MPEG4 – what is it ?

- Extension of MPEG1/2 to arbitrarily shaped **multimedia objects**
- Has different versions; version 1 is already an international standard (ISO/IEC 14496, 1999). Version 2 is being finalized, while versions 3 and 4 are under development
- Video part includes H.263 (ITU-T low bitrate video compression international standard) as a subset; audio part includes AAC (MPEG2) as a subset

# MPEG4

- MPEG4: ISO/IEC 14496
  - Published as International Standard in 2000/2001
  - 6 parts: Systems (with 1 Amendment), Video (with 2 Amendments), Audio, Conformance Testing, Reference Software and Delivery Media Integration Framework
  - Covers all bit-rates: from few kbps to 100's of Mbps
  - Applications: 3G wireless networks, internet streaming, digital storage, broadcasting ...

# MPEG4 video: new coding tools

- New objects: (natural) video, face, mesh
- Shape coding: video objects are no longer (only) rectangular – transparency too
- Scalability: temporal, spatial, quality (SNR)
- Error resilience
- 4-12 bit per color-component support
- More flexibility, higher coding efficiency



# MPEG4 video: new coding tools

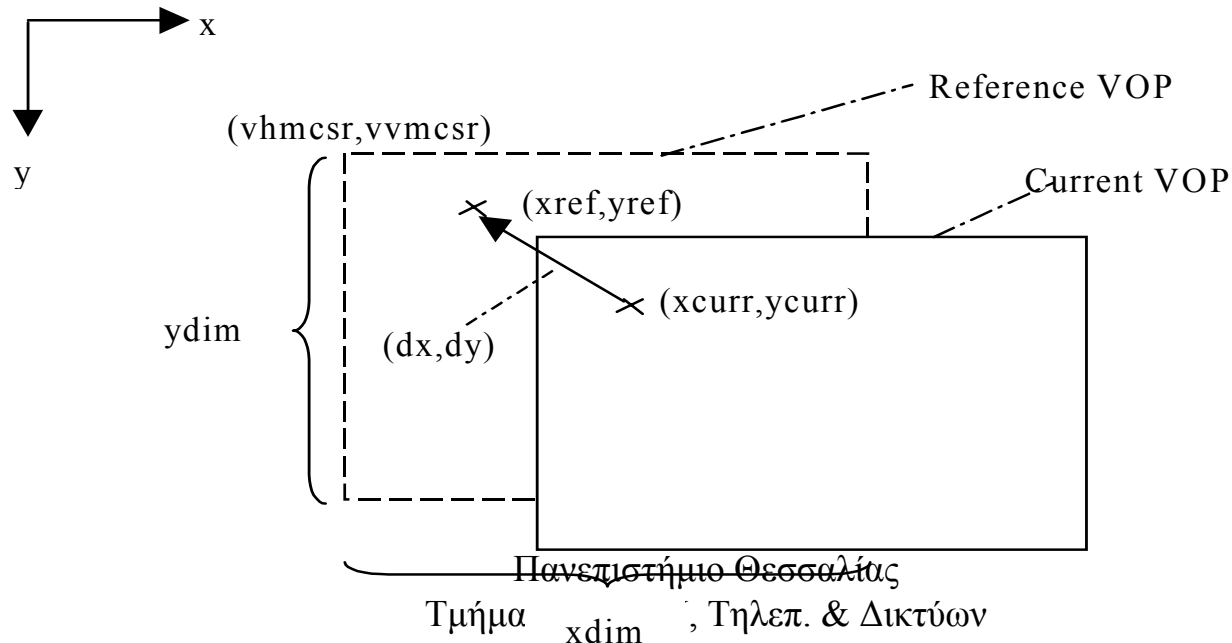
- (MPEG1/2) pictures = (MPEG4) Visual Object Planes, a.k.a. **VOPs**. Same VOP types (I/B/P) + Shape (S)
- Macroblock-based processing (16x16) of VOPs, with same block structure (8x8), DCT of residuals, Quantization, VLC coding same as MPEG1/2 but with different VLC tables and headers (**MPEG4 stream is not backwards compatible with MPEG1/2 streams**)

# MPEG4 video: new coding tools

- Unrestricted Motion Compensation
- 4MV
- Advanced prediction mode (Inter MBs)
- OBMC
- AC/DC prediction (Intra MBs)
- 3-D VLC (run, last, level) with more efficient ESC, 3 zig-zag scan orders
- 2 quantization methods

