MPEG-4: Fallacies and Paradoxes

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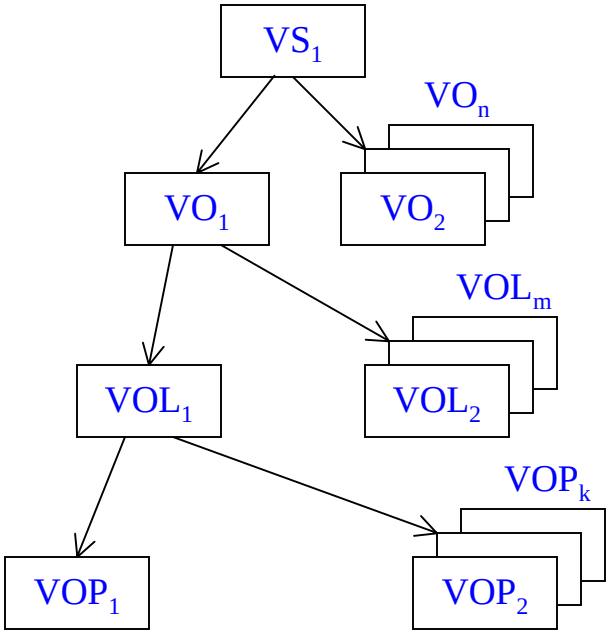
MPEG-4: Multimedia for Our Time

- **Internet streaming video, Digital TV, mobile multimedia, broadcast …**
- **Improved from MPEG-1 and MPEG-2**
  - Interactivity
  - Streaming
- **You have been using it !**
  - .avi, .wmv, .asx, .mp4, …
  - Few of them are true MPEG-4.

MPEG-4 Visual: a Hierarchical Structure



Video Session

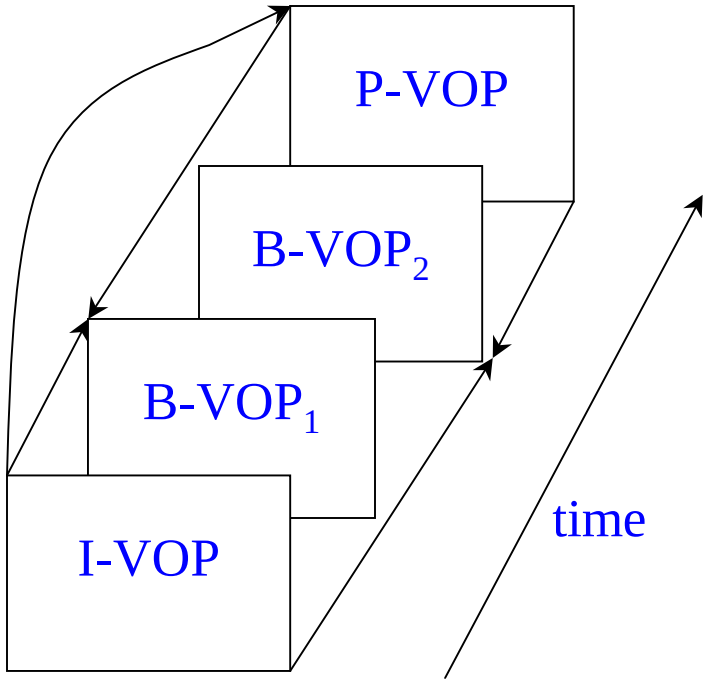
Visual Object

Visual Object Layer

Visual Object Plane

- **Object-based approach enables interactivity and streaming**
- **Each VOP contains motion, shape and texture data**

Motion Estimation



- **Spatial *and temporal* compression**
- **OoO processing increases memory and computation demand**

Popular Assumptions on MPEG4 Visual

- **Memory-streaming**
- **Bus-bandwidth limited**
- **Memory latency sensitive**
- **Adversely affected by larger image sizes**
- **Adversely affected by a greater number of images or layers**
- ***These are all intuitive and plausible!***

Experiment Environment

- **SGI O2 (R12000, 1MB L2C)**
- **SGI Onyx VTX (R10000, 2MB L2C)**
- **SGI Onyx2 InfiniteReality (R12000, 8MB L2C)**

L1 data cache	32KB, 2-way, 32B/line, LRU, WB
L2 unified cache	2-way, 128B/line, LRU, WB
System bus	64 bits, 133MHz, split transaction
main memory	4-way interleaved SDRAM, 680MB/s sustained, 800MB/s peak

Experiment Environment (2)

- **ISO reference software**
  - by EU ACTS Project MoMuSys
- **MIPS cc compiler at -O3**
- **SGI SpeedShop performance analysis package**
  - 2 hardware performance counters
  - 32 virtual counters via multiplexing
- **720x576 / 1024x768 pixels, 8 bits/pixel, 30 frames/s**

