Low Power Techniques for Massive Data Rate Multiview Video Coding

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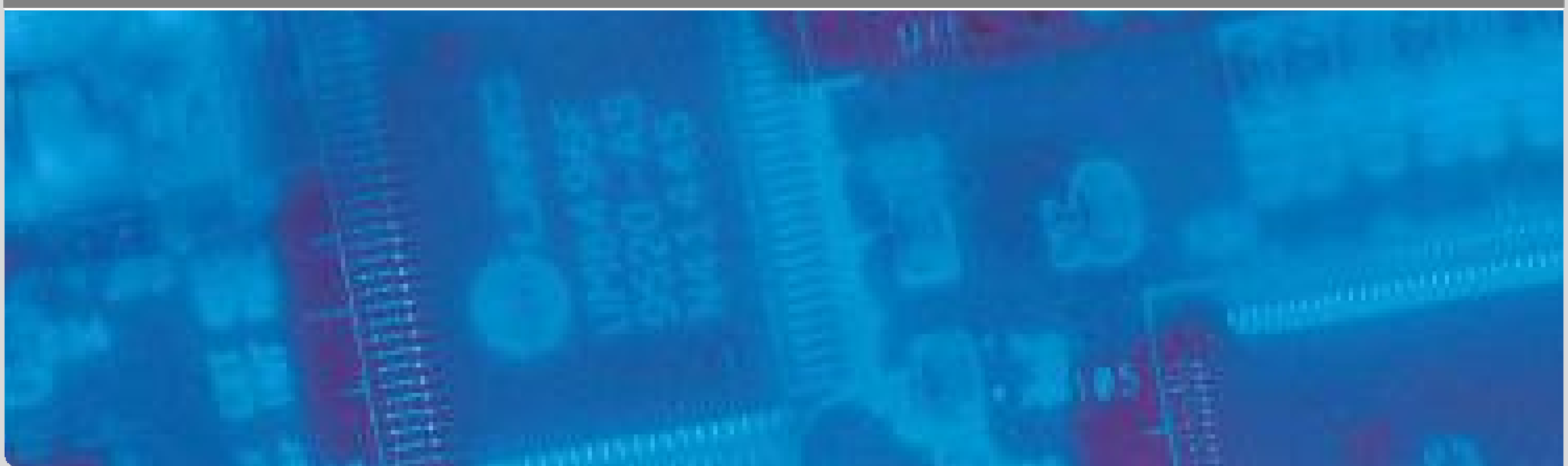

Outline

- Introduction and Basics
- Multiview Video Coding
- Challenges: Performance, Memory, Energy/Power
- Low-Power Algorithms for MVC
- Low-Power Architectures for MVC
- VideoArch^{3D}- A Joint Collaborative Project between KIT and UFRGS (PROBRAL)
- Conclusion

Introduction

- Increasing trend of devices with 3D-video
- Encoding and decoding features
  - 3D personal recording, 3DTV, FTV, Immersive Teleconferencing
- Growing number of views
  - Currently: 2 views
  - Expected:
    4 - 8 views: PCS'10 panel sessions
    16 - >100 views: IEEE Themes'11
- Multiview Video Coding (MVC)
  - 20-50% better compression and quality
  - 10-19x increased computational complexity and energy
  - Expanded mode decision space due to inter-view dependencies and prediction
  - HW acceleration is required!!!

Ref: Mercedes, Panasonic, Sony, Nintendo, Minox, LG, Fujifilm, Mitsubishi

Digital Video Basics

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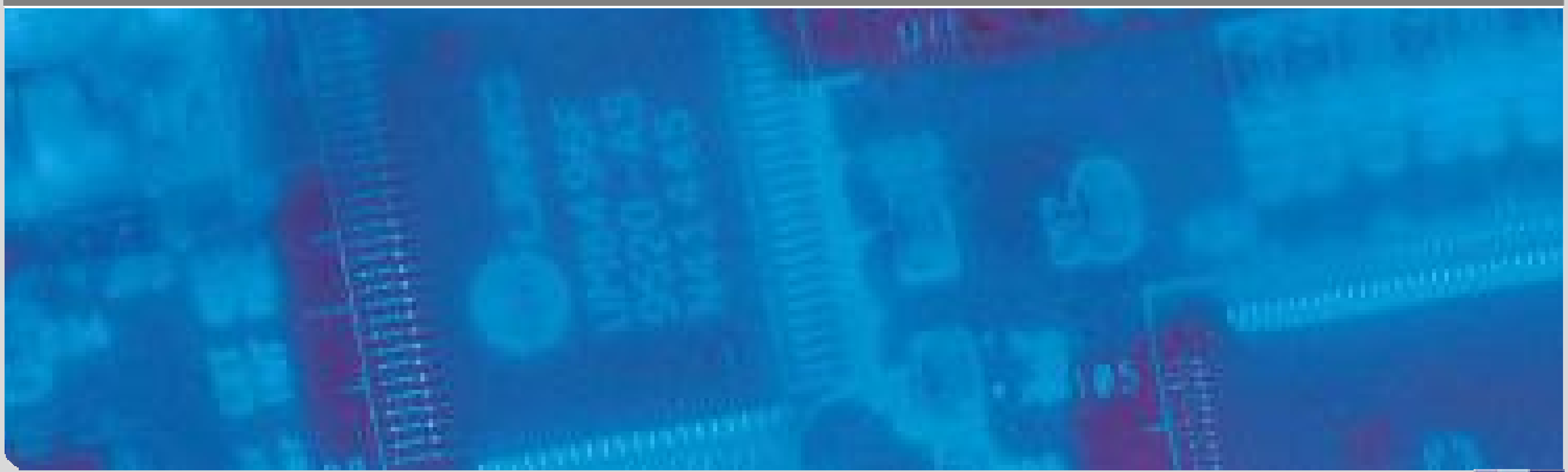

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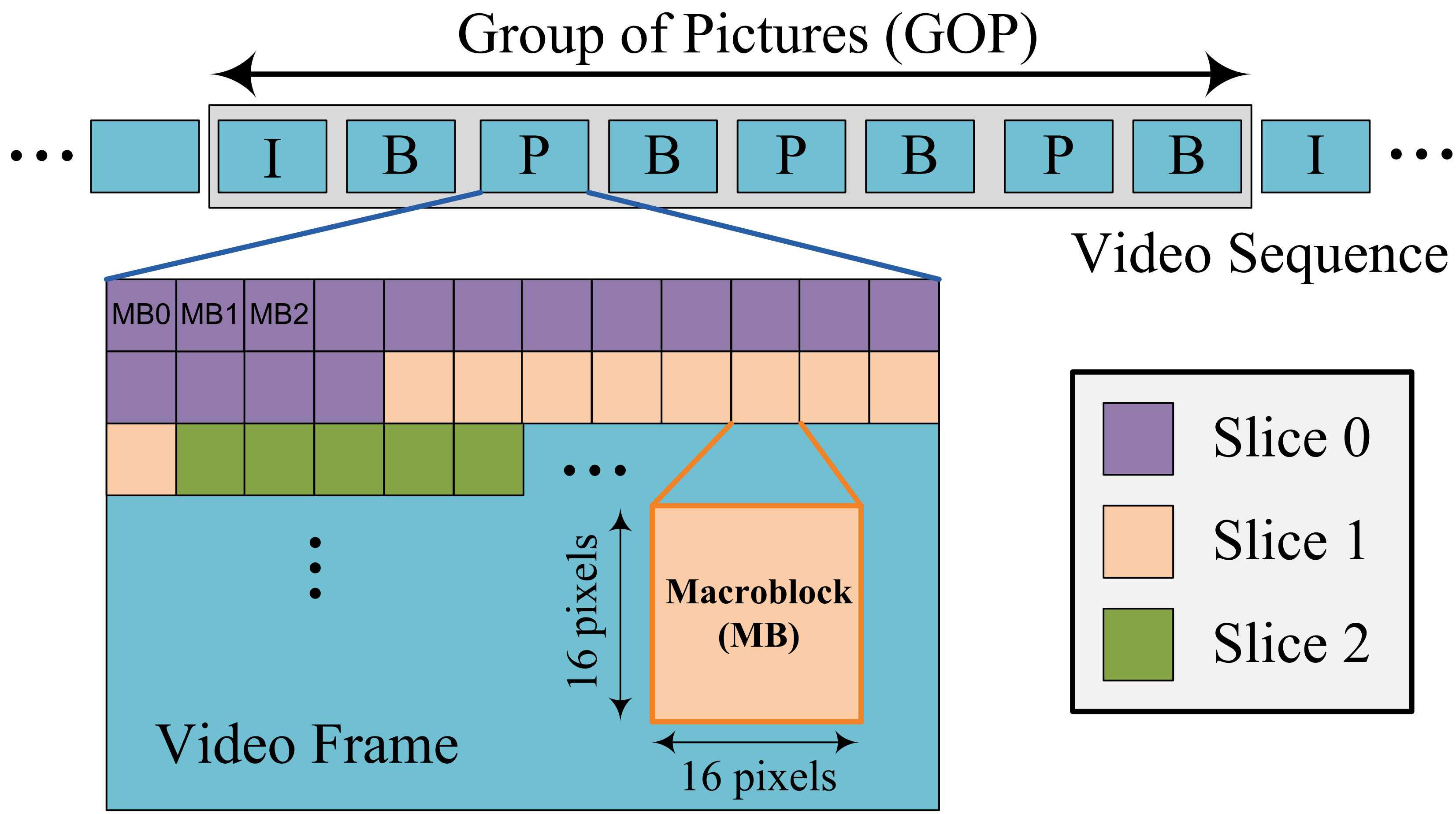
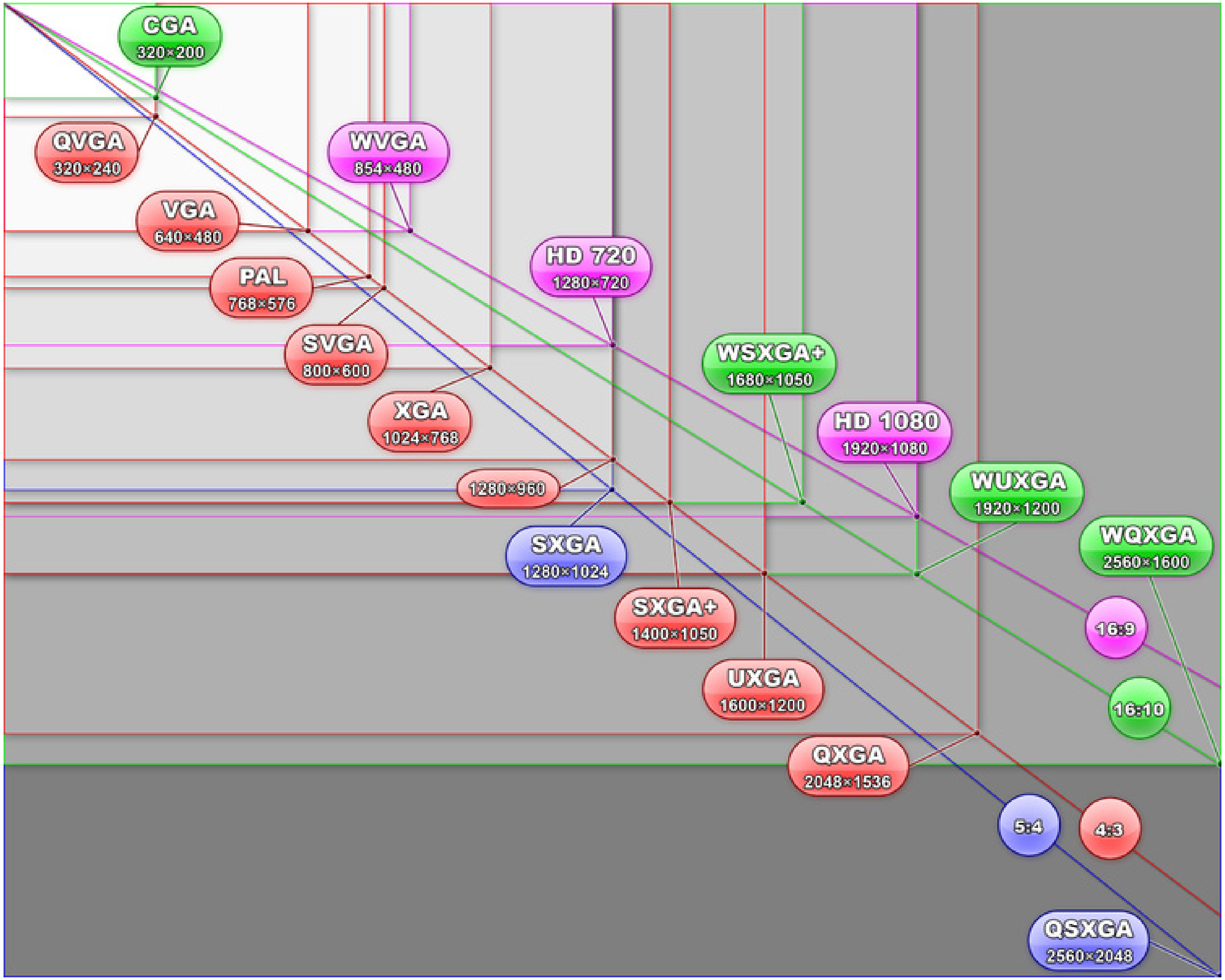
Digital Videos: Terminology



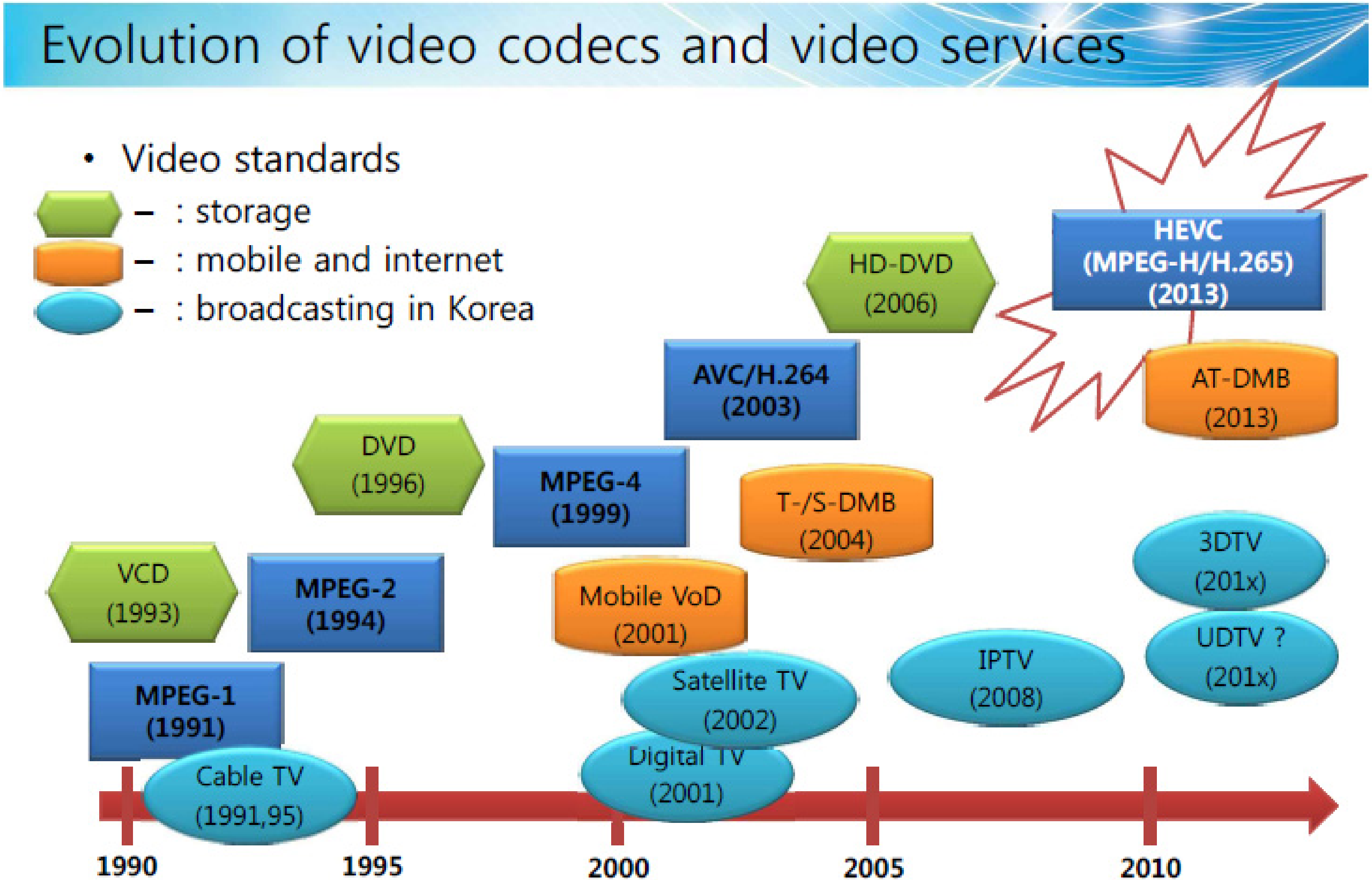
Trends in Video Resolutions

- Quad-HD
- Super Hi-Vision 7K videos
- …



Src. Wikipedia, Matrix, Pdurland

Digital Video Coding



Sim, Donggyu 2011: High Efficiency Video Coding(HEVC)

Scaling Trends

- Spatial Scaling
  - HD1080p → QuadHD (4Kx2K pixels) → 7K videos
- Pixel-Accuracy Scaling
  - higher pixel data representations from 8-bit to 16 bit pixel representation to realized high-dynamic range videos
- Temporal Scaling
  - 30fps → 60fps → 120fps
- Camera View Scaling
  - Mobile devices: 2→4→8 views
  - High-end devices: 8→16→>100

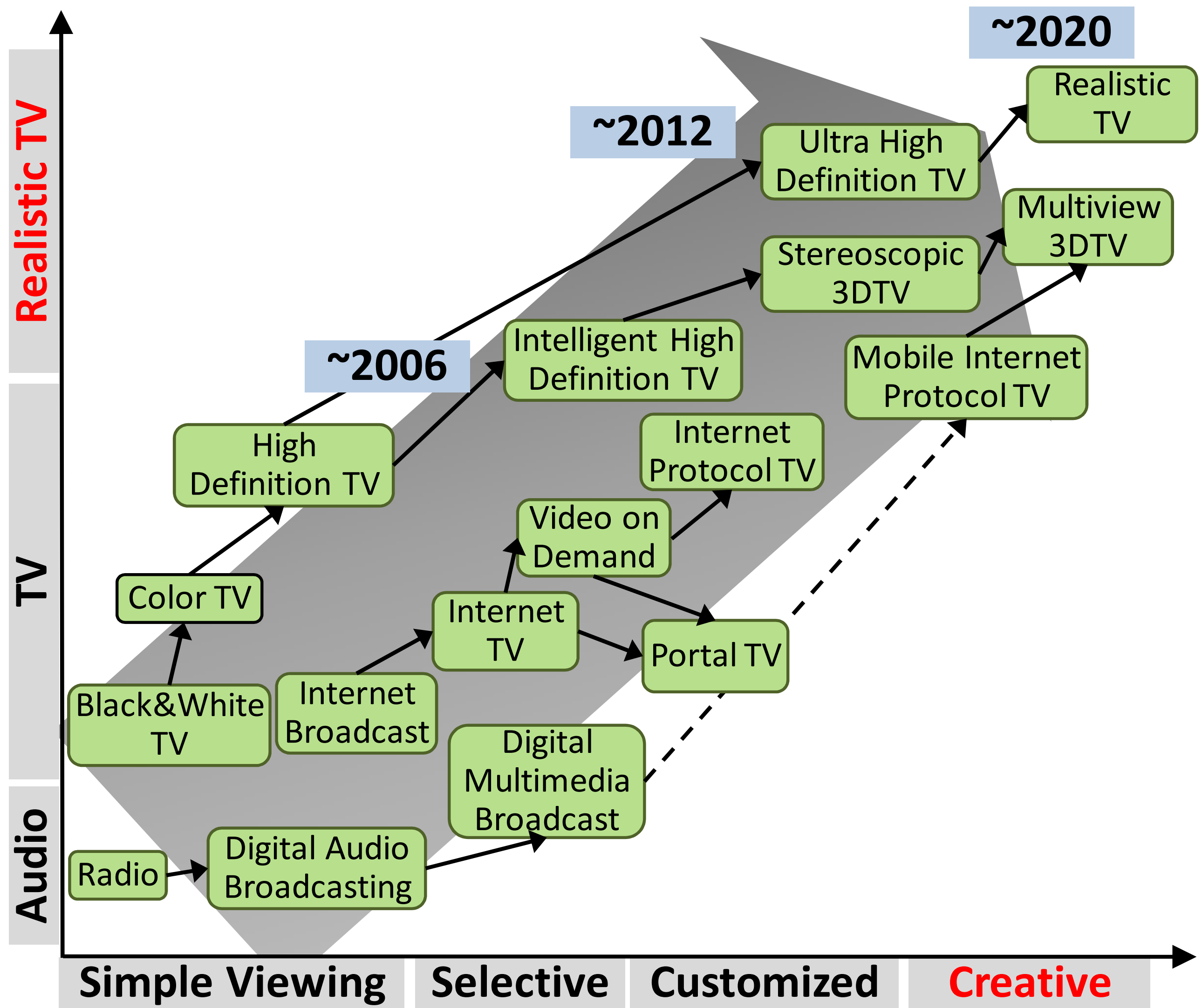
  => Massive Data Rate Processing

  - On-demand streaming of multiple views

Emerging Application Scenarios

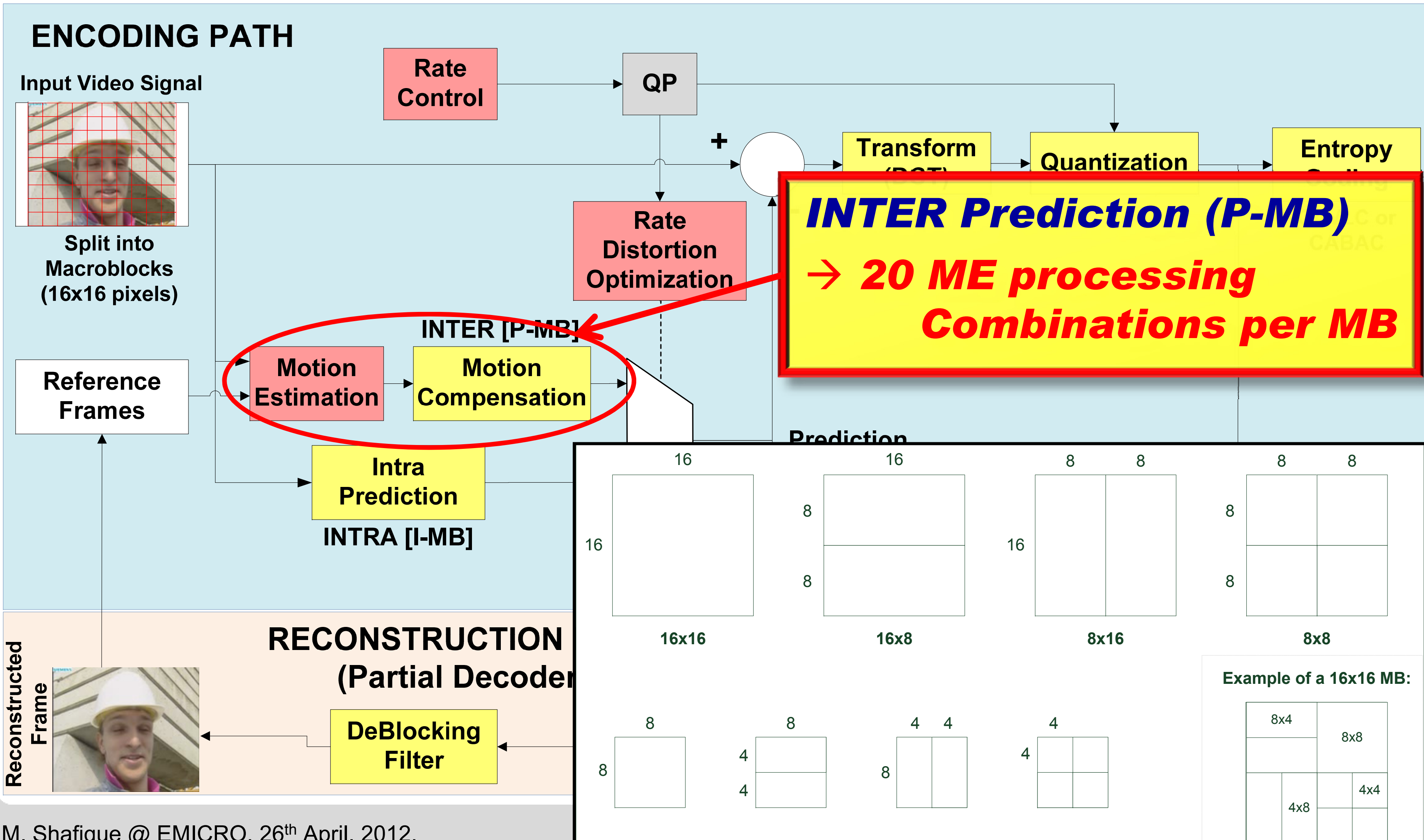
- Free-View Point TV (FTV), Realitic-TV, True-3D-TV, etc.
- 3D-surveillance, immersive video conferencing, etc.
- Multiview personal video recording and playback
- Telepresence, tele-office, tele-work, tele-shopping, etc.
- Telemedicine, Teleoperation theaters
- Real time conversational services (video phone)
- Audiovisual communication over mobile networks
- Video storage and retrieval services (video on demand)
- …