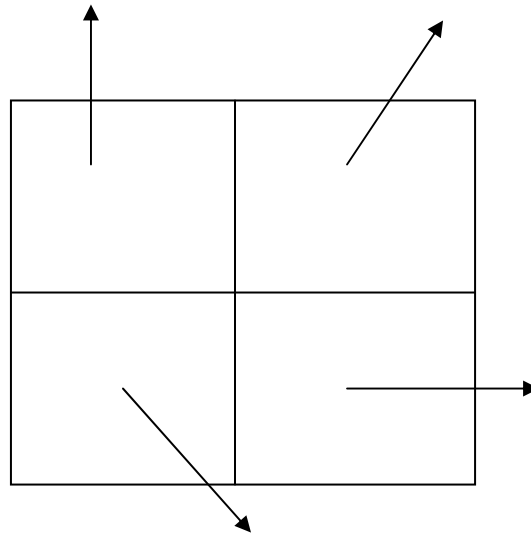
# MPEG4 video: new coding tools

- Unrestricted motion search: VOP is extended over its boundaries by pixel repetition to allow for motion vector reference outside the VOP



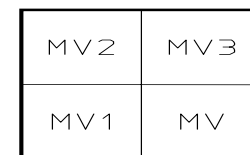
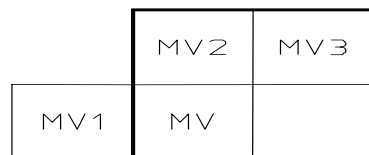
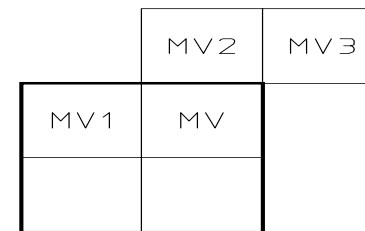
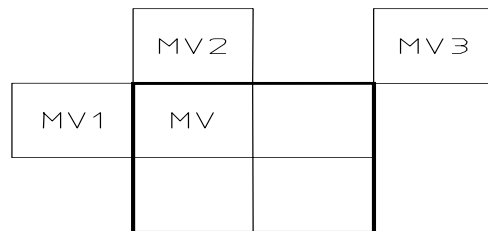
# MPEG4 video: new coding tools

- 4MV: each 16x16 macroblock can have 4 motion vectors, 1 for each 8x8 luminance block



# MPEG4 video: new coding tools

- Advanced prediction mode: differential coding of MV using median prediction of upper and left MVs



# MPEG4 video: new coding tools

- OBMC: overlapped block motion compensation

*Prediction with motion vector of current luminance block.*

4	5	5	5	5	5	5	4
5	5	5	5	5	5	5	5
5	5	6	6	6	6	5	5
5	5	6	6	6	6	5	5
5	5	6	6	6	6	5	5
5	5	6	6	6	6	5	5
5	5	5	5	5	5	5	5
4	5	5	5	5	5	5	4