Fallacy #1: Data References in MPEG-4 Stream

		R12000	*R10000*	*R12000*
enc	*L1C miss rate*	0.08%	0.08%	0.08%
	L1C line reuse	1254.3	1287.9	1310.8
dec	*L1C miss rate*	0.37%	0.38%	0.35%
	L1C line reuse	268.7	264.1	288.1

(720x576 pixels, 1 VO, 1 VOL)

Fallacy #2: MPEG-4 Is DRAM Latency Sensitive

		R12000 1MB L2C	*R10000 2MB L2C*	*R12000 8MB L2C*
enc	*L2C miss rate*	32.62%	15.70%	7.28%
	DRAM time	2.4%	1.3%	0.2%
	prefetch L1 miss	41.4%	n/a	36.0%
dec	*L2C miss rate*	39.27%	19.31%	10.72%
	DRAM time	11.6%	6.6%	1.5%
	prefetch L1 miss	36.4%	n/a	45.2%

(720x576 pixels, 1 VO, 1 VOL)

Fallacy #3: MPEG-4 Is Hungry for Bus Bandwidth

		R12000 1MB L2C	*R10000 2MB L2C*	*R12000 8MB L2C*
enc	*L1-L2 b/w*	4.5	4.2	4.0
	L2-DRAM b/w	4.9	2.7	1.9
dec	*L1-L2 b/w*	18.9	18.3	22.4
	L2-DRAM b/w	24.3	14.9	9.8

in MB/s

(720x576 pixels, 1 VO, 1 VOL)

Fallacy #4: MPEG-4 Memory Performance Degrades w/ Growing Image Size

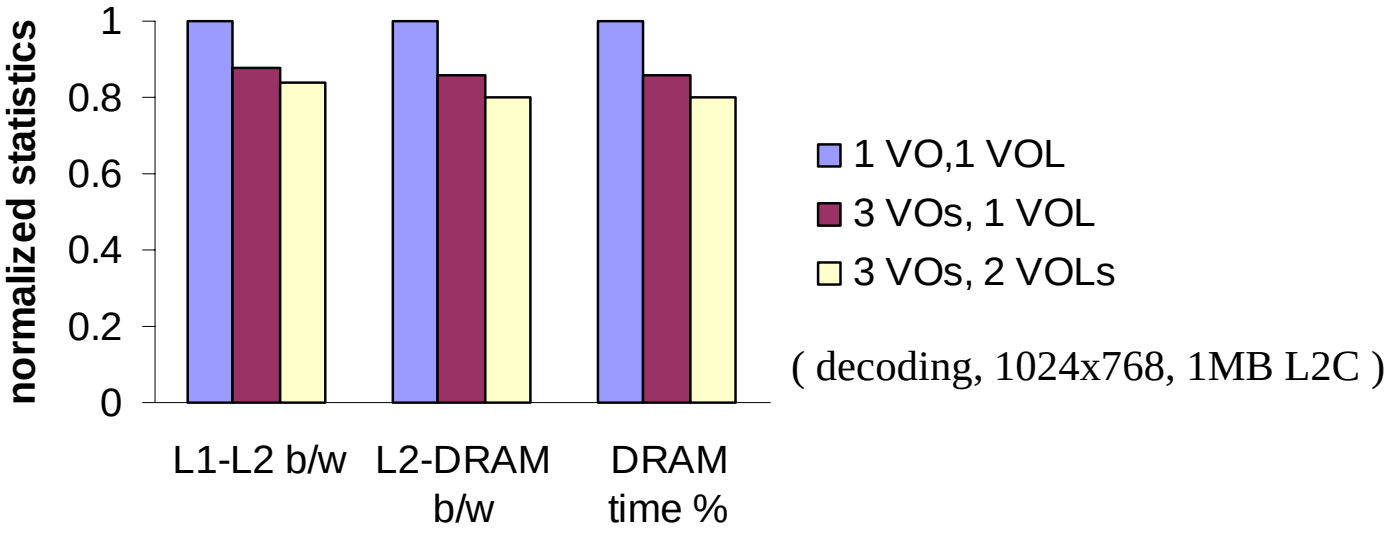
- **When image size is increased to 1024x768 (1.9X)**
  - Memory performance remains almost the same
  - In several cases it actually *improves:*

	720x576	*1024x768*
L2C miss rate	39.27%	36.48%
DRAM b/w (MB/s)	24.3	24.0
DRAM stall time	11.6%	11.3%

(decoding, L2C=1MB, 1 VO, 1 VOL)

Fallacy #5: MPEG-4 Memory Performance Degrades w/ Increased Number of VOs and VOLs

- **As the number of VOs and VOLs is increased**
  - Memory performance does not change noticeably
  - It can get *better:*



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Conclusions and Future Work

- **MPEG-4 visual has good memory performance**
  - High L1C hit ratios
  - High cache line reuse
  - Low bus b/w requirements
  - Low main-memory stall time
- **Future Work**
  - With SIMD ISA extensions
  - Other representative platforms
    - IA32, IA64, Power4, …
    - Software simulation