Video Services Over Time

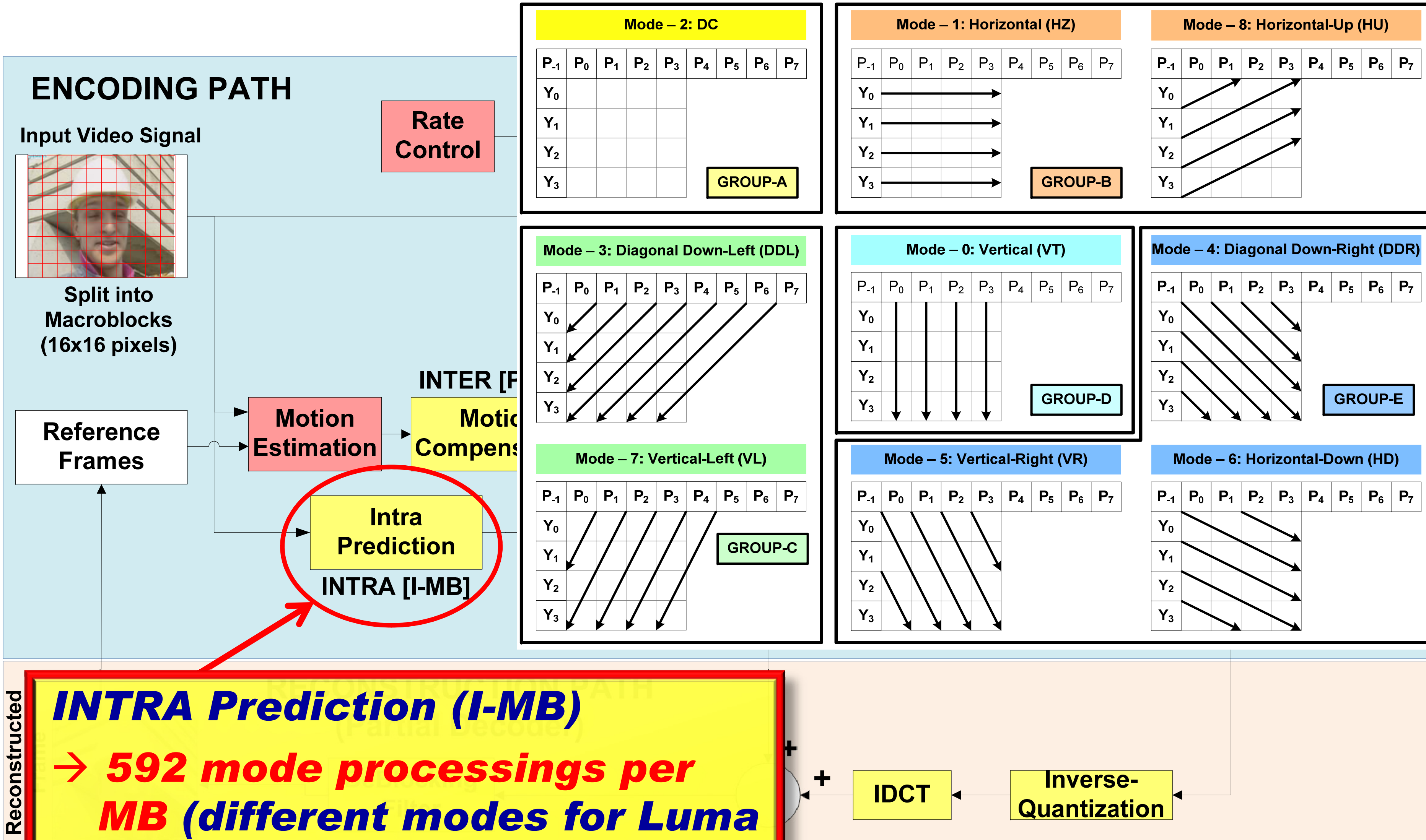


Hui Yong Kim, "Next generation video coding standardization, 2010

Issues in H.264/MPEG-4 AVC Video Encoder



Issues in H.264/MPEG-4 AVC Video Encoder



INTRA Prediction (I-MB)

→ 592 mode processings per MB (different modes for Luma and Chroma)

Karlsruhe Institute of Technology

Multiview Video Technologies

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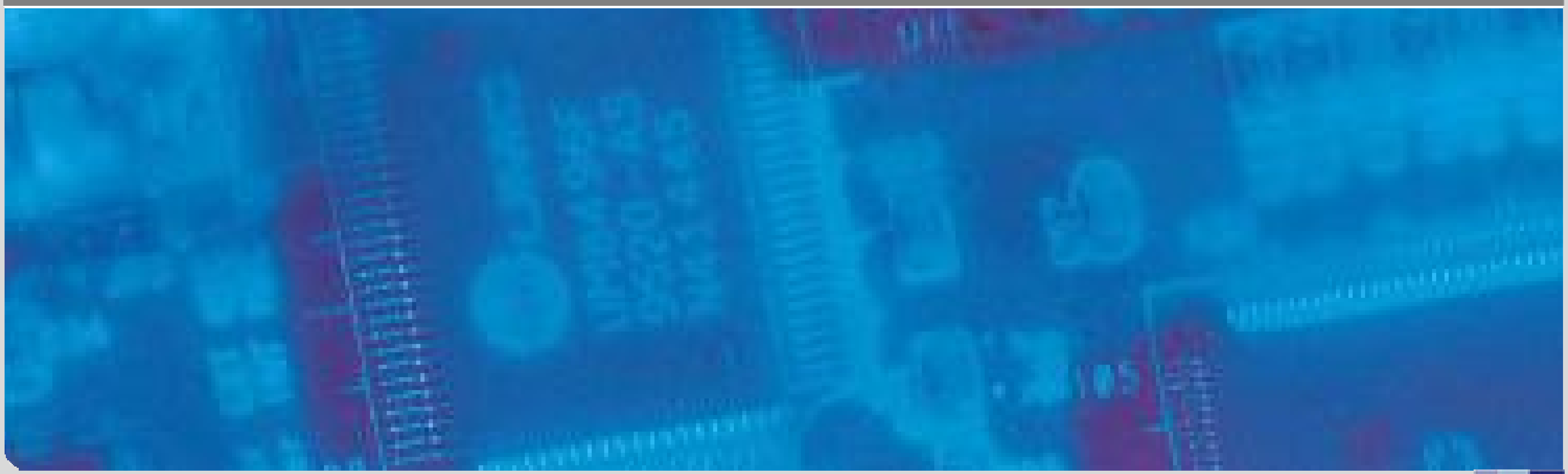

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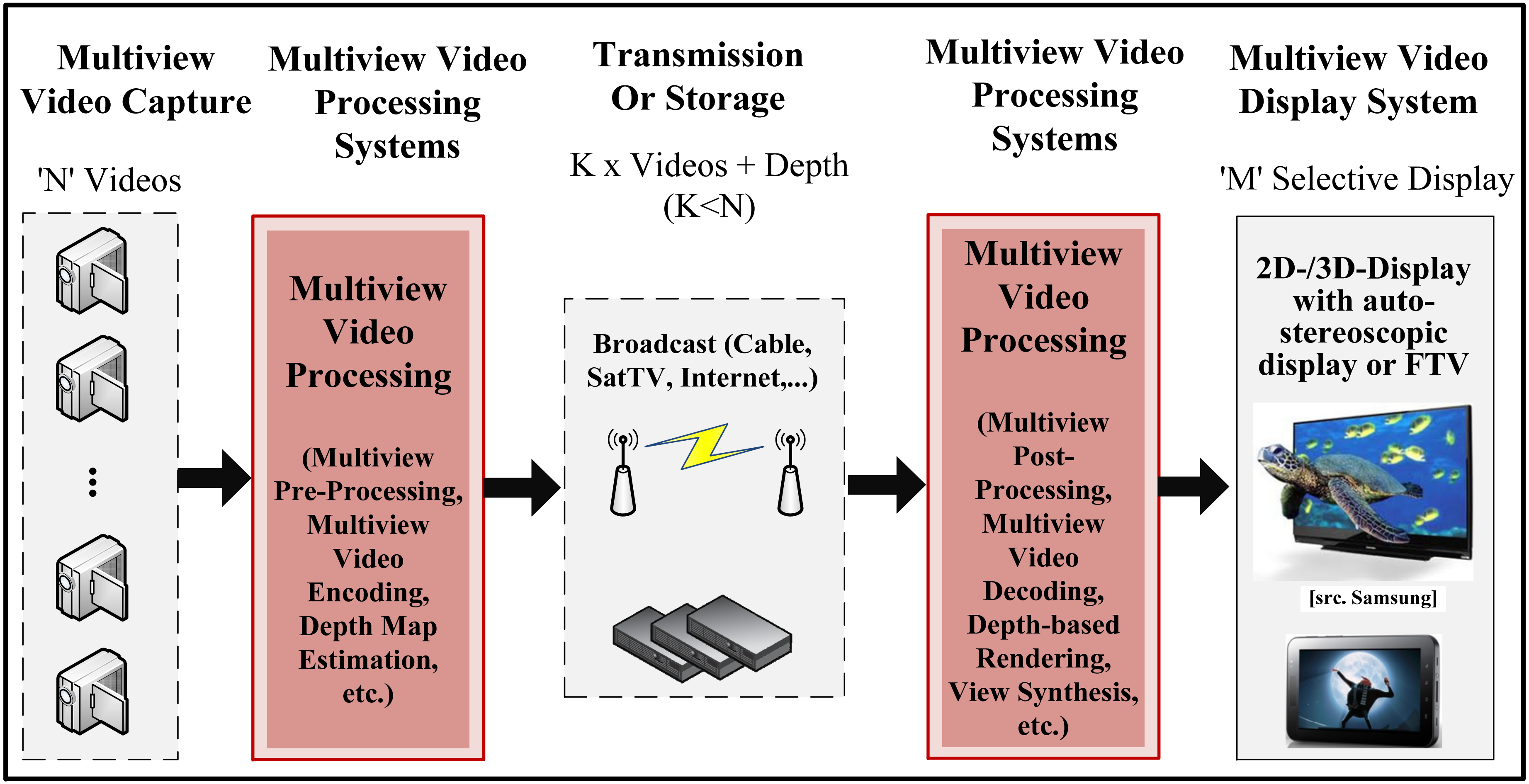
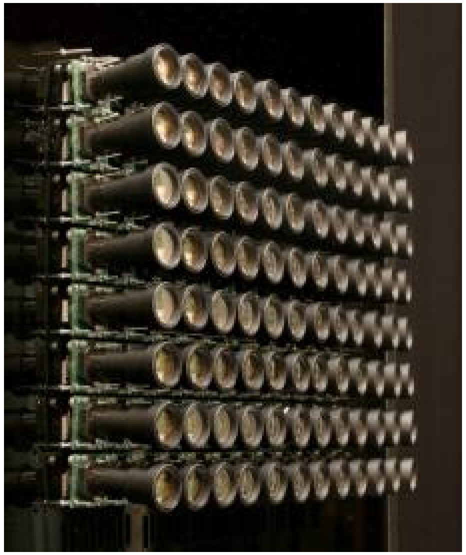
Multiview Video Processing System



Multiview Video Acquisition

- Array of multiple synchronized cameras
- One producer PC has implemented PCI card to synchronize all cameras
- Arbitrary arrangement of cameras
- Densely-spaced linear alignment of cameras
    - Hard calibration procedures

Multiview Video Encoding

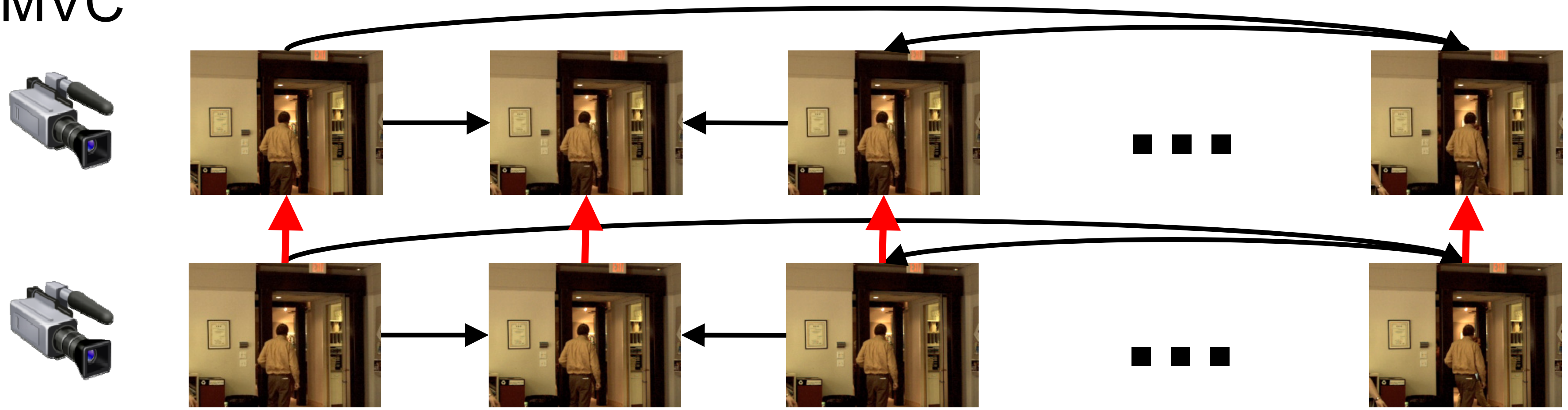
- Huge amount of raw video data to be encoded for transmission
- Video coding approaches
  - Simulcast: video streams are encoded individually with existing video coding standards (e.g. H.264)
  - Multiview video coding (MVC)
    - Based on H.264/AVC standard
    - Provides random access and bit-stream switching, stream adaption, buffer management, parallel processing of different views, etc.
    - MVC structure combines inter-view and temporal prediction

Multiview Video Encoding

Simulcast vs. MVC

- 20-50% higher coding gains [Merkle,2007]
- Enormous complexity increase
  - Multiple block-sized Motion and Disparity Estimation

MVC

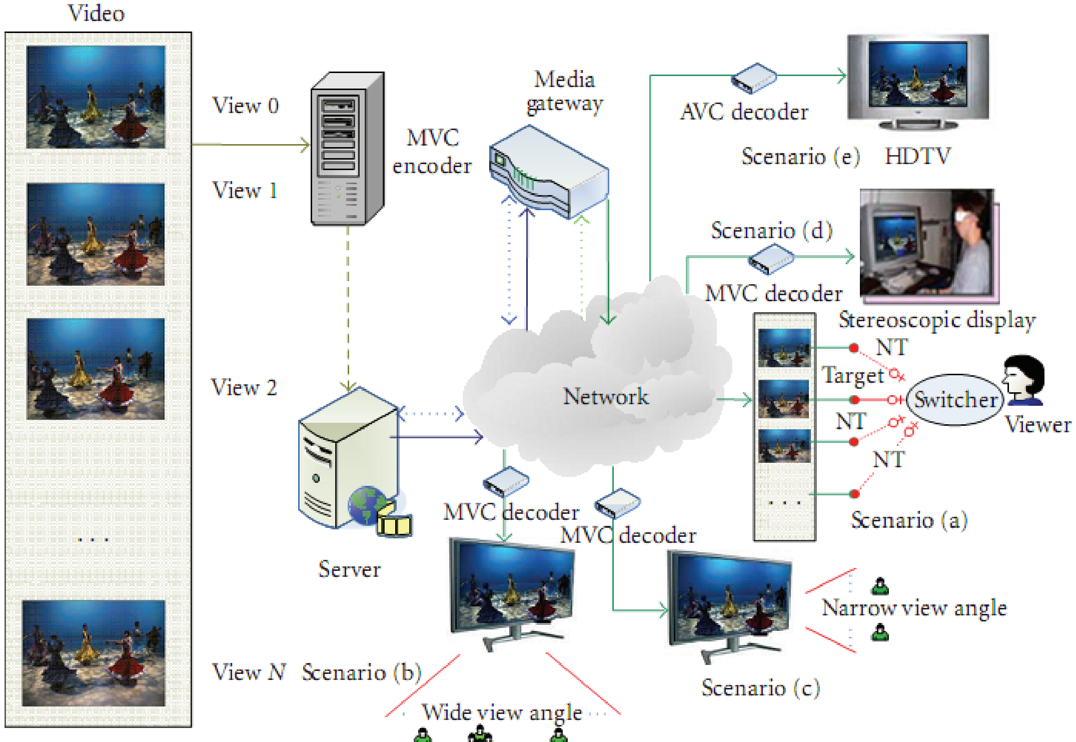


Multiview Video Transmission

- High quality 3D TV broadcasting requires transmission to multiple users simultaneously
- MVC has layered approach → suitable for independent transmission of each layer over broadcast

Multiview Video Decoding

- Receiver side generates the appropriate views
  - Decoded only needed views → depends on the type of display (how many views can provide a display and which ones)
- Viewpoint generation

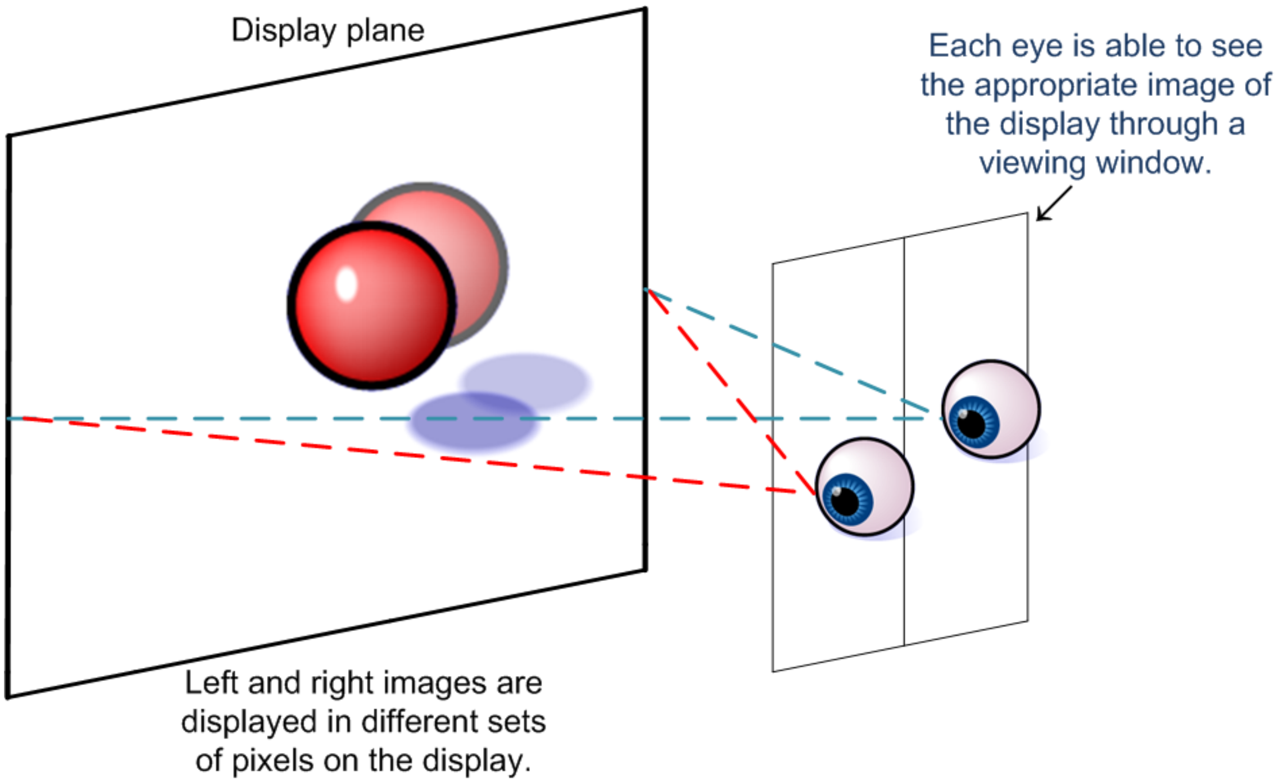


[Chen, 2009] Y. Chen, et al. The Emmerging MVC Standard for 3D Video Services. EURASIP Journal on Advances on Video Processing. 2009.