*Prediction with motion vectors on top/bottom of current luminance block.*

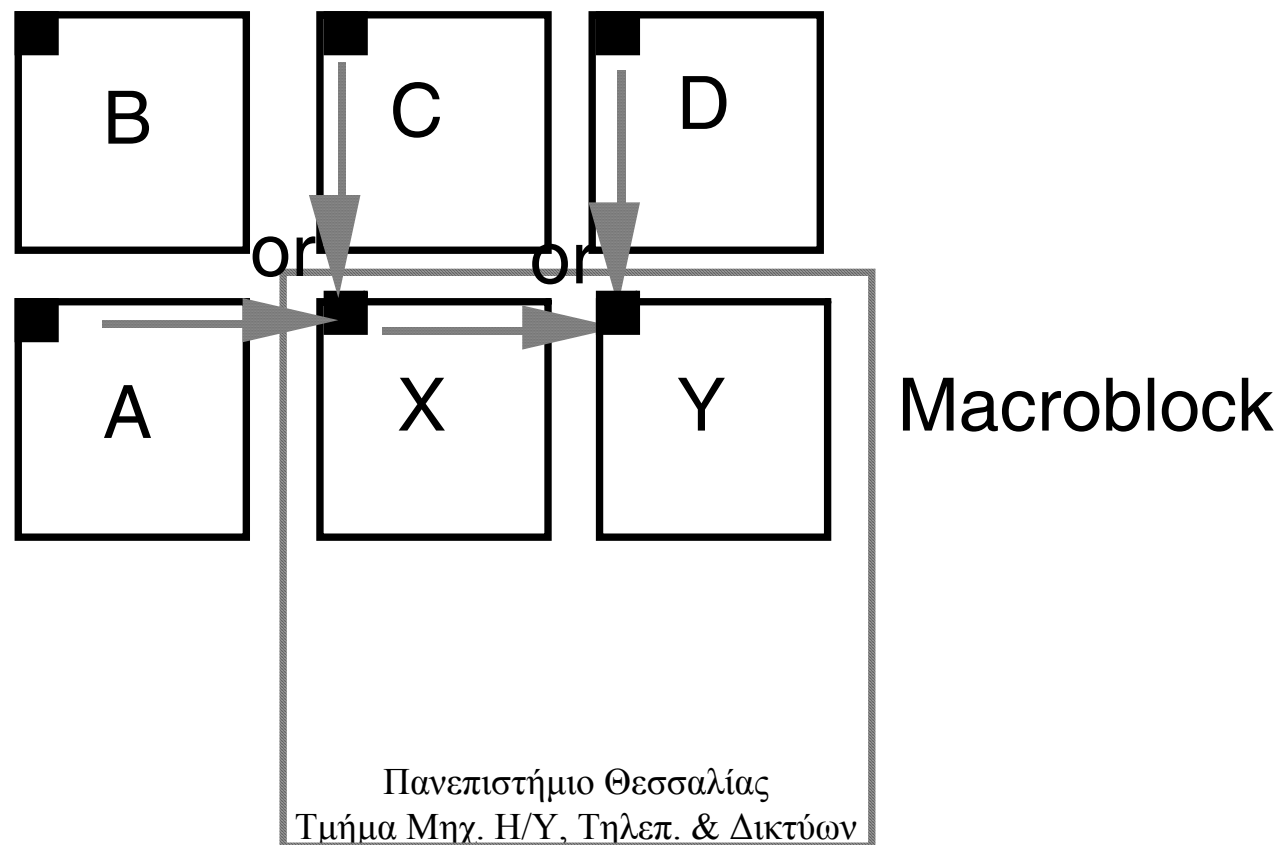
2	2	2	2	2	2	2	2
1	1	2	2	2	2	1	1
1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1
1	1	2	2	2	2	1	1
2	2	2	2	2	2	2	2

*Prediction with motion vectors on left/right of current luminance block.*

2	1	1	1	1	1	1	2
2	2	1	1	1	1	2	2
2	2	1	1	1	1	2	2
2	2	1	1	1	1	2	2
2	2	1	1	1	1	2	2
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2	2	1	1	1	1	2	2
2	1	1	1	1	1	1	2