Multiview Video Displaying

- Stereoscopic 3D display → 2 views glasses
- Autostereoscopic 3D display → 2 views w/ support of glasses
- Multiview 3D display
  - Head tracking (2views, 1 observer)
  - Multiple views (multiple observer, multiple viewpoints)
  - Holography
- Design approaches stereo/multiview displays
  - Autostereoscopic display (parallax barrier, lenticular)
  - Head-tracked two-view display
  - Multi-view display
- Natural view perception → infinite number of views

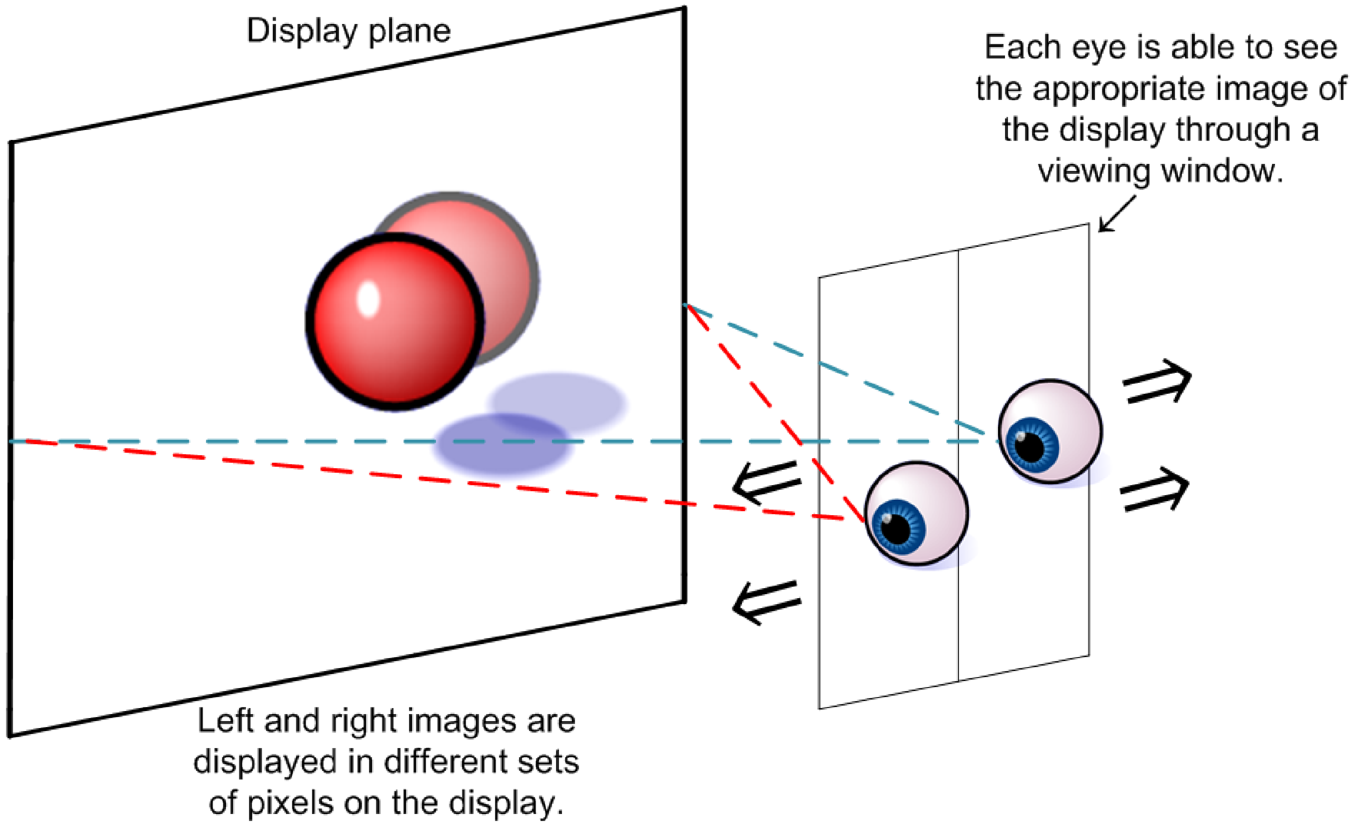
Autostereoscopic Display



- Two different views of the scene where each is appropriate only for the corresponding viewer's eye → otherwise pseudoscopic image
- Provide only binocular parallax

Nick Holliman, “Auto-stereoscopic 3D Display Designs”

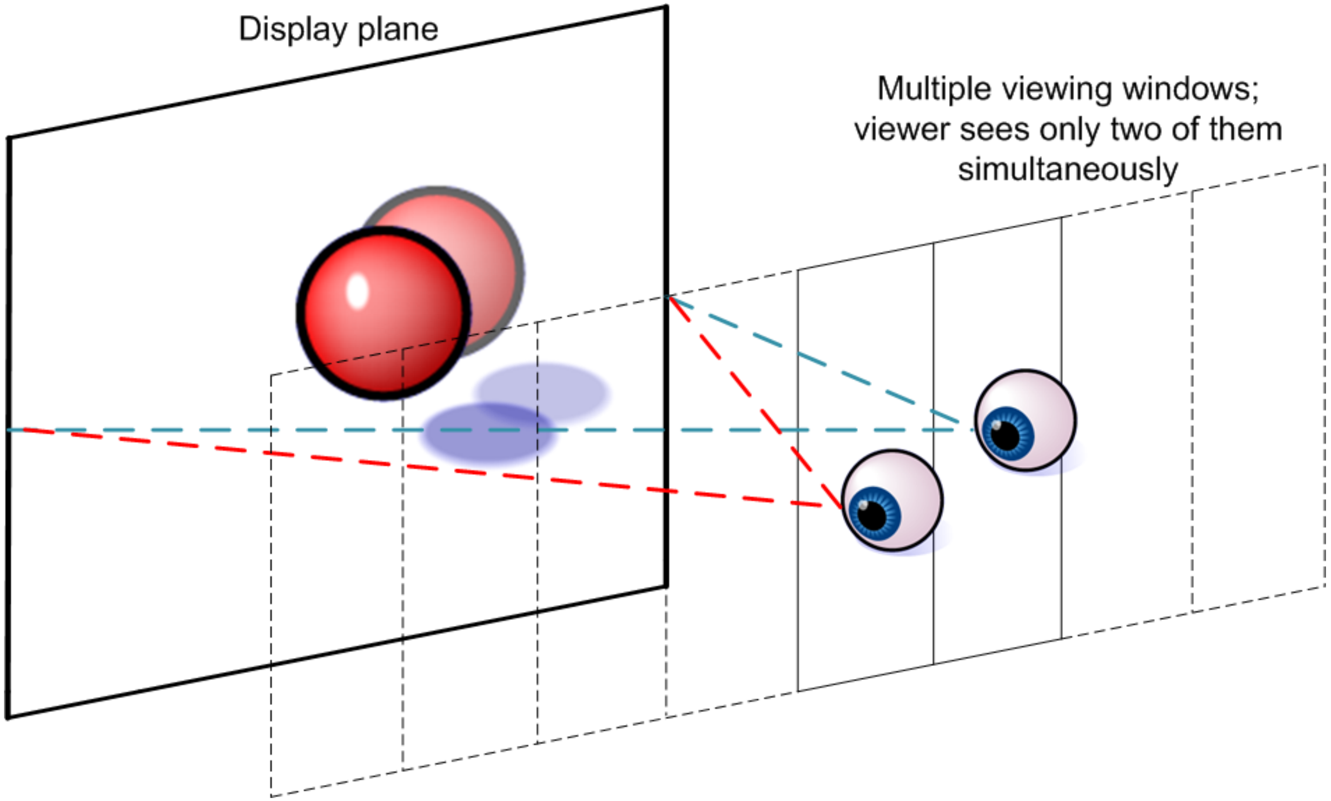
Head-Tracked Stereo Display



- Two-views of a scene at once
- Require a viewing window steering mechanism in the display for and head-tracking mechanism linked to it to detect viewer's head → motion parallax
- Available only for one viewer

Nick Holliman, "Auto-stereoscopic 3D Display Designs"

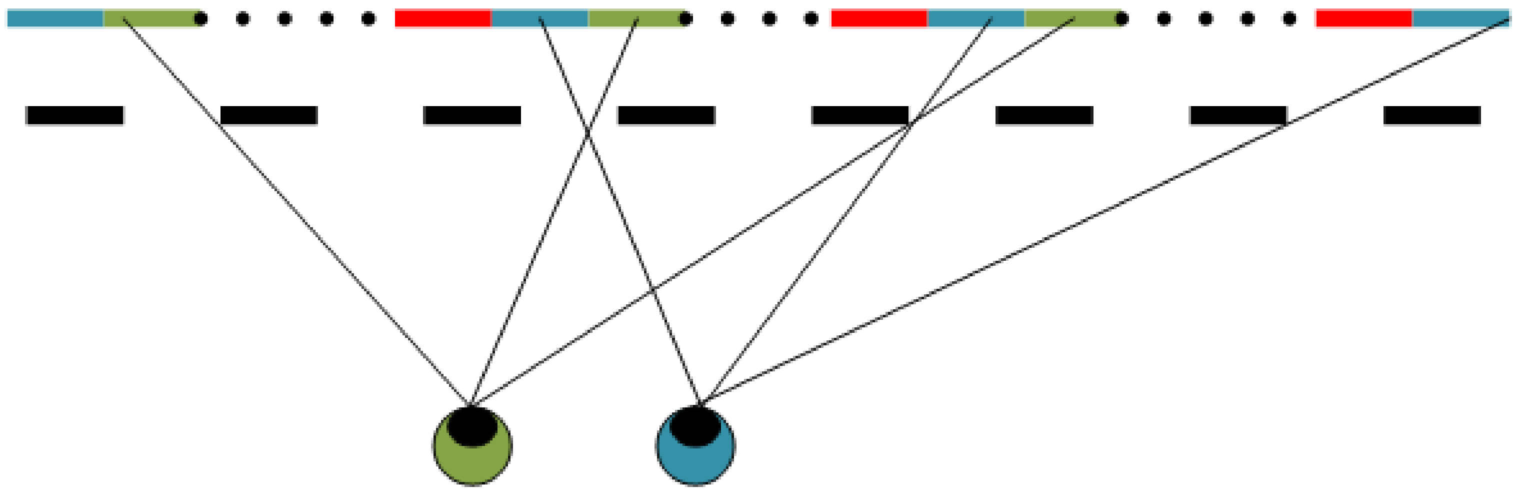
Multiview Display



- Multiple viewing windows (typically 8 – 16 views) each simultaneously visible → one viewer sees only two of them at once
- Wide viewing freedom

Nick Holliman, "Auto-stereoscopic 3D Display Designs"

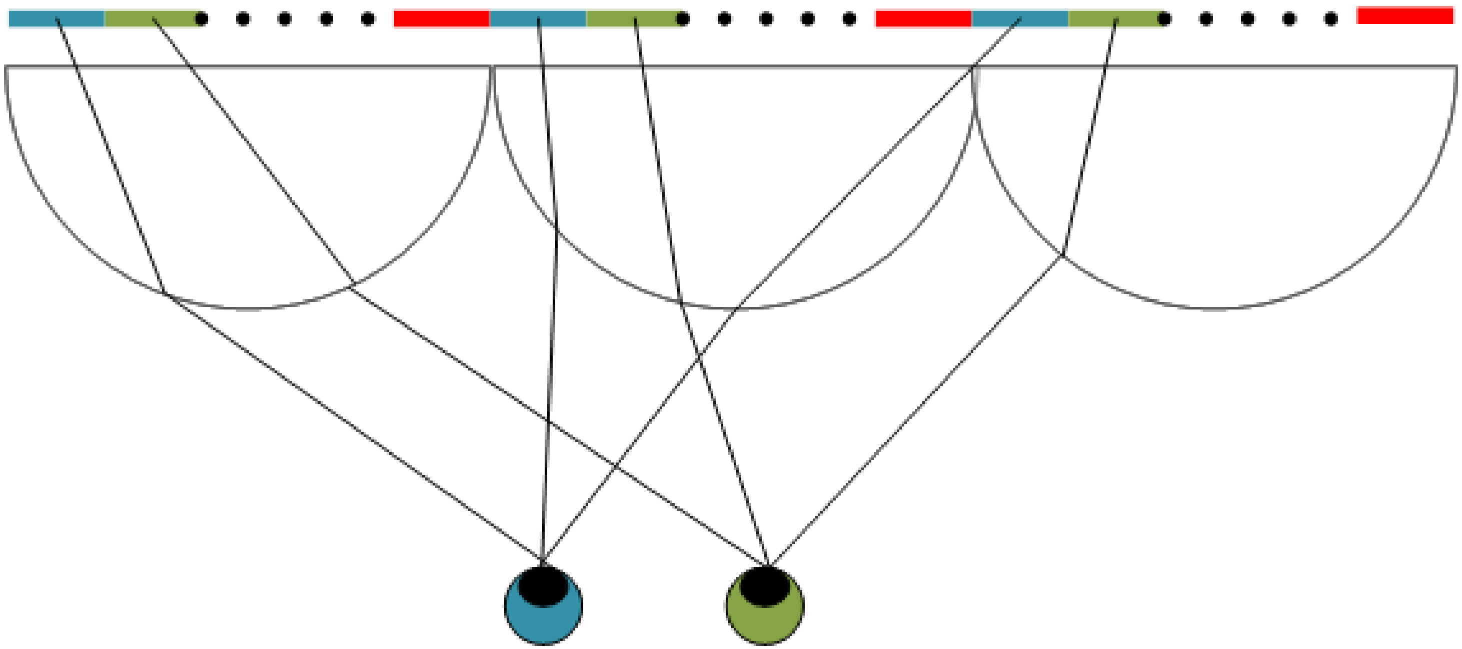
Parallax Display



- Window width set to average viewer‘s eye separation (65 mm)
- Each pair of left and right view pixels visible at the center of the viewing window
- Parallax barrier placed
  - behind the display → lower crosstalk performance
  - In front of the display → better utilization of a viewing-window and more uniform intensity

Nick Holliman, “Auto-stereoscopic 3D Display Designs”

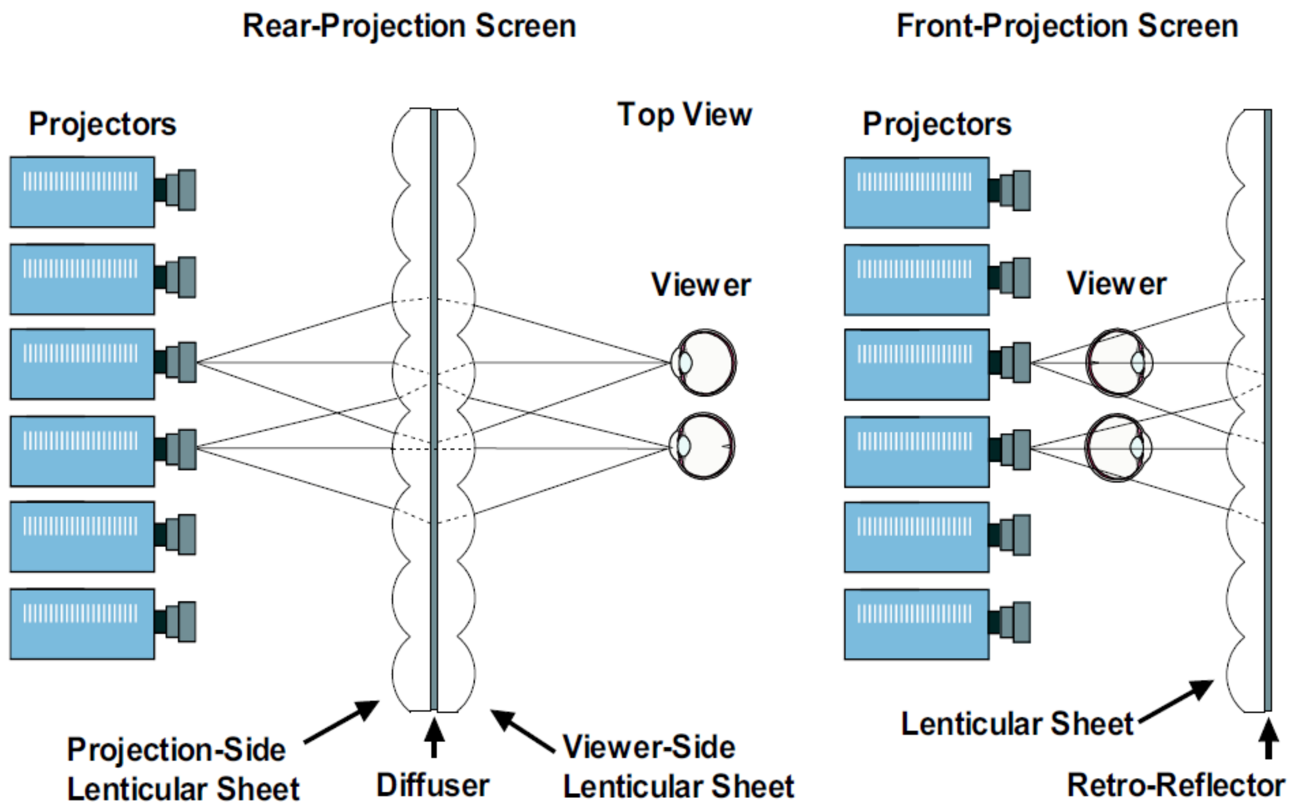
Lenticular Display



- Lenticular sheet → a linear array of narrow cylindrical lenses called lenticules that acts as a light multiplexer
- Lenticules direct diffuse light from a pixel and it can only be seen in a limited angle in front of a display
- Lenticules disturbingly magnify the underlying display's pixel structure → dark zones between viewing slots

Nick Holliman, “Auto-stereoscopic 3D Display Designs”

Multi-Projector Display



- Rear-projection system → two lenticular sheets mounted back-to-back with optical diffuser material in the center
- Front-projection system → only one lenticular sheet with retro-reflexive front-projection screen material mounted in the back

Nick Holliman, “Auto-stereoscopic 3D Display Designs”

MVC: Multiview Video Coding Standard

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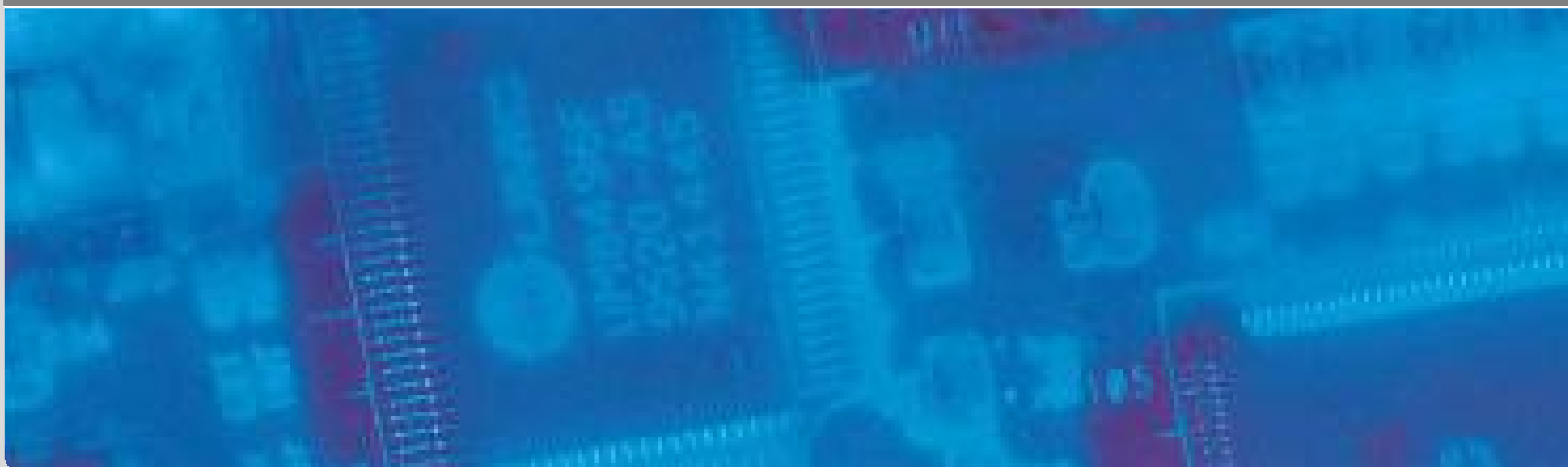

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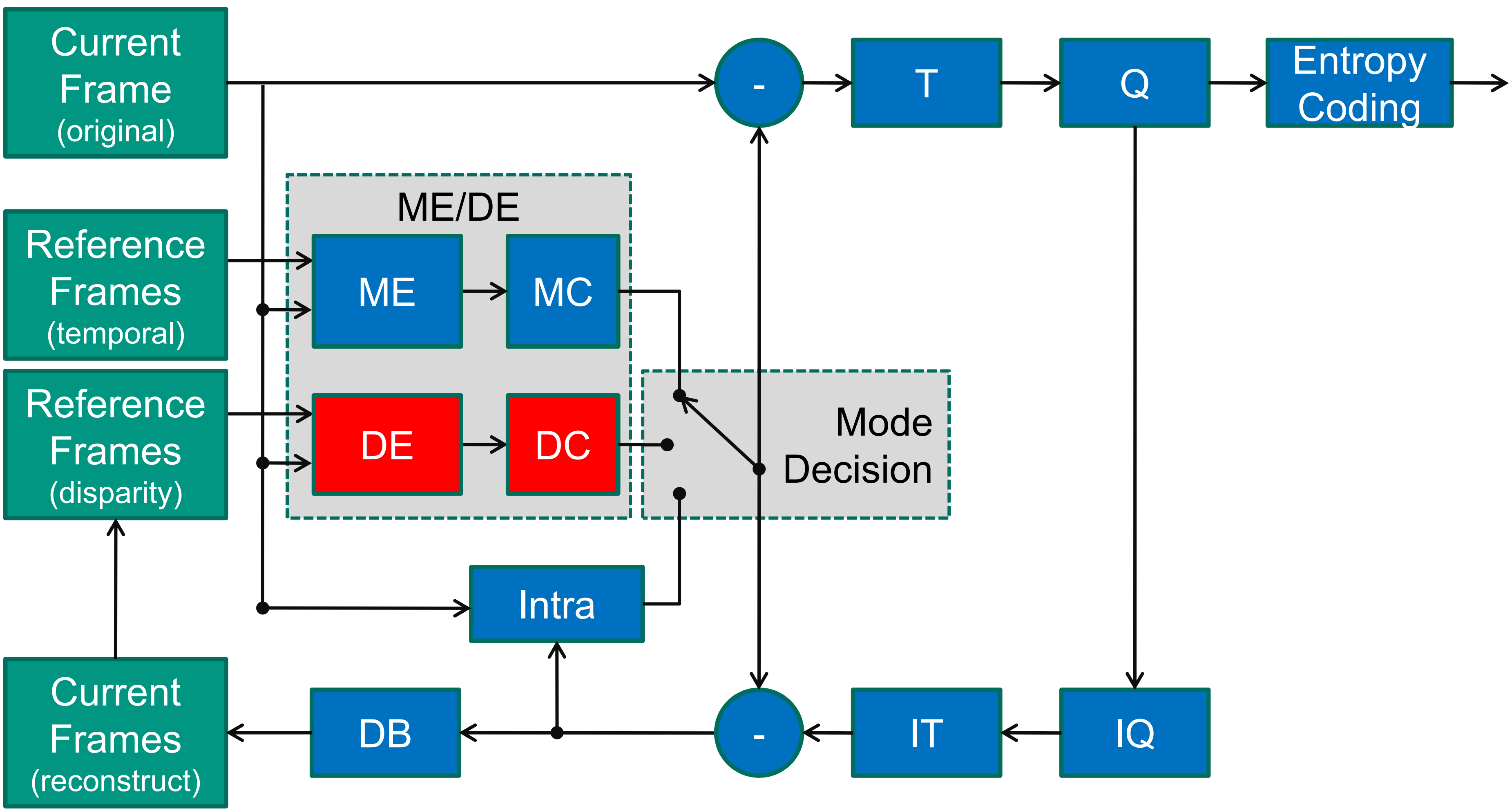
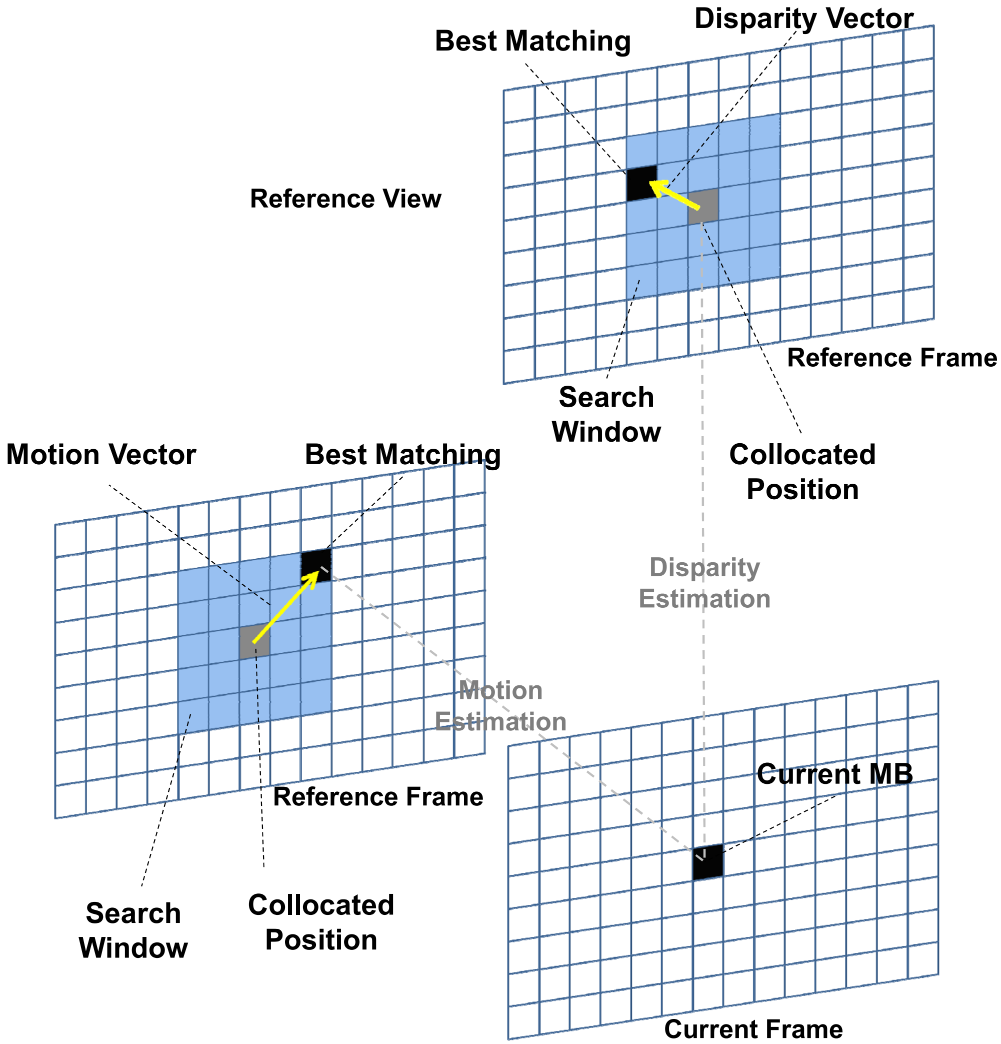
MVC Encoder based on H.264



Motion and Disparity Estimation

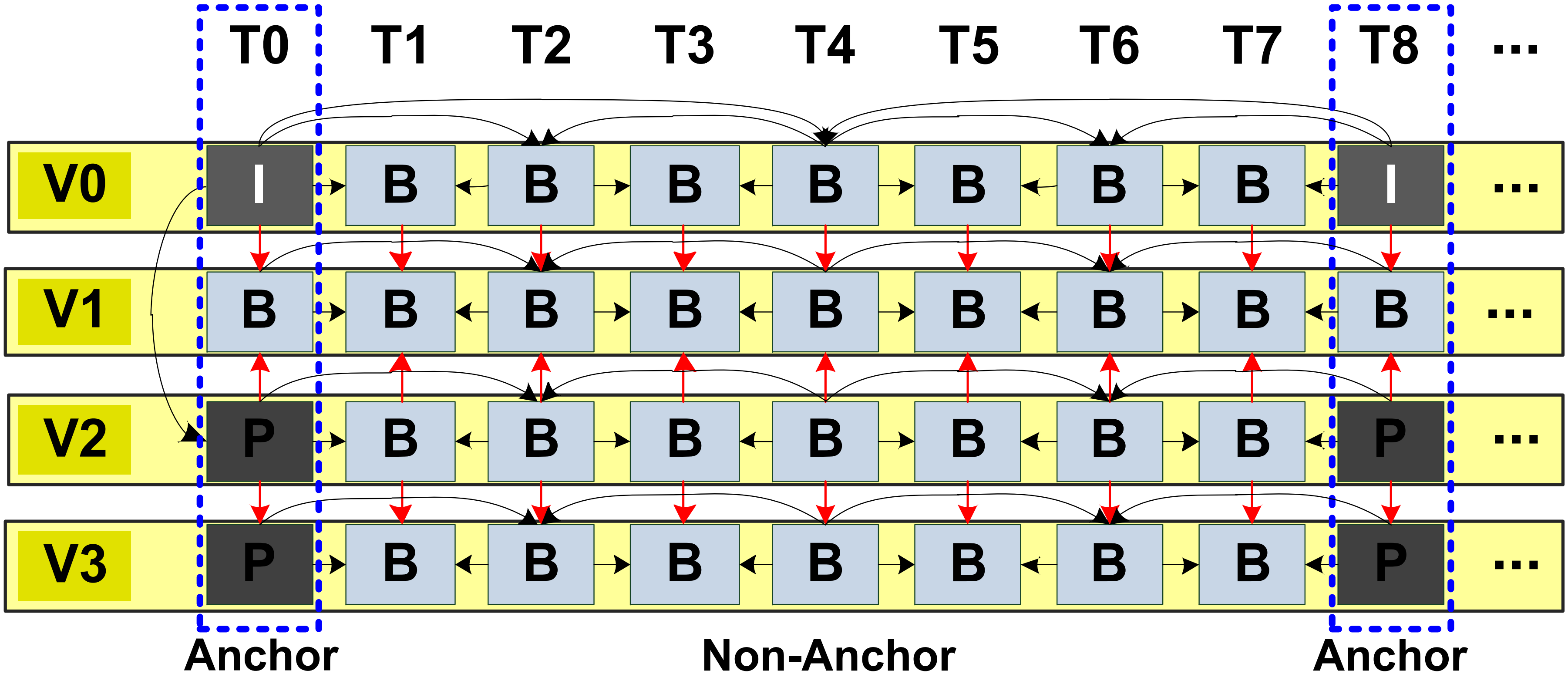


- Search a good matching block in reference frame/view
- FS, DS, TSS, EPZS, UMHex, TZ
- SAD, SATD, SSE

$$SAD = \sum_{i=0}^{w} \sum_{j=0}^{h} Abs(O_{(i,j)} - R_{(i,j)})$$

- Motion/Disparity Vectors (MV, DV)
- Optimal Full Search
- Fast Algorithms
- ME/DE present distinct search behavior
- DE tends to require more search steps and find longer vectors

Encoding Structure



MVC Mode Decision

- The mode decision targets the reduction of Rate-Distortion cost (RDCost)

$$J = RDCost(c, r, Mode|QP) = D(c, r, Mode|QP) + \lambda_{Mode} * R(c, r, Mode|QP)$$

- D → Distortion
  - SSE, SATD, SAD measured after complete coding & reconstruction
- R → Rate
  - Number of bits to encode the macroblock (MB – 16x16 samples)
- λ → Lagrange Multiplier
  - Depends on the Quantization Parameter (QP = (0...51))
- Optimal/Exhaustive solution is called RDO (Rate-Distortion Optimization), test all possible coding modes
- All Intra-frame, Inter-frame and Inter-view prediction modes

MVC Challenges
(Performance, Memory, Power/Energy)

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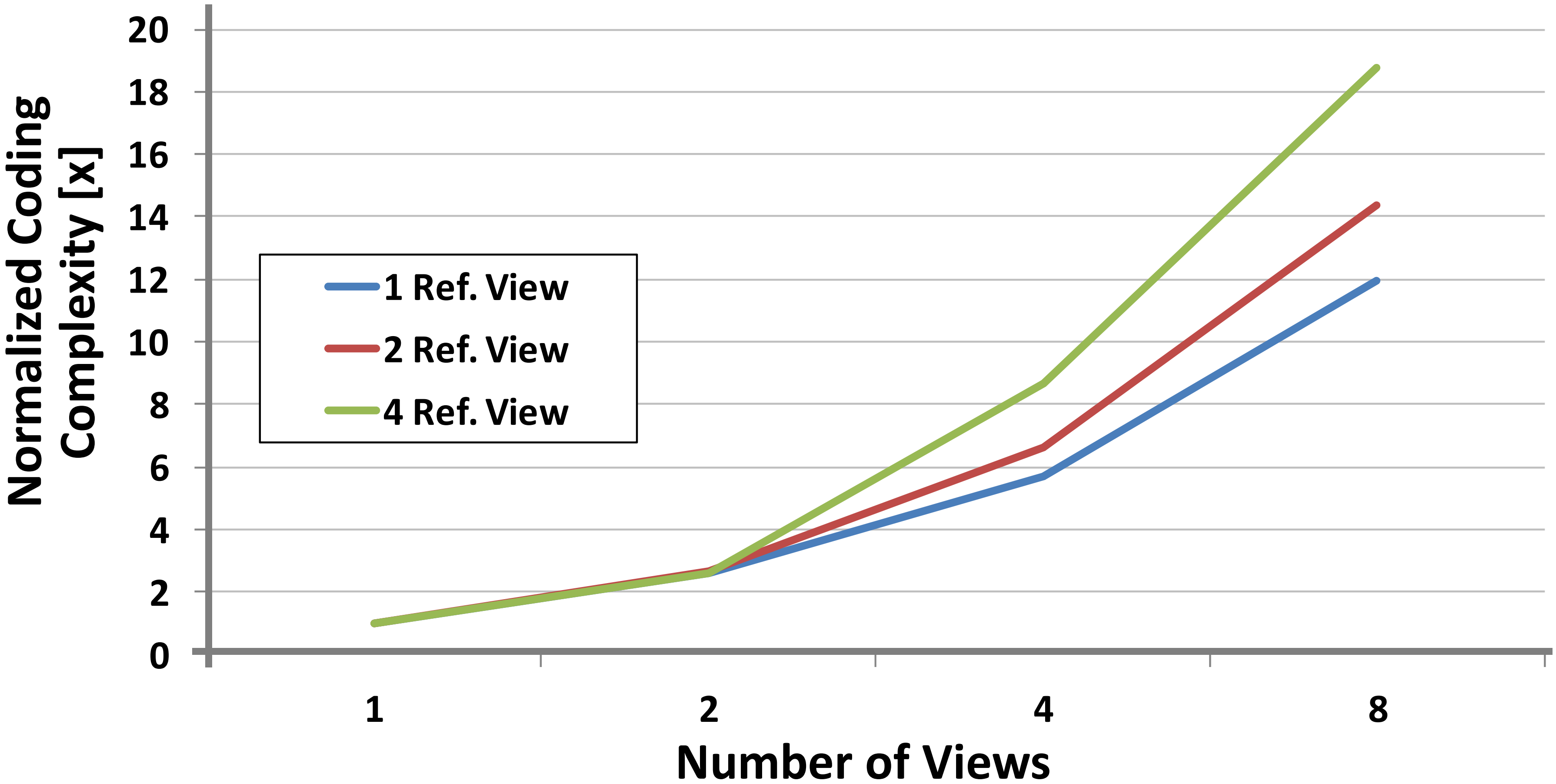
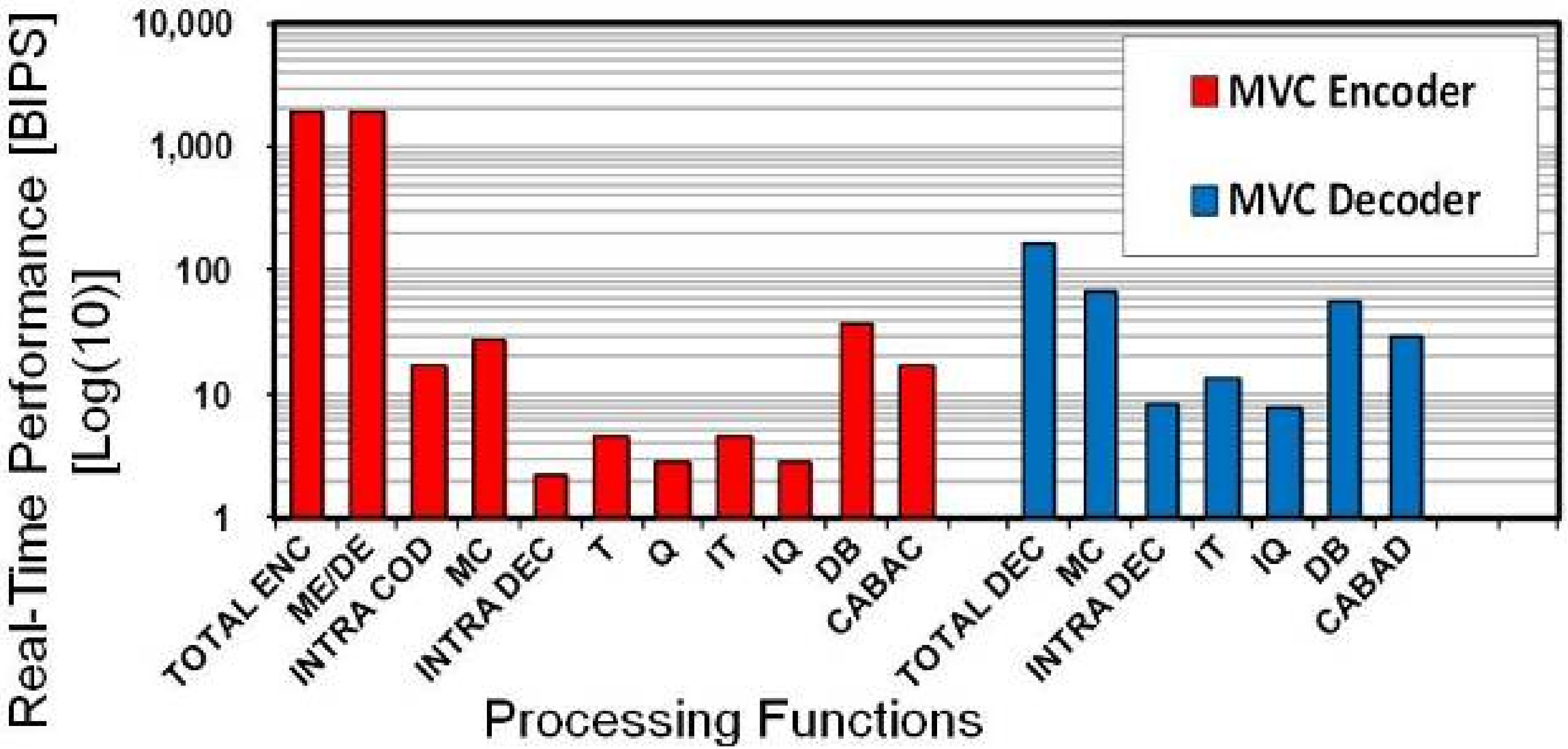
Computational Complexity – ME/DE

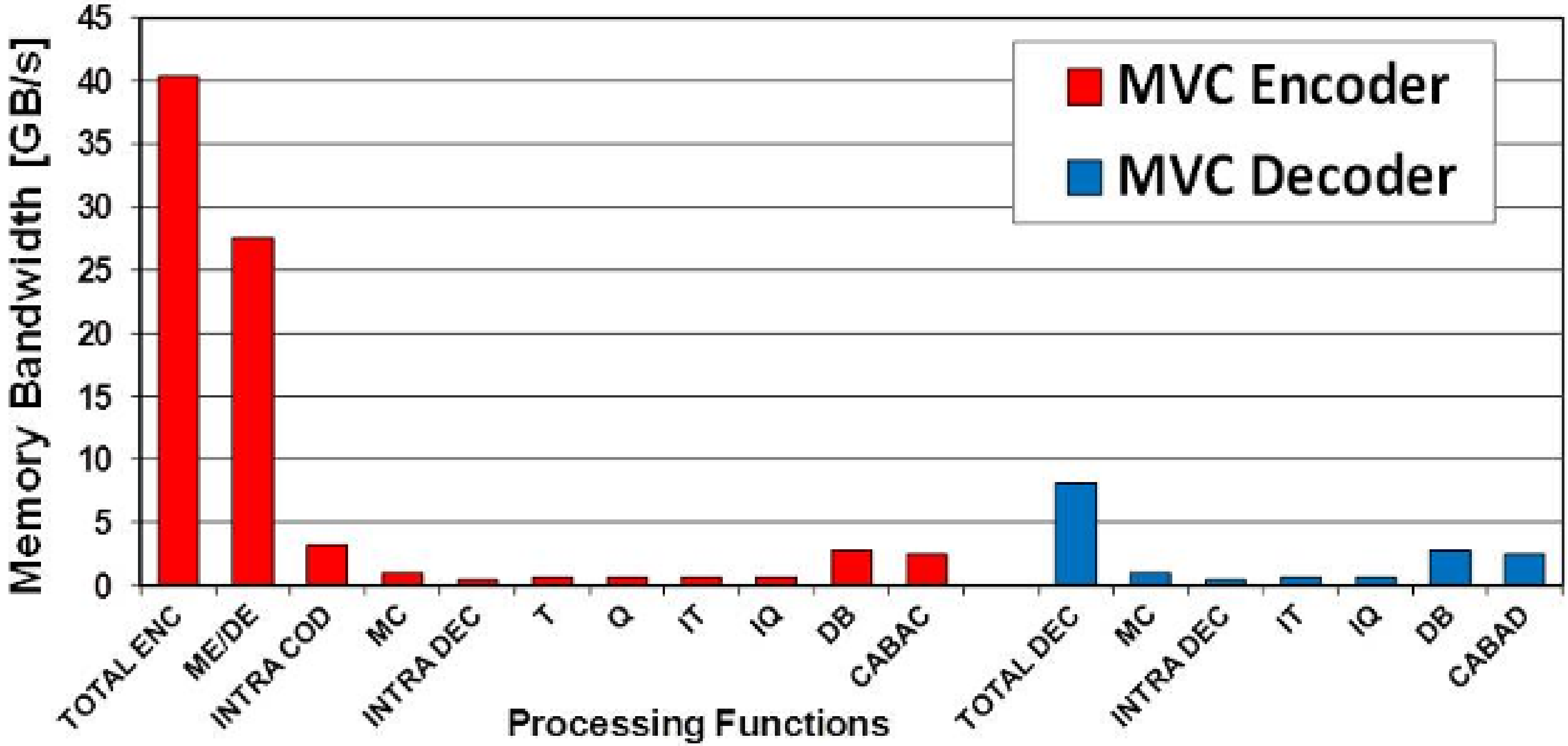


Performance-Related Challenges

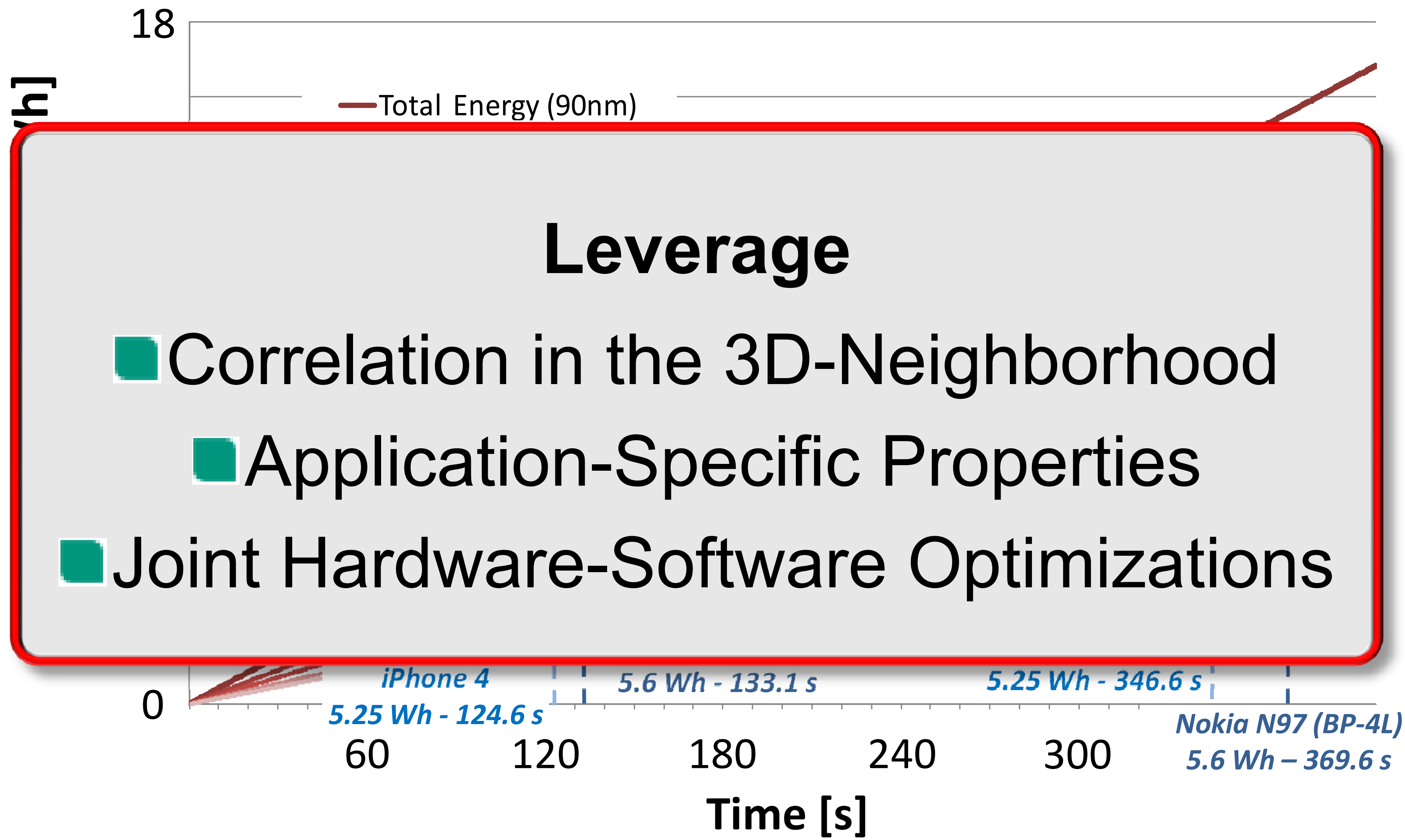


Memory-Related Challenges

- 4-Views HD1080p @ 30fps using Full Search [±96,±96]
  101.90 GBps for ME/DE



Power/Energy-Related Challenges



Leverage

- Correlation in the 3D-Neighborhood
- Application-Specific Properties
- Joint Hardware-Software Optimizations

3D-Neighborhood Correlation Analysis

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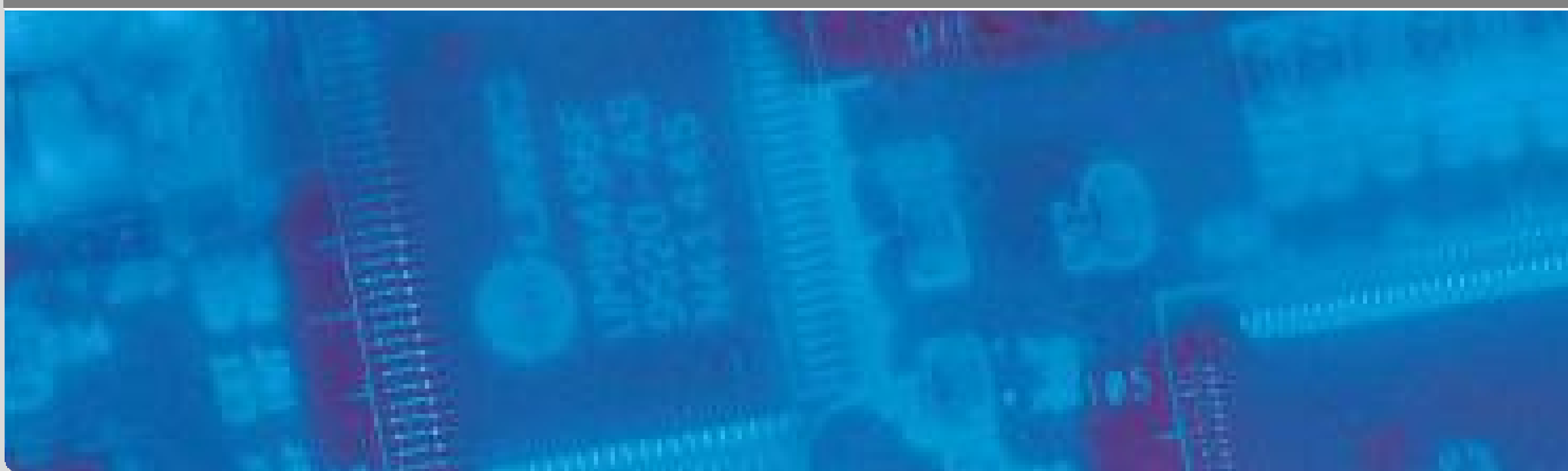
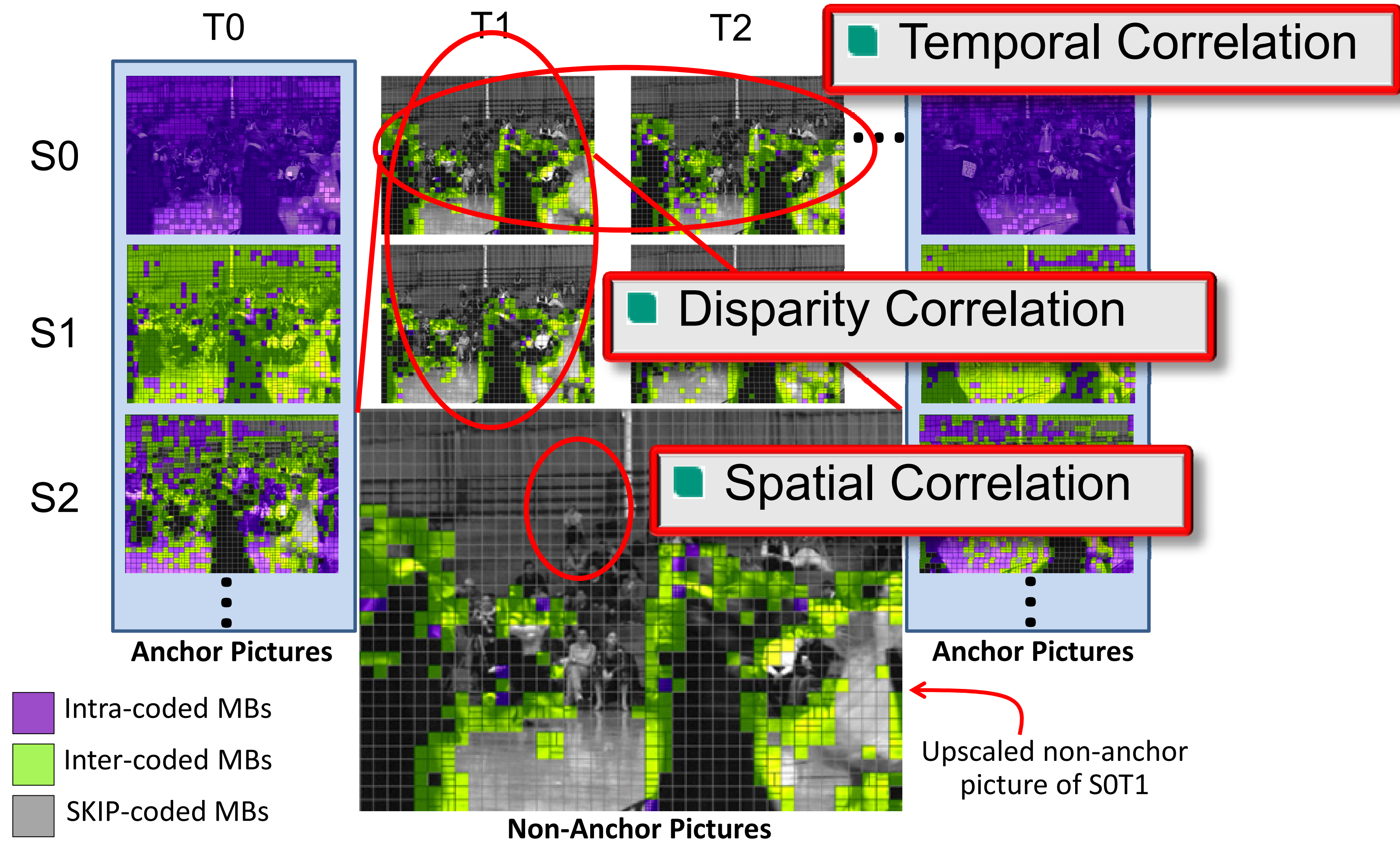
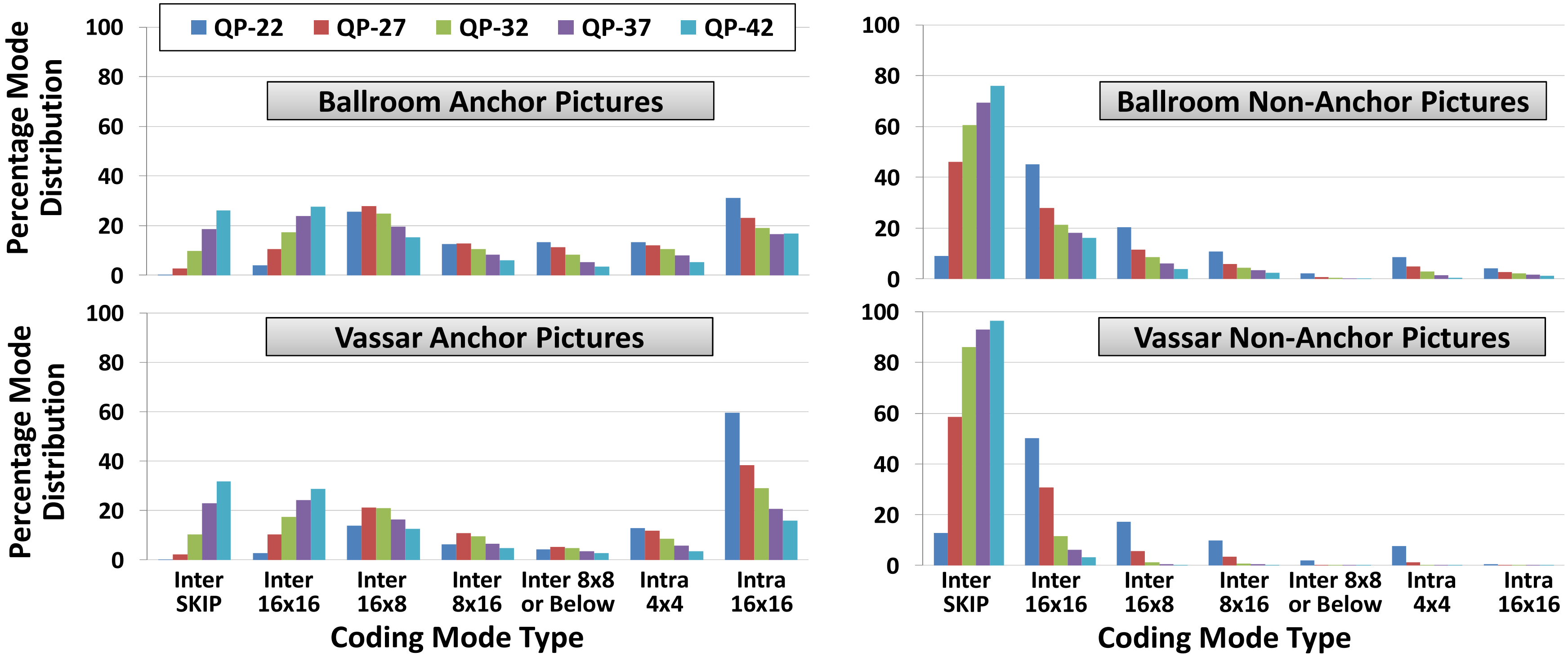


3D-Neighborhood



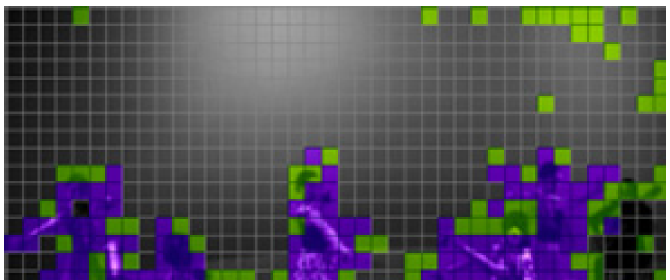
3D-Neighborhood: Coding Mode Distribution



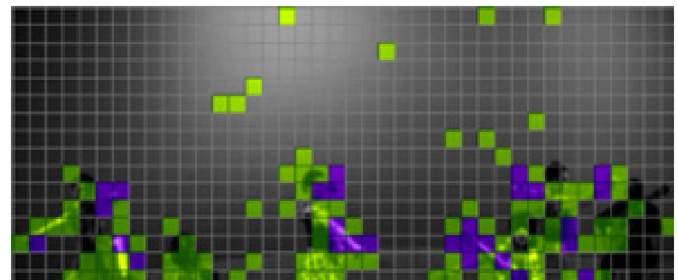
ME/DE Distribution Analysis

Disparity Estimation	Motion Estimation (SKIP MBs)	Motion Estimation (Non-SKIP MBs)

T4 Ref. Distance = 4
Hierarchy Level = 2



T5 Ref. Distance = 1
Hierarchy Level = 4

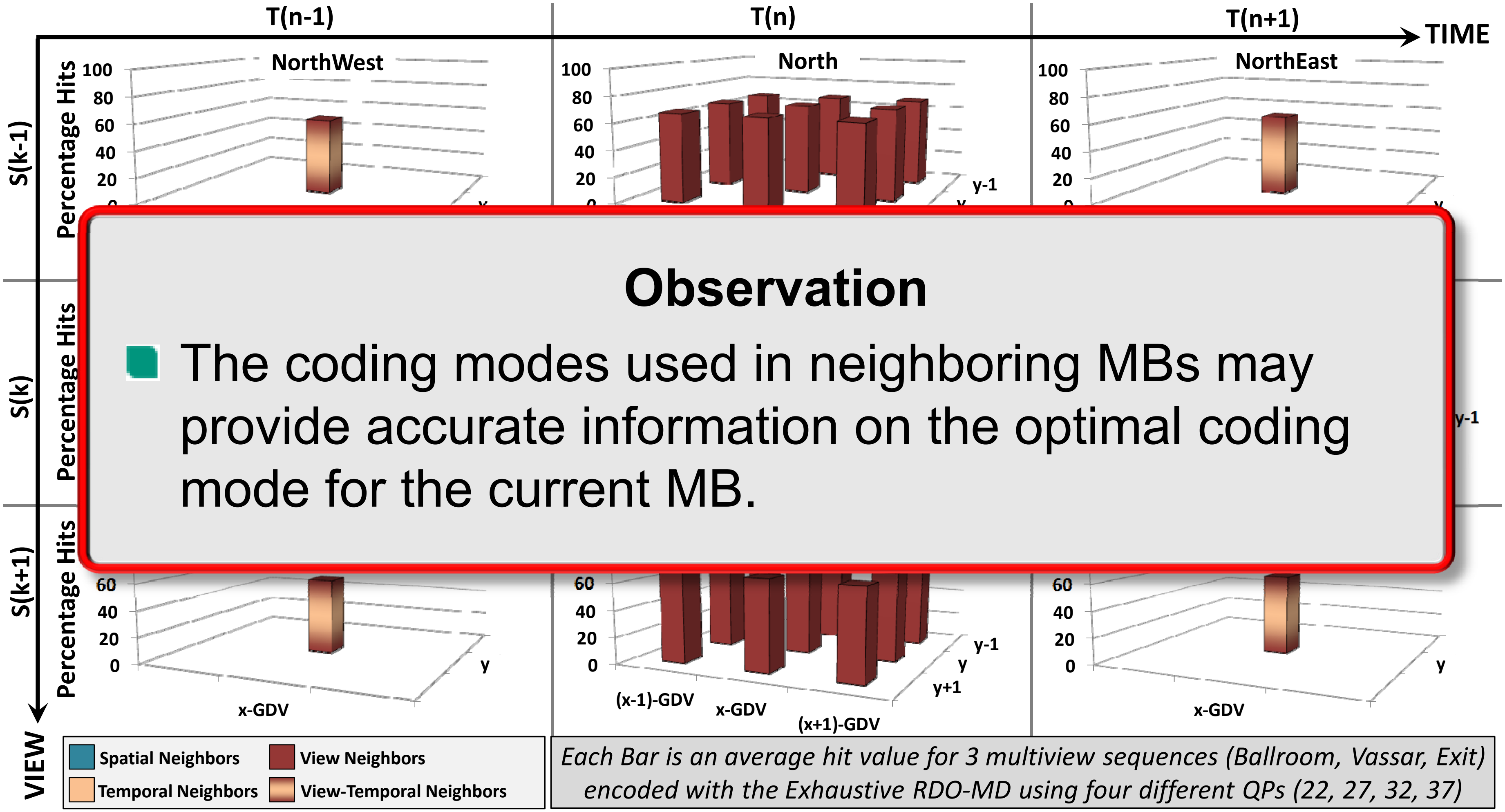


Key Challenge

- Reducing the optimization space to curtail the computational requirements while keeping the video quality loss low

T0 T1 T2 T3 T4 T5 T6 T7 T8

3D-Neighborhood: Coding Mode Correlation



Each Bar is an average hit value for 3 multiview sequences (Ballroom, Vassar, Exit) encoded with the Exhaustive RDO-MD using four different QPs (22, 27, 32, 37)

Observation

- The coding modes used in neighboring MBs may provide accurate information on the optimal coding mode for the current MB.

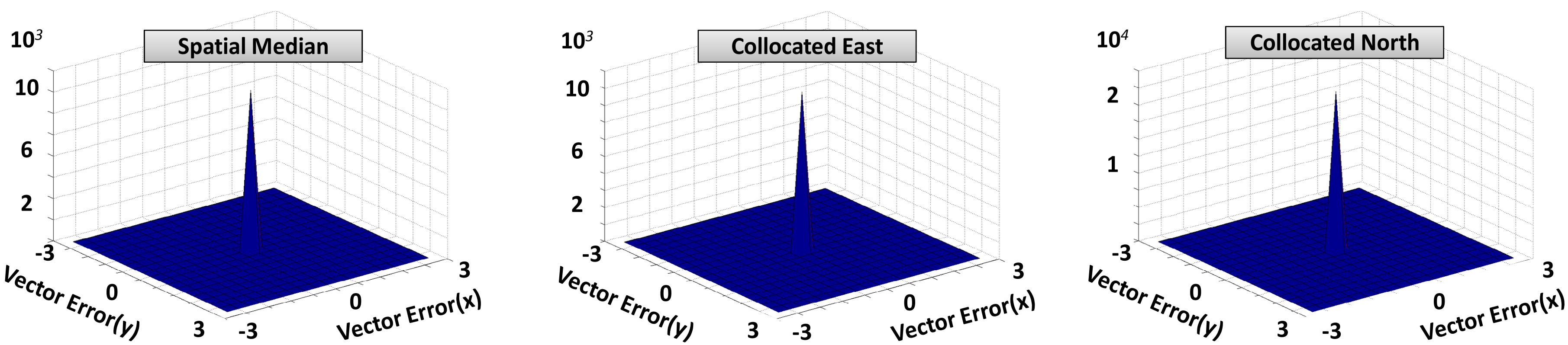
3D-Neighborhood: Vectors Correlation

- Offline analysis of motion and disparity vectors (MV, DV)
-

Observation

- Vectors from the neighborhood may accurately predict the motion vectors of the current MB.

- Selected 13 predictors → 99% Hit Probability



3D-Neighborhood: Vector Hit Ratio

- *Hit*: the frequency that the predictor is equal to the optimal vector ($MV_{Pred} = MV_{Curr}$)
- *Availability*: percentage of cases when the predictor is available

Predictor	Neighbor	Hit [%]	Available		Neighbor	Hit [%]	Available
					West	54.99	99.89
Collocated	***East***	66.79	99.90	**Median Down**	***East***	63.92	99.89
	North	95.39	72.39		***North***	93.21	74.13
	South	96.75	23.48		***South***	94.70	23.93

- ***For most of the cases the predictors' accuracy is high enough to completely avoid the ME/DE search or pattern stages***

Low-Power Algorithms for MVC

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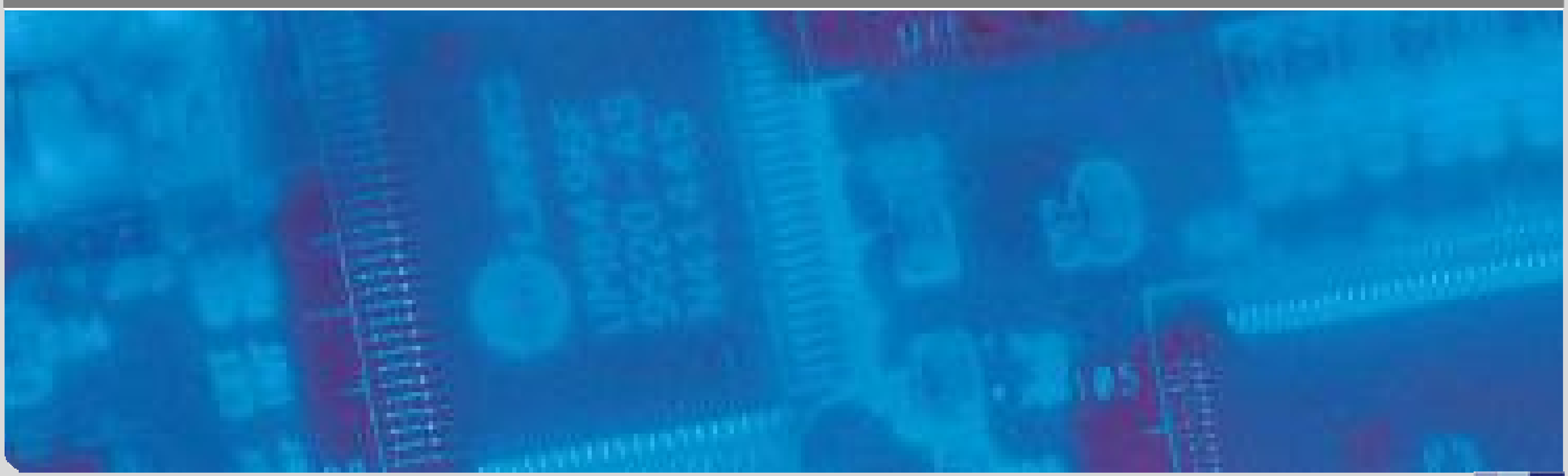

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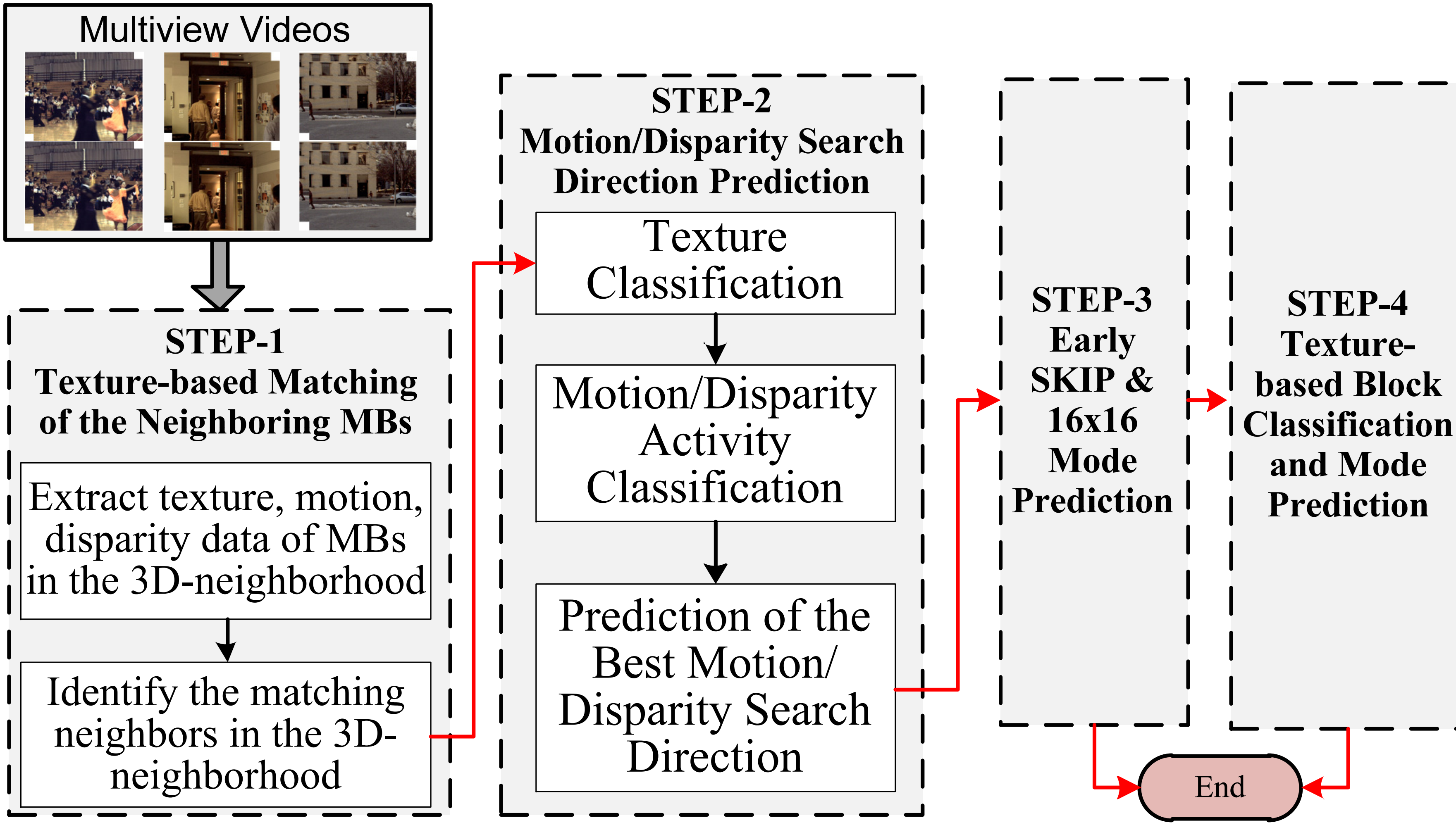
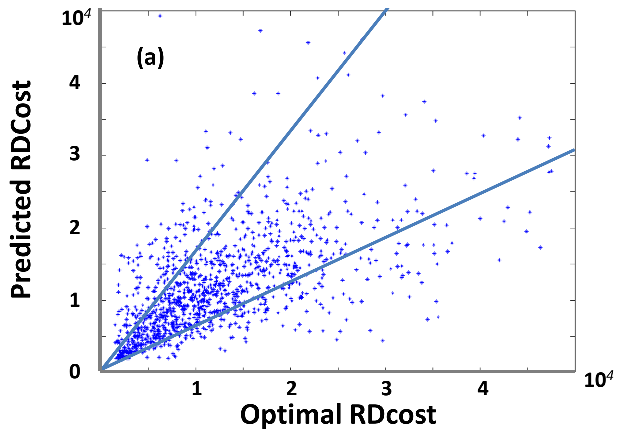
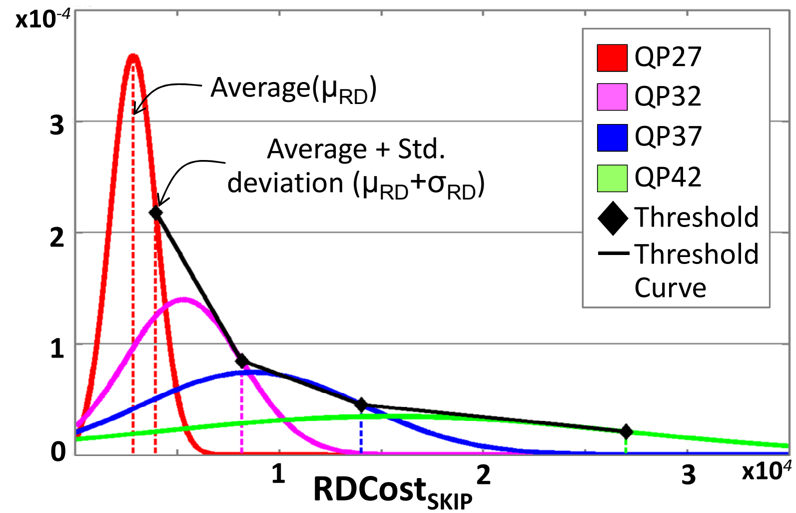
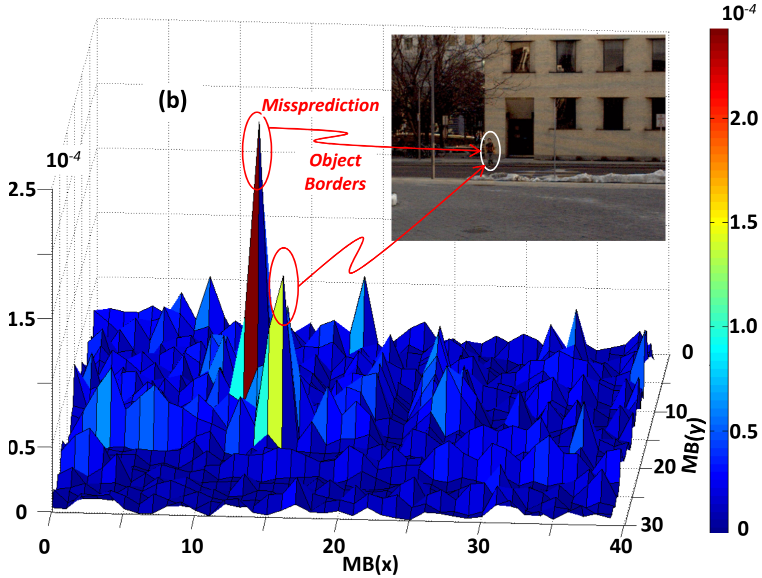
Adaptive Heirarchical Complexity Reduction

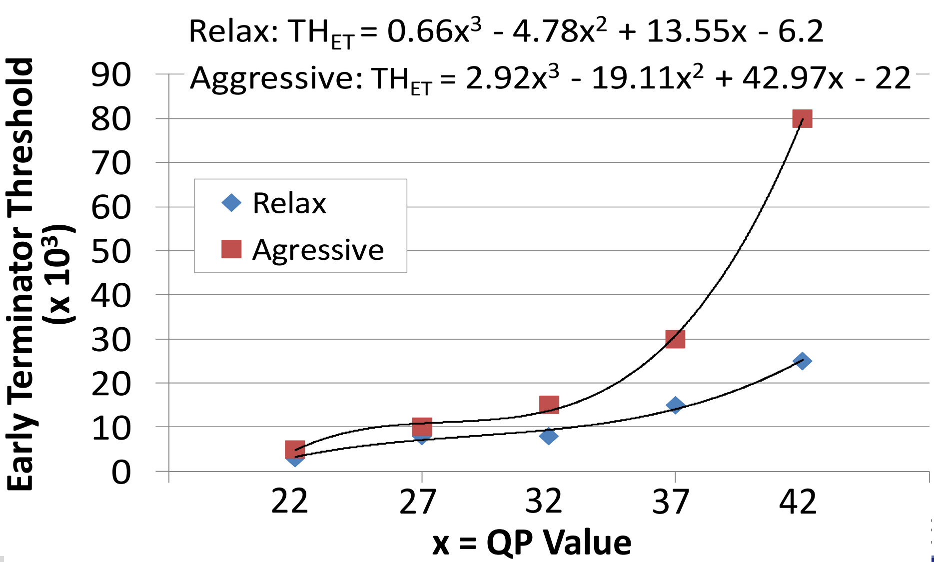


Adaptive Heirarchical Complexity Reduction



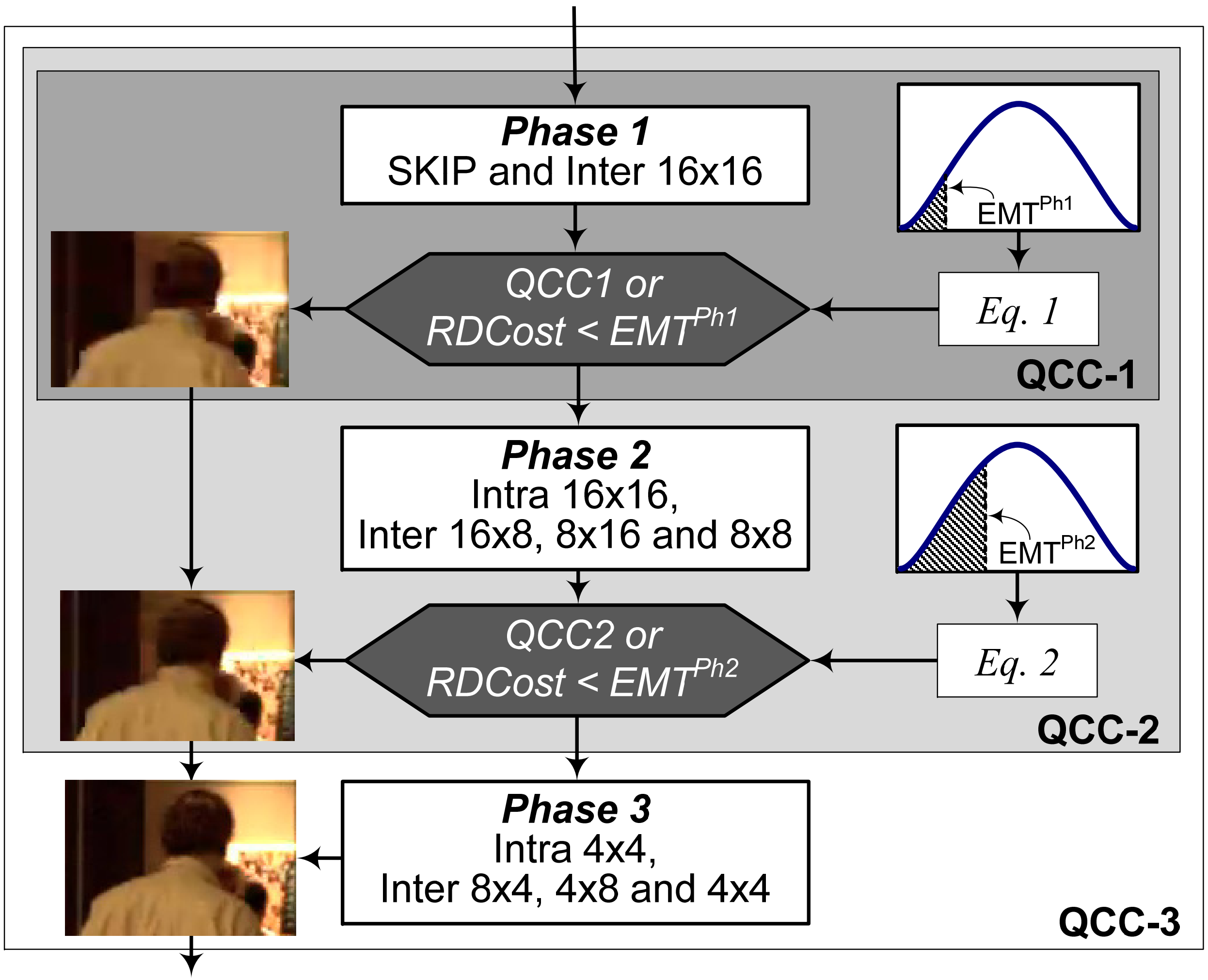






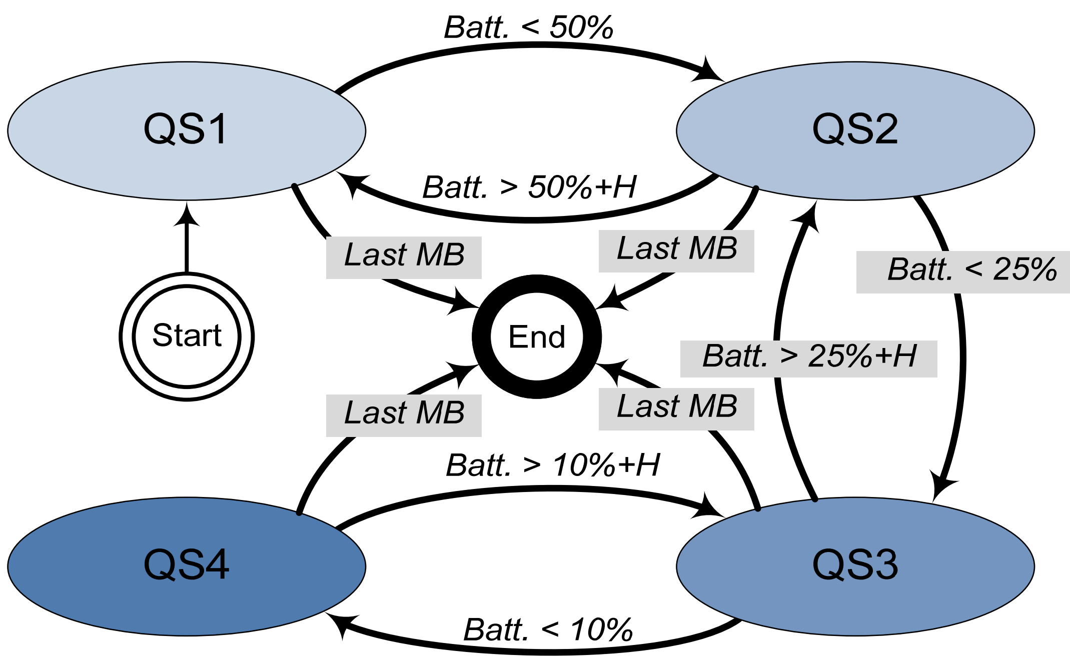
Energy-Aware Complexity Control

- Three Quality Complexity Classes (QCC) are defined



Enabling Energy~Quality Tradeoff

Quality State	Video Quality	Even Views	Odd Views
QS1	Highest	*QCC-3*	*QCC-3*
QS2	High	*QCC-3*	*QCC-2*
QS3	Medium	*QCC-2*	*QCC-1*
QS4	Low	*QCC-1*	*QCC-1*



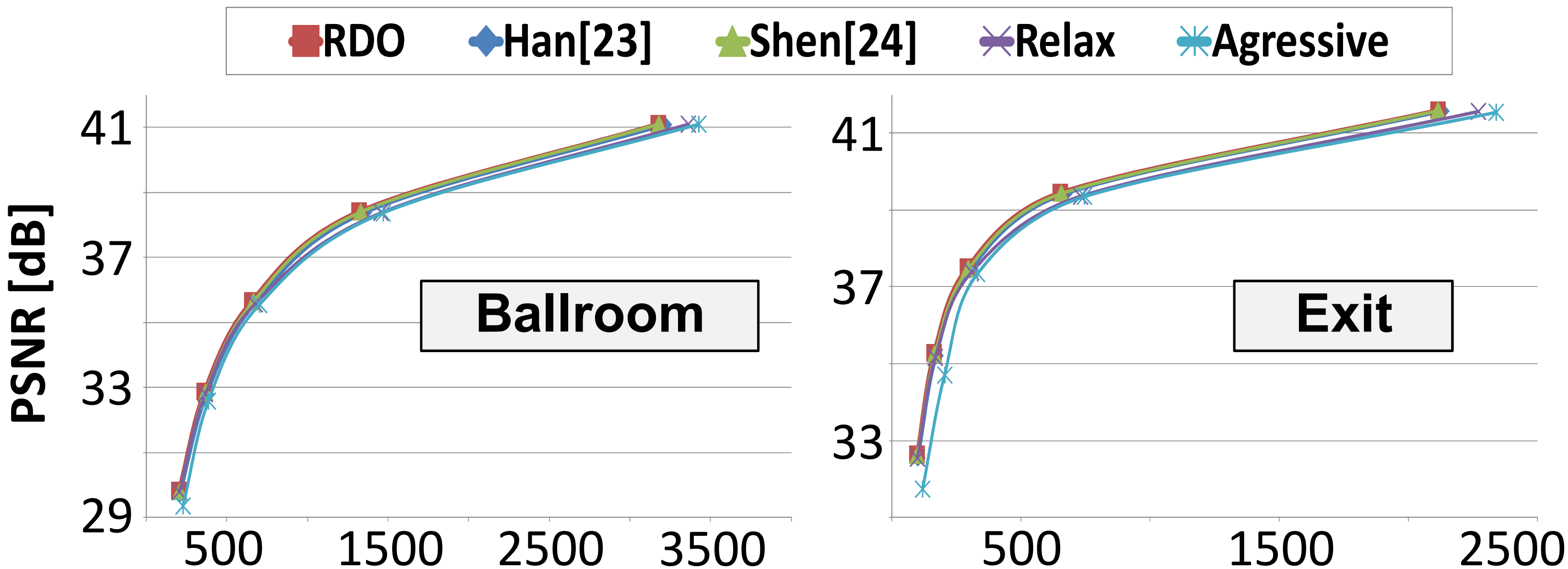
Results & Evaluation

JMVC @ 35.69dB

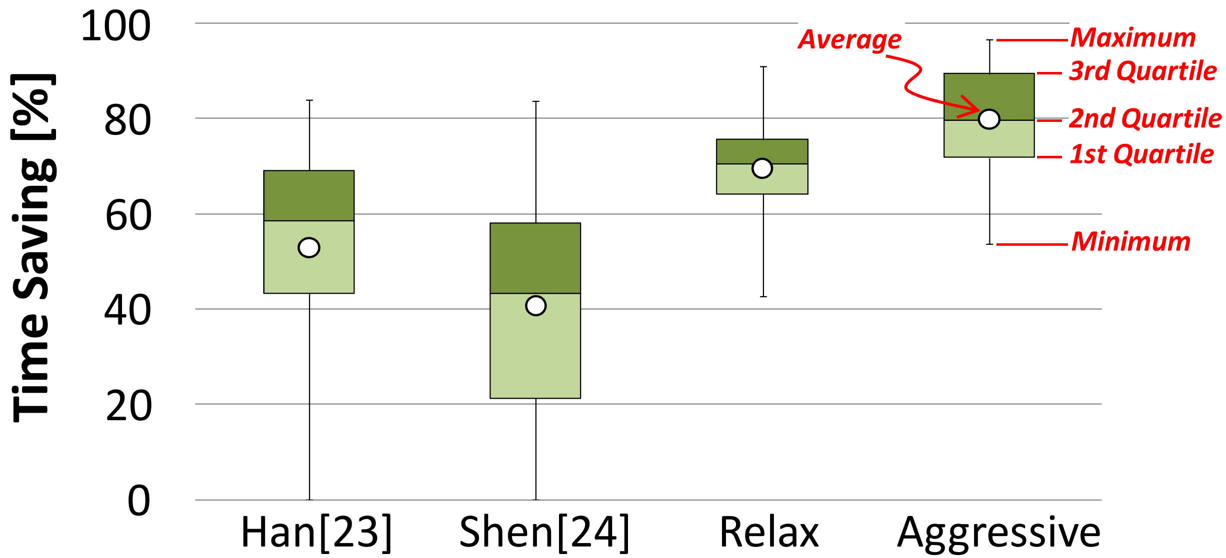
Shen[24]@ 35.64dB

Relax @ 35.62dB

Aggressive @ 35.37dB

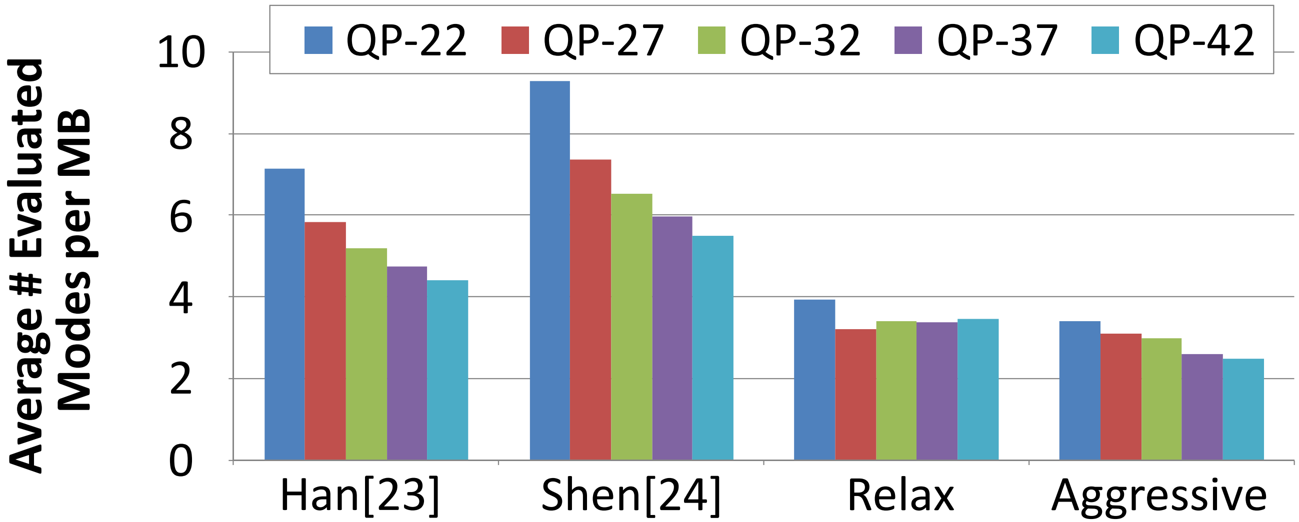


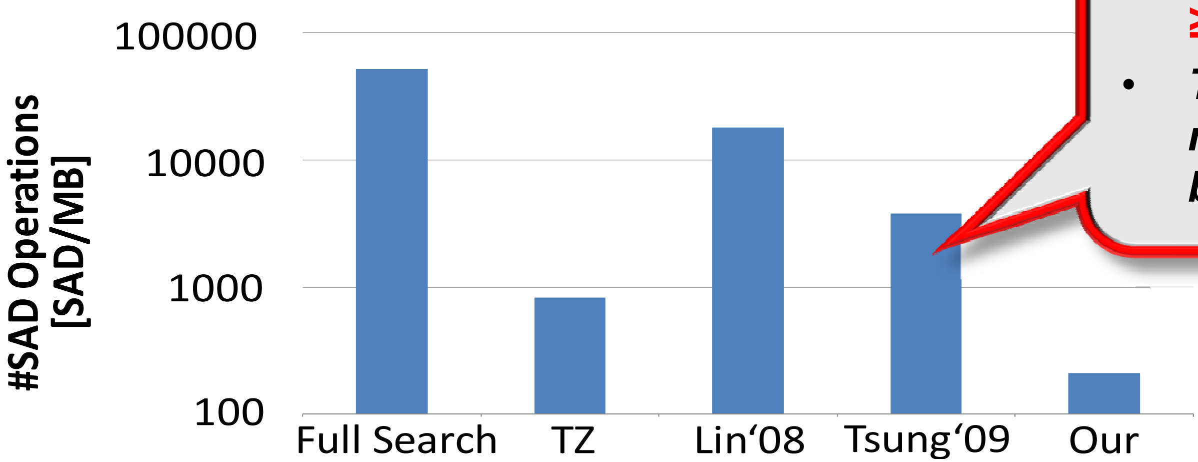
Results & Evaluation



	Time Savings [%]	ΔPSNR	ΔBR
QS1	75.29	0.089	-5.48
QS2	76.96	0.093	-0.53
QS3	82.64	0.123	4.76
QS4	85.26	0.195	7.40
Han[6]	61.57	0.150	13.16

Results & Evaluation





- ***All views present time savings ≥80% (except Vassar view 0)***
- ***Time savings for the high-motion sequences are slightly bigger***

Low-Power Architectures for MVC

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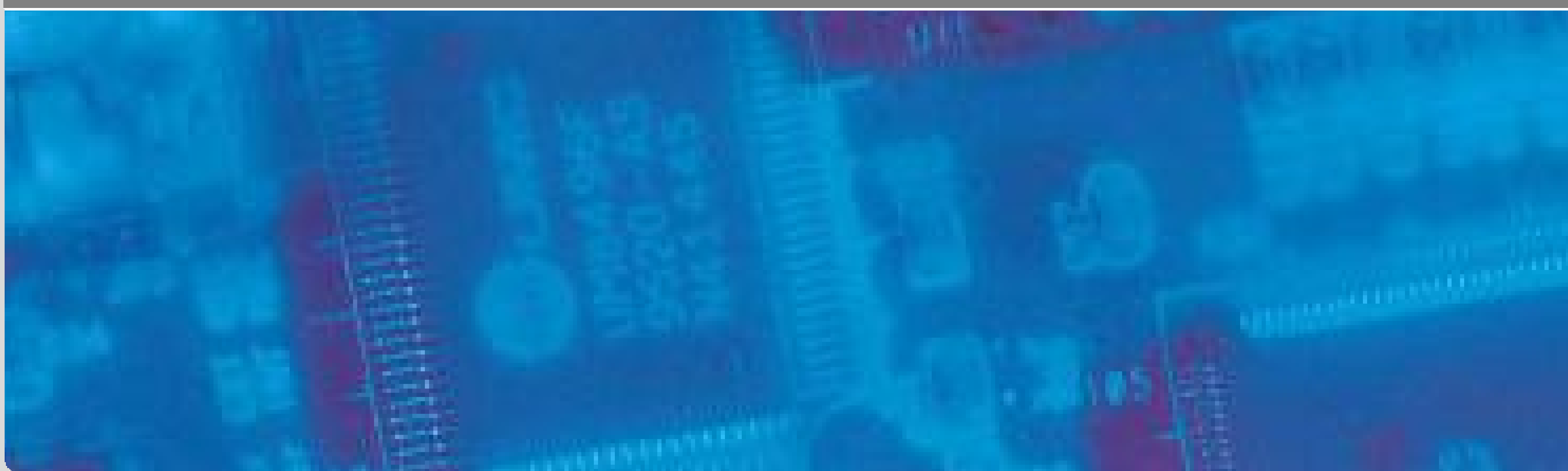
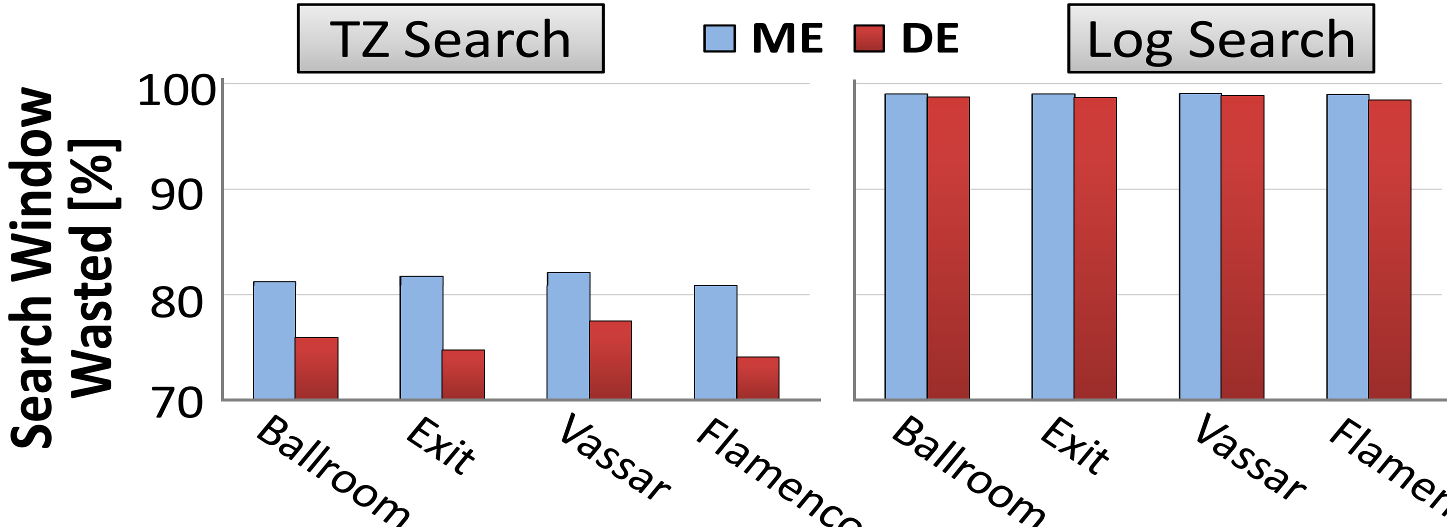


M. Shafique @ EMICRO, 26th April. 2012,
São Miguel das Missões, Brazil

Power/Energy-Related Challenges

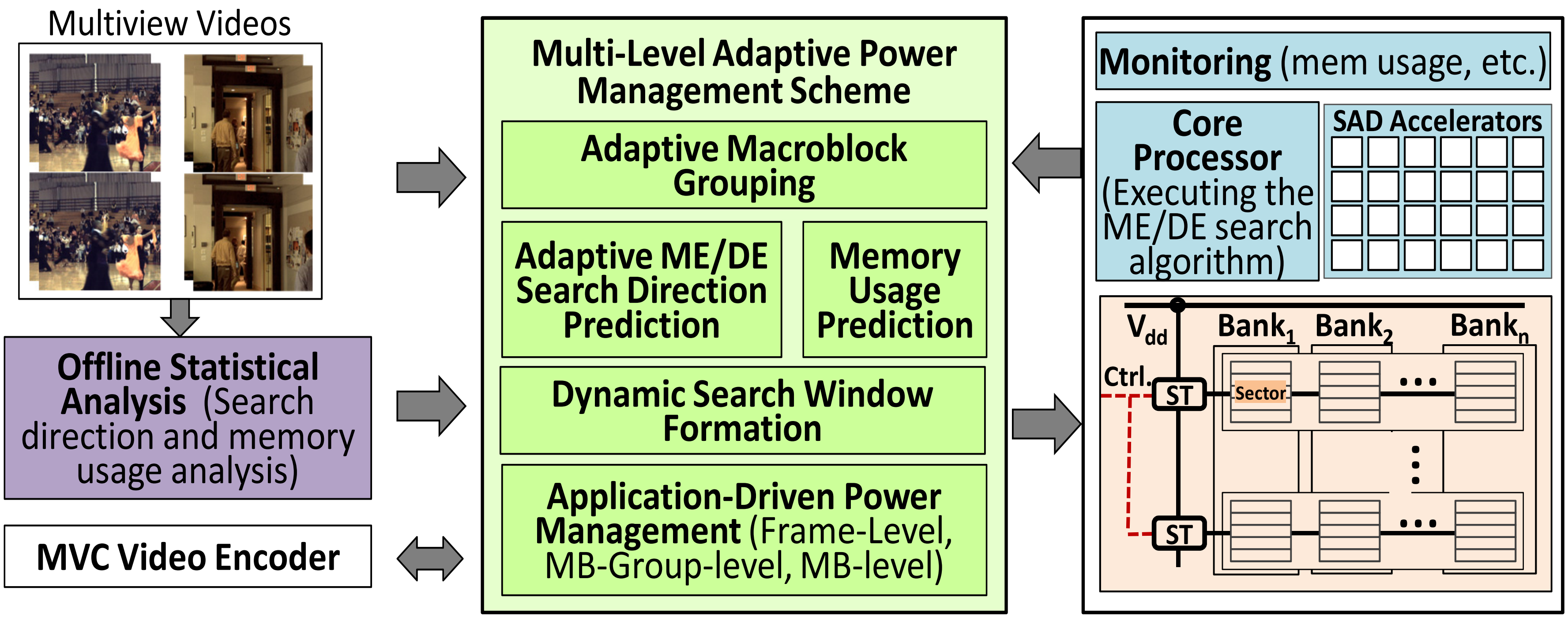
- The memory is responsible for about 90% of the energy consumption in ME/DE



Key Challenge

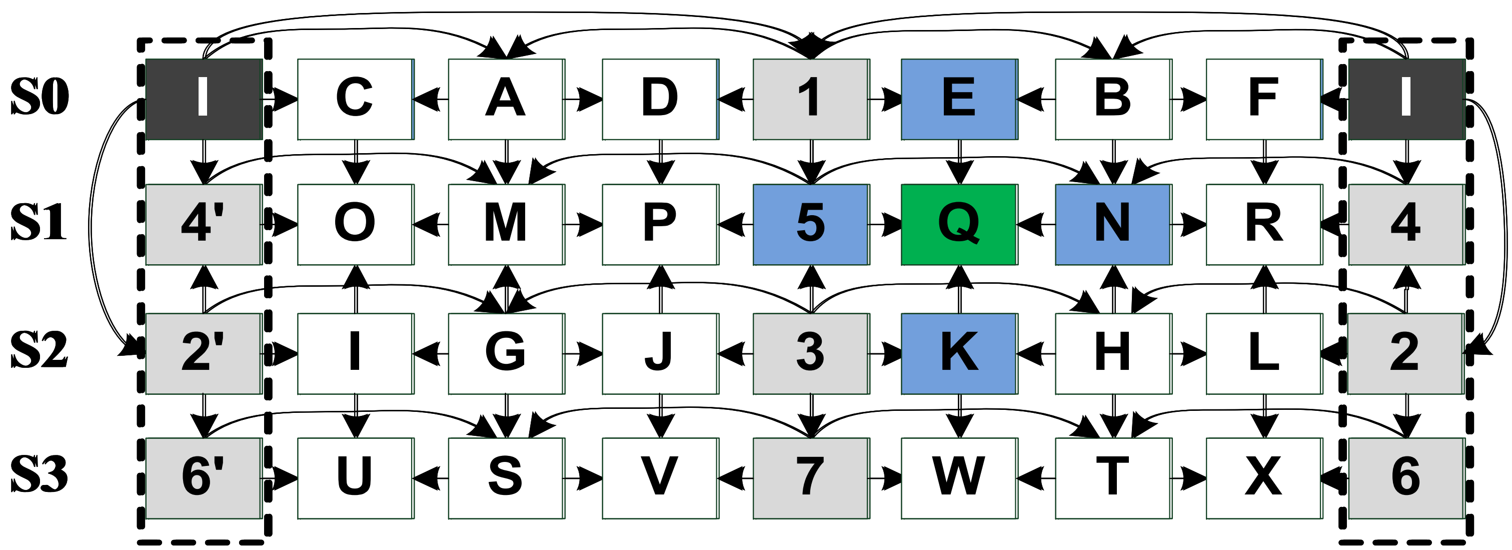
- How to reduce the number of external memory accesses and number of bits for on-chip storage in order to reduce the energy consumption?

Motion/Disparity Estimation Architecture with Application-Driven Power Management



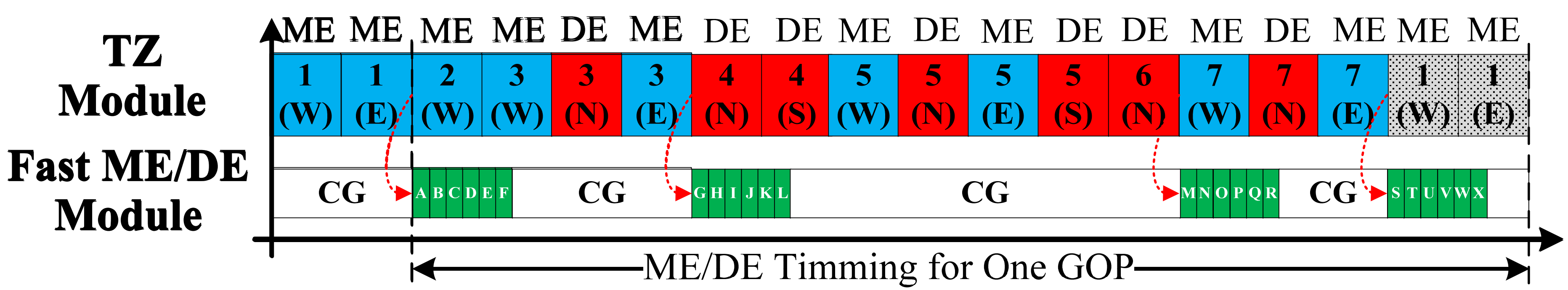
Multi-Level Pipeline Schedule: Parallelism

- Multi-Level Parallelism
  - *View-Level*
  - *Frame-Level*
  - *Reference Frame-Level*
  - *MB-Level*



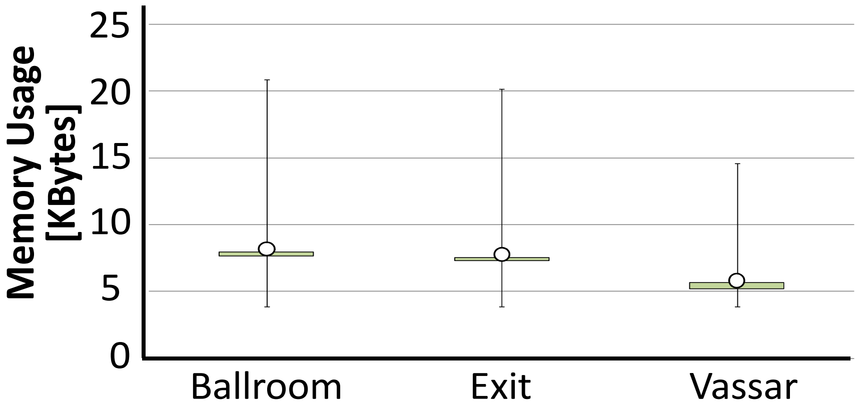
Multi-Level Pipeline Schedule: GOP-Level Schedule

- TZ Search and Fast ME/DE Modules in parallel
- The coding time for one GOP is the time of 16 TZ searches
  - 4-views, GOP=8
  - 81% reduction compared to the 88 searches without Fast ME/DE
- The KF are processed following our predefined order
- Solved the KF dependencies the NKF are processed in burst
- Fast ME/DE control is clock-gated

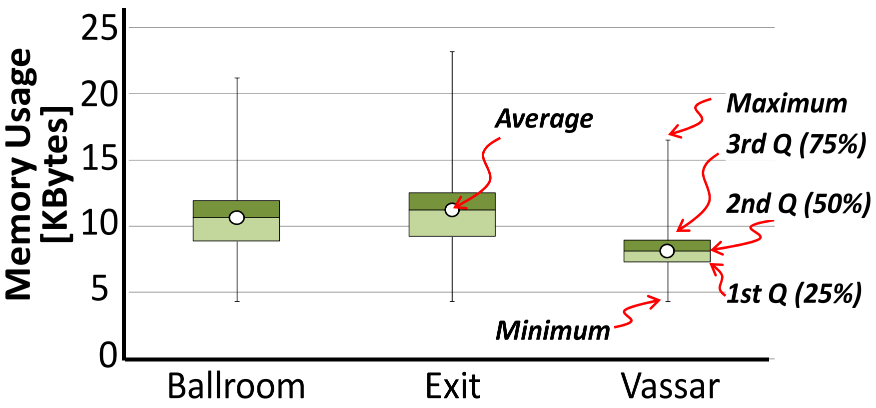


Case Study: On-Chip Memory Usage Analysis

Motion Estimation

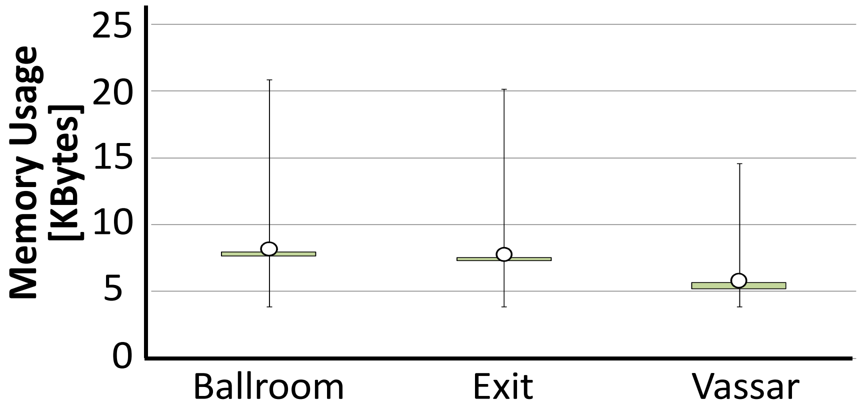


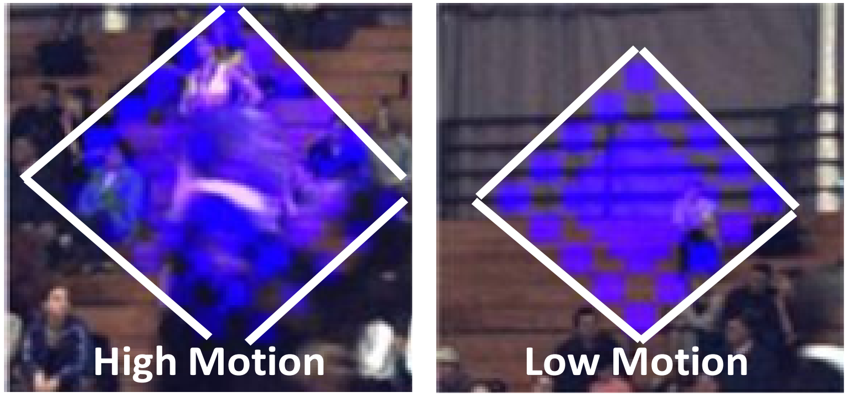
Disparity Estimation

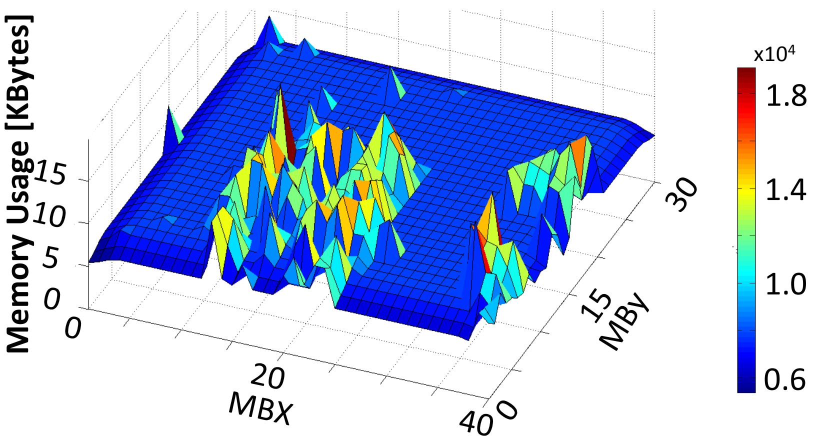


Case Study: On-Chip Memory Usage Analysis

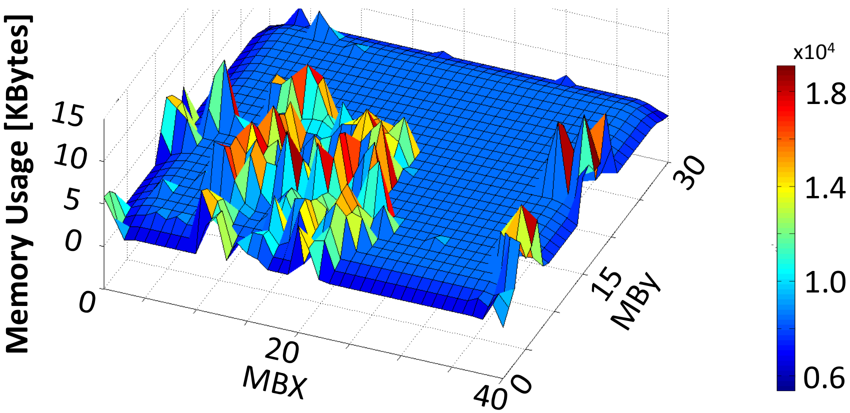
Motion Estimation





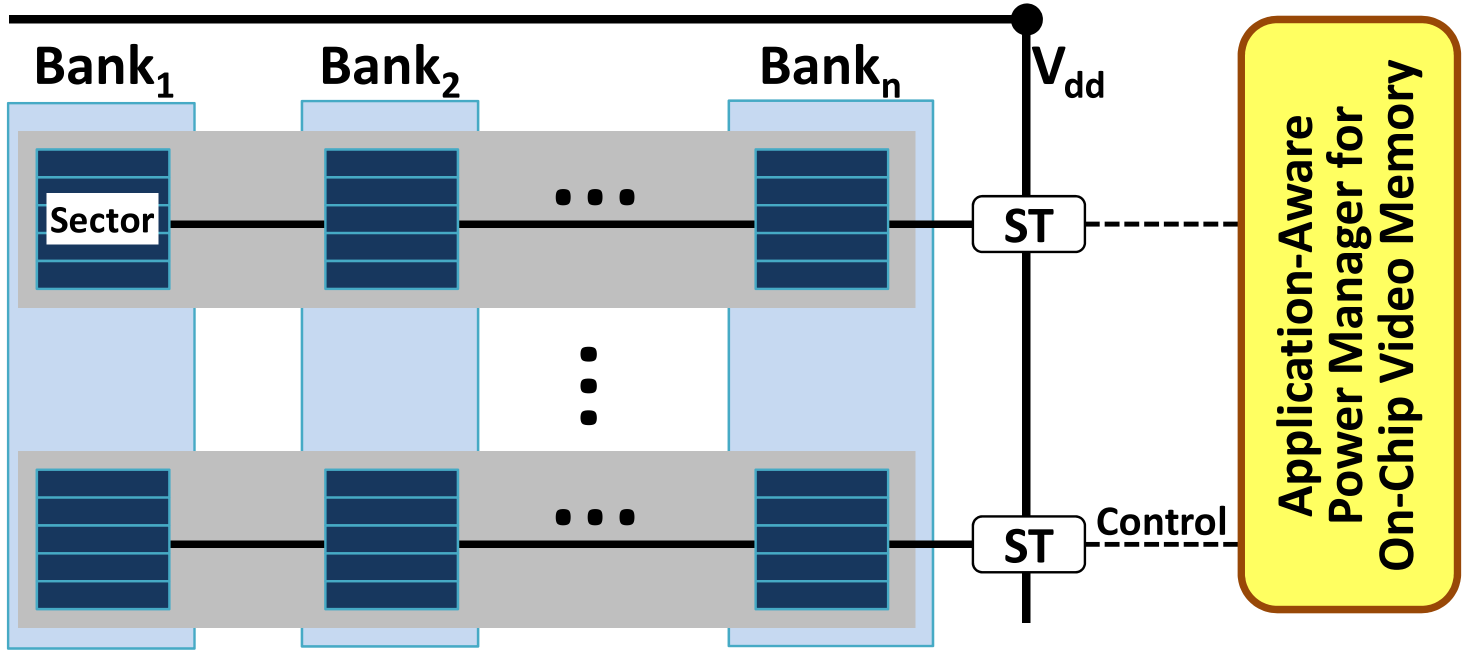


Frame F_{t-1}



Frame F_t

Multibank Memory and Power Model



$$E_{Leak} = P_{Leak} \times T_{MEDE}$$

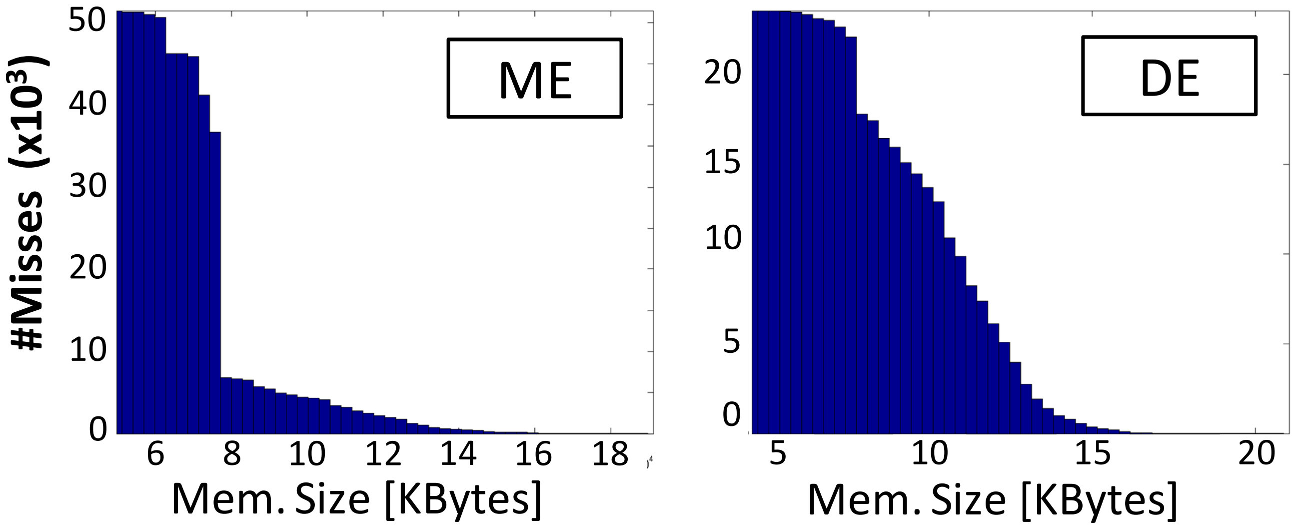
$$E_{MissTotal} = E_{Miss} \times N_{Miss}$$

Legend

- Memory bank
- Memory line
- Group of sectors which is gated with a common circuitry
- ST Sleep transistor

Multibank Video Memory: Size

- Balancing leakage savings vs. data miss energy overhead



Multibank Video Memory: Size

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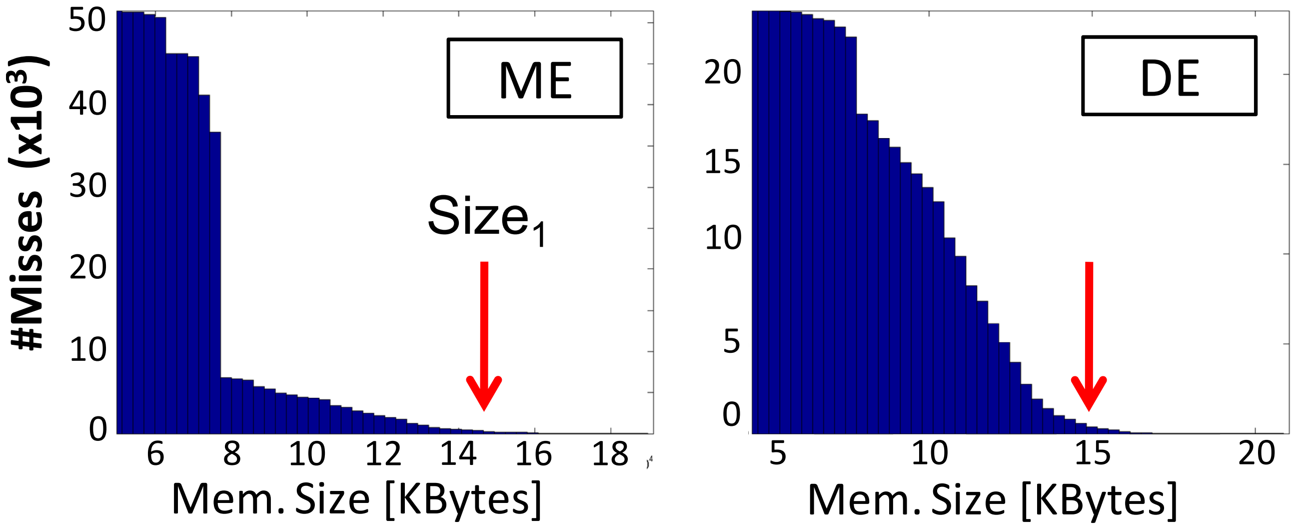

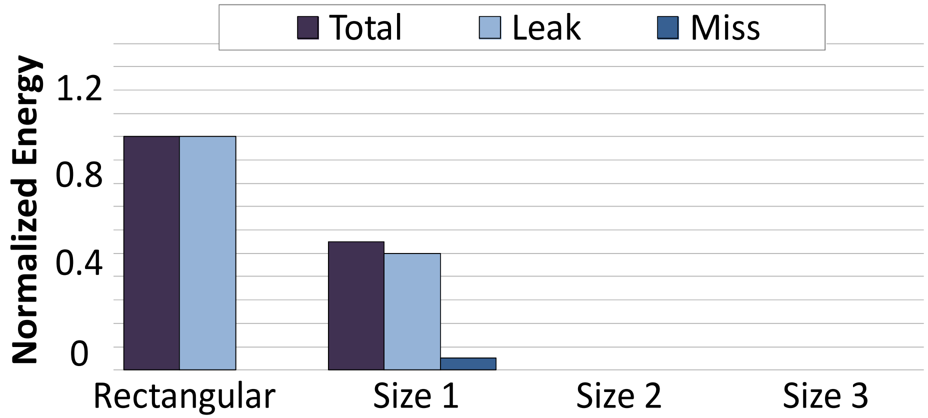

Multibank Video Memory: Size

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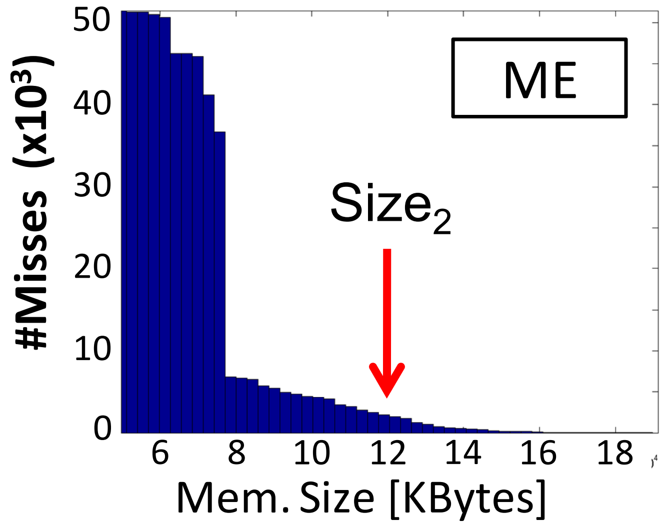

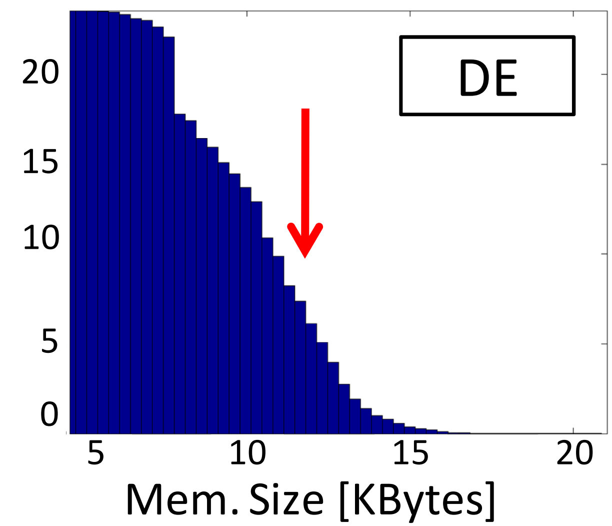

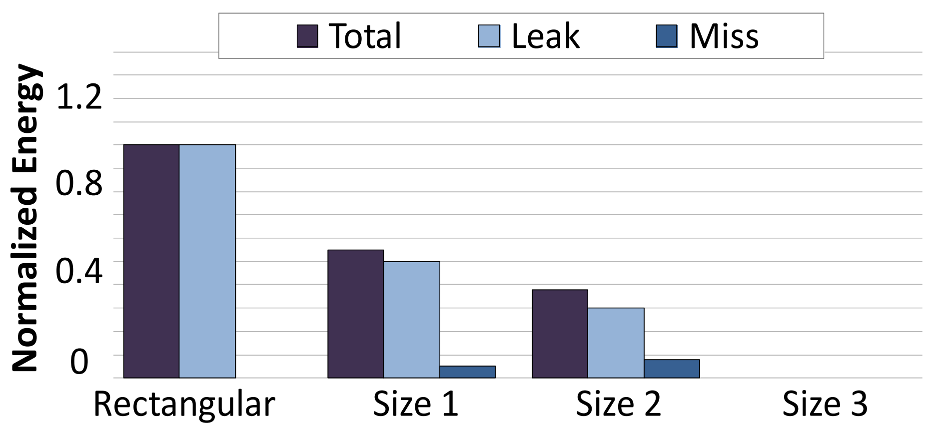

Multibank Video Memory: Size

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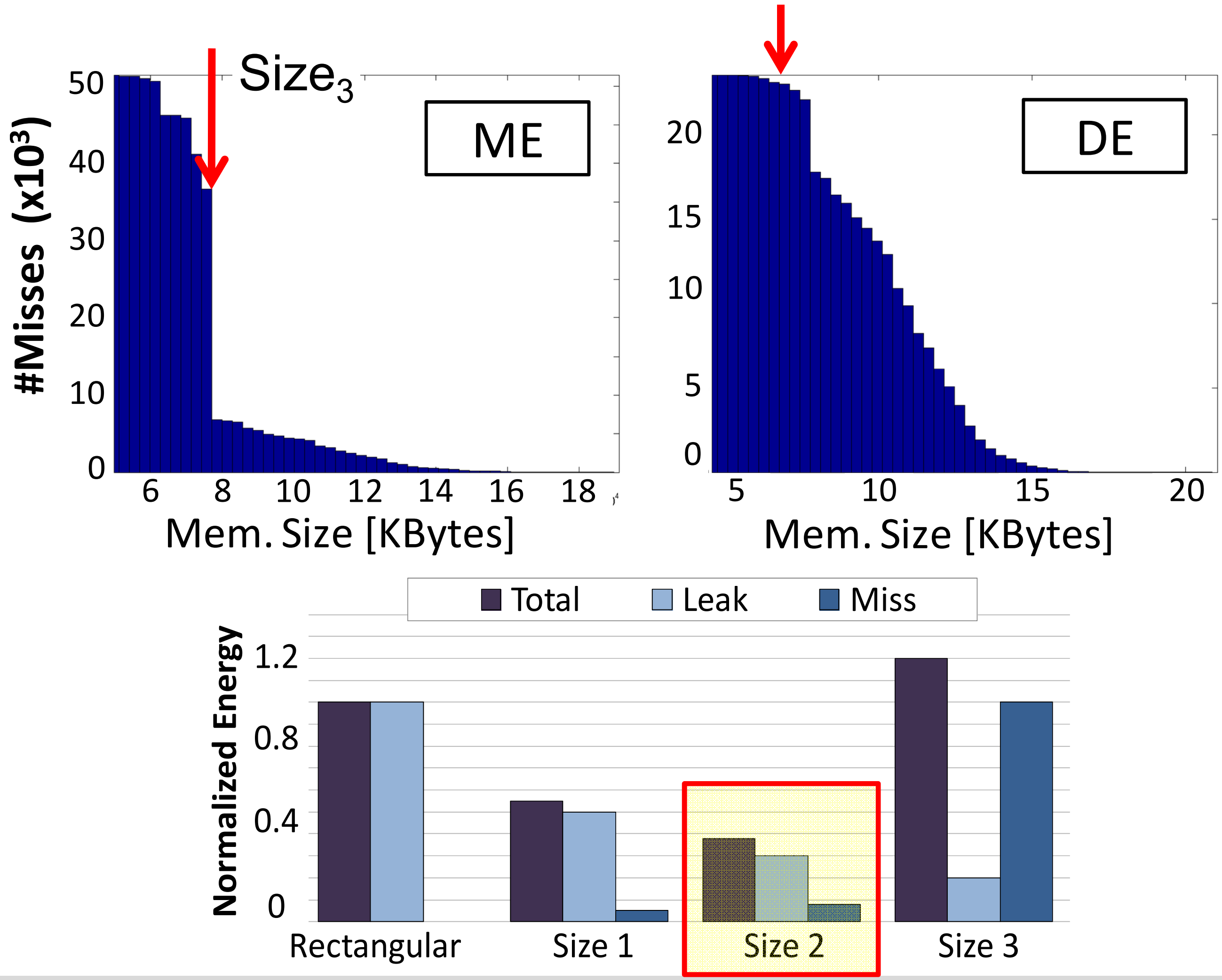
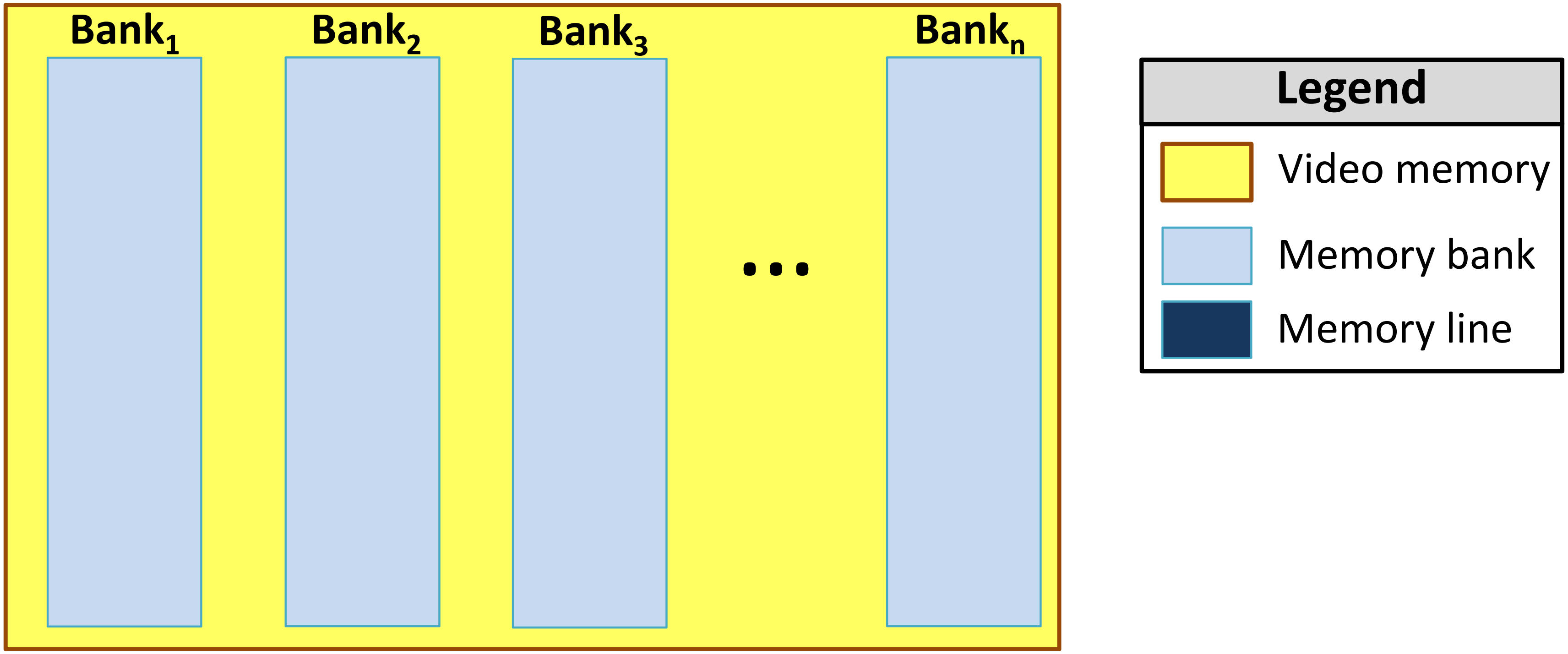
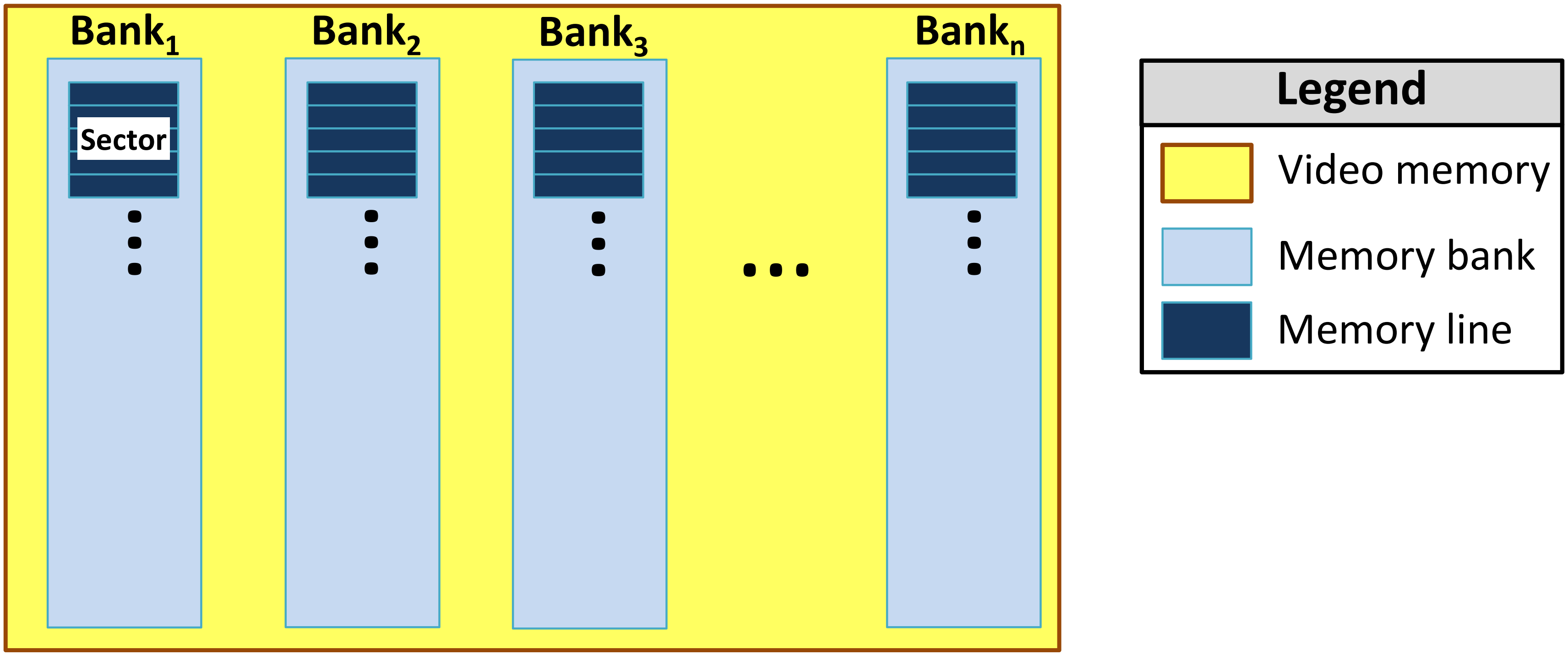


Multibank Video Memory: Organization



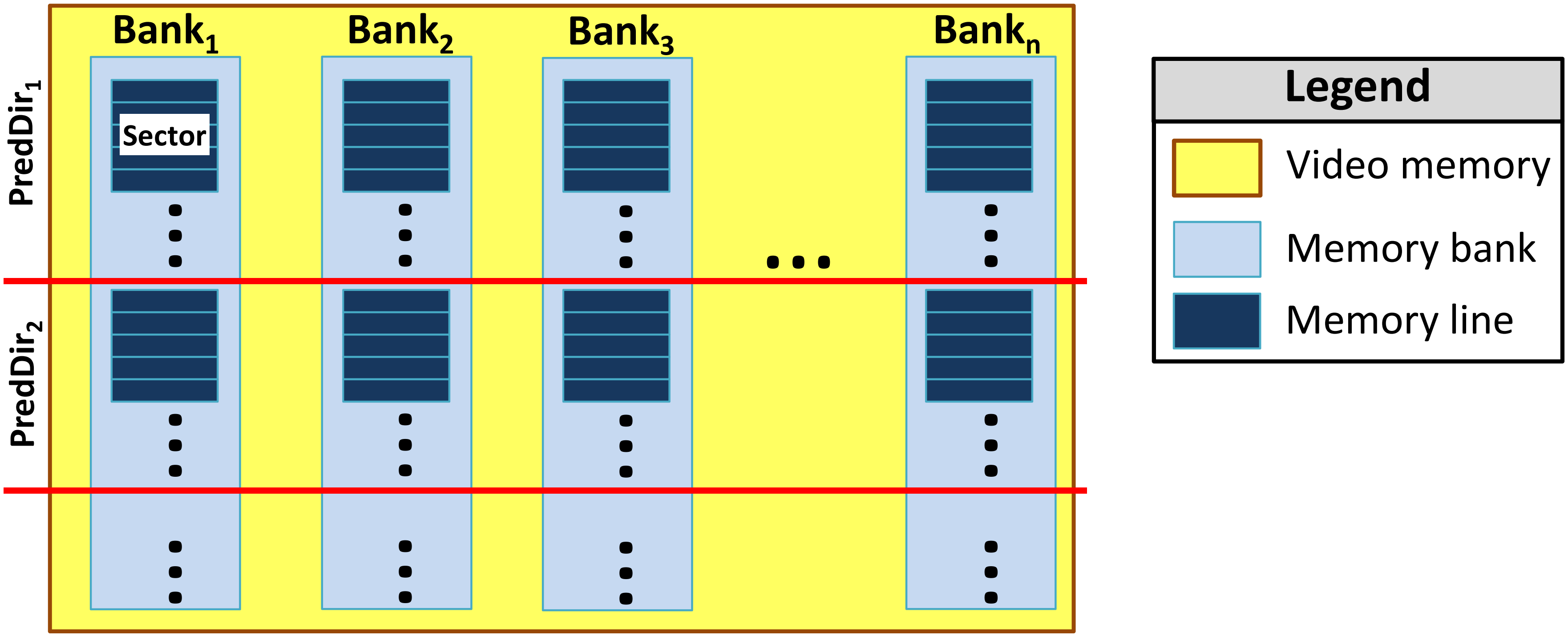
$$N_{Banks} = \frac{1}{NB_{Line}} \times \left(\frac{f \times 10^6}{\left(Width \times Height / 256 \right) \times FrameRate \times N_{SAD\_dir} \times N_{dir}} \right)$$

Multibank Video Memory: Organization



$$Size_{Sector} = \left\lfloor (Usage_{Max} - Usage_{Min}) / Usage_{StdDeviation} \right\rfloor$$

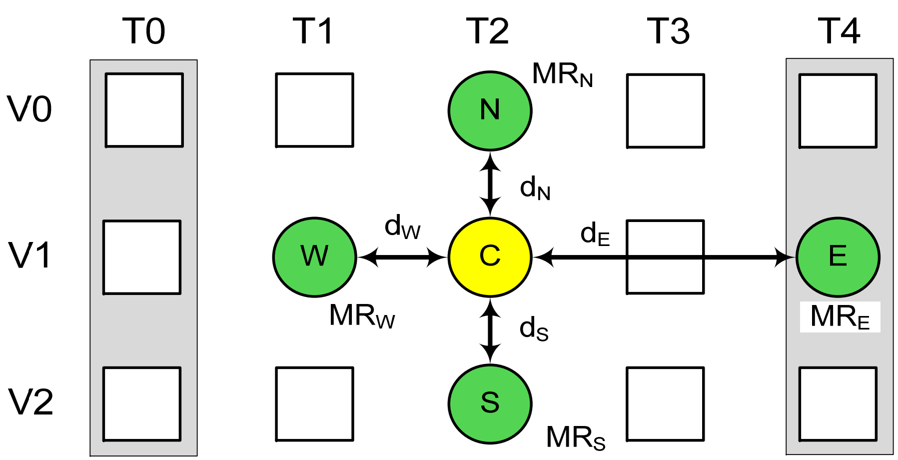
Multibank Video Memory: Organization



$$N_{Sector\_dir} = \lceil Size_{dir} / (N_{Banks} \times Size_{Sector}) \rceil$$

Application-Aware Power Management

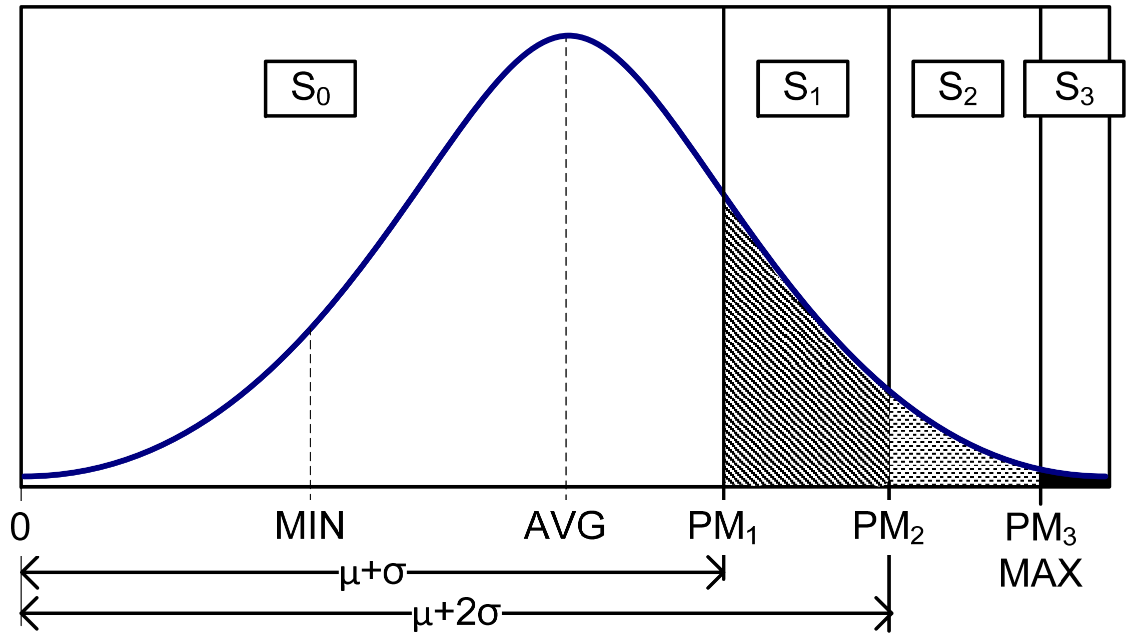
Frame-Level




```
ApplicationAwarePowerManager(dir, v, f, S_Total, S_Sector, MR_Offline)
BEGIN
list<NeighboringFrames> N ← getNeighboringFrames(dir, v, f);
∀n ∈ N   MR_n ← (