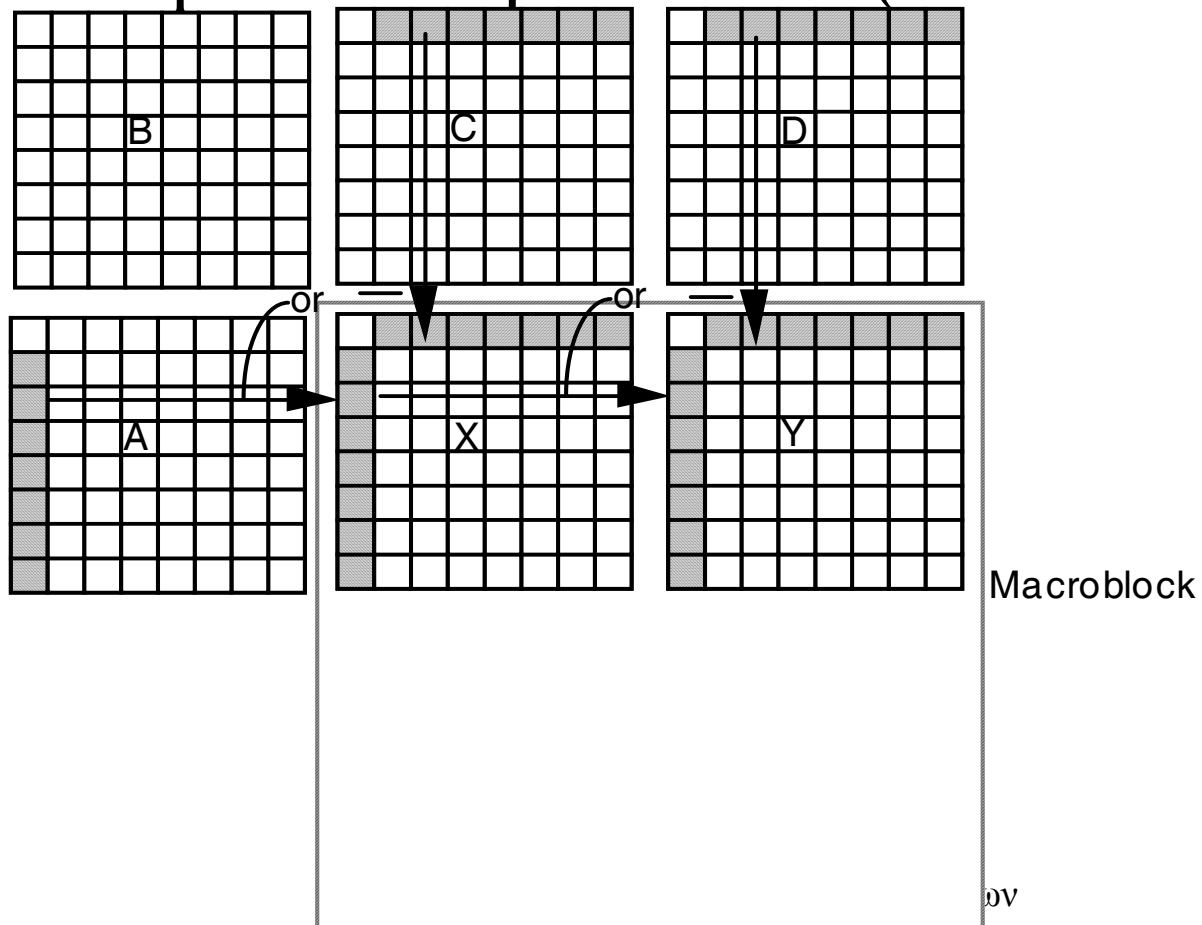
# MPEG4 video: new coding tools

- Adaptive DC prediction (Intra MBs only)



# MPEG4 video: new coding tools

- Adaptive AC prediction (Intra MBs only)





# MPEG4 video: new coding tools

- 2 choices of quantization methods: H.263 and MPEG
- Quantization matrices similar to MPEG2
- 3-D VLC (run, level, last) vs. 2-D VLC for MPEG2 (run, level) with more efficient ESC coding
- 3 zig-zag scanning orders
- Generalized slice (“packet”)/GOB optional
- MPEG4 ver. 2 allows for  $\frac{1}{4}$ -pel motion

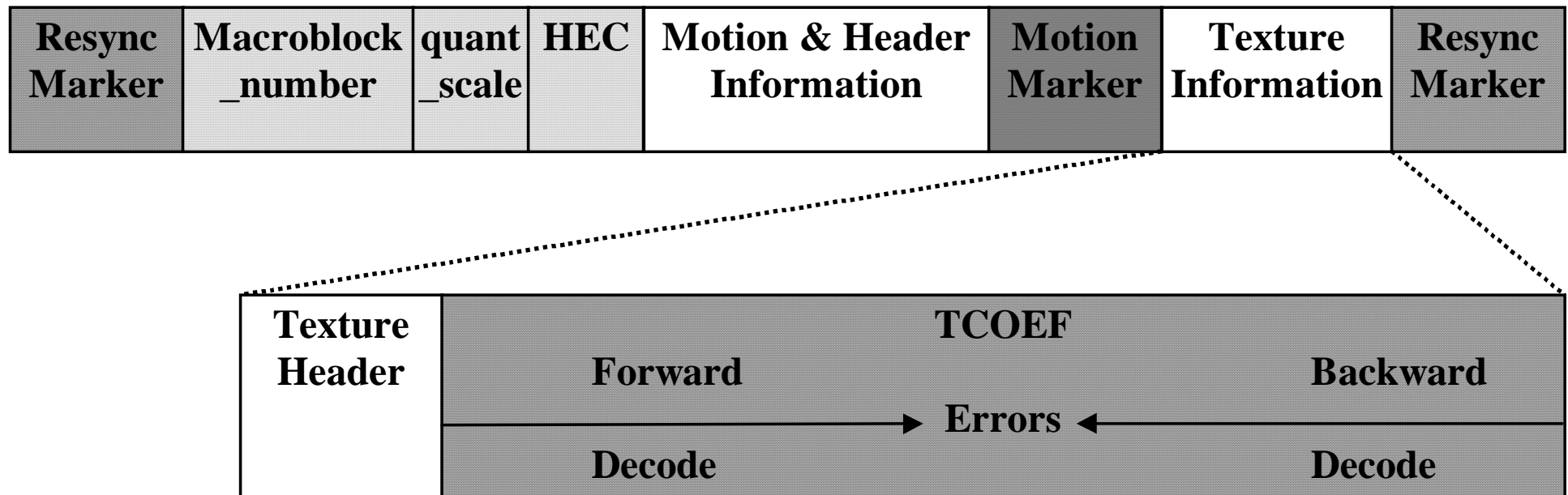
# MPEG4 video: error resilience

- Very important feature that allows for robust transmission, especially in wireless networks (3G) and internet streaming
- MPEG4 offers a variety of error resilience tools that can be tuned for specific applications and channel noise patterns
- Can be grouped in encoder-related (non-normative) and decoder-related (normative) tools; the later are also reflected in syntax

# MPEG4 video: error resilience

- Resynchronization Markers (RM), also called Video Packets (VP)
- Header Extension Codes (HEC)
- Data Partitioning (DP)
- Reversible Variable Length Codes (RVLC)
- Cyclic Intra Refresh (CIR)
- Adaptive Intra Refresh (AIR)

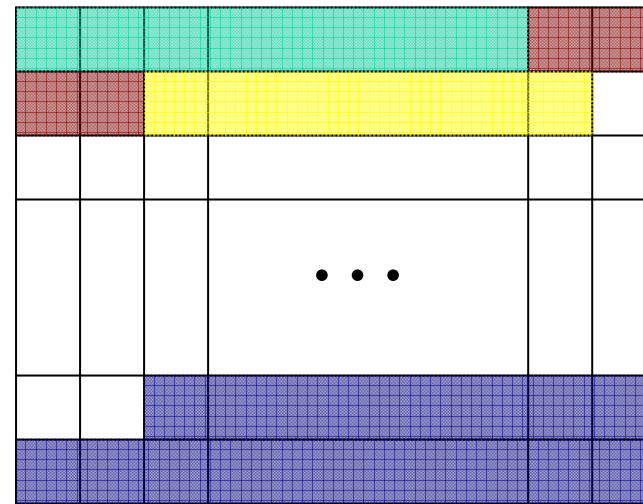
# MPEG4 video: error resilience



# MPEG4 video: error resilience

- Resynchronization Marker is a special code ‘0 0000 0000 0000 0001’ that delimits independently decodable parts of a VOP in bitstream – maps to integer number of MBs

Bit Rate (kbit/s)	Spacing (bits)
0-48	480
49-128	600
128-384	4096
384-1000	TBD



# MPEG4 video: error resilience

- Header Extension Code is controlled by a flag that indicates that important information that is normally located in the VOP header are repeated for a packet:
  - Modulo time-base
  - VOP time increment
  - VOP coding type (I/P/B/S)
  - VOP width, height
  - Intra DC VLC threshold

# MPEG4 video: error resilience

- Data Partitioning is controlled by a flag indicating that motion (for P-VOP) or DC (for I-VOP) data are separated from texture data through some special motion marker ‘1111 0000 0000 0001’ or DC marker ‘1101011 0000 0000 0001’. In this way, critical data (motion/DC) can be recovered in case of error.

# MPEG4 video: error resilience

- Reversible Variable Length Codes (RLVC) are special VLCs that can be uniquely decoded both in forward and reverse bit parsing.
  - Ex: ‘0110’
  - MPEG4 uses a special family of RVLC that can be grouped in two categories.



# MPEG4 video: error resilience

- Either has 2 ones (one at the beginning and one at the end) with a number of 0's between 0-11, i.e. 11, 101, ..., 10000000000001
- Or has 3 zeroes (one at the beginning, one in the middle and one at the end) with a number of 1's between 0-11, i.e. 000, 0010, ..., 01111110111110
- Each RVLC codeword is followed by 1 bit (0/1) that allows for 2 symbols to be coded + 1 sign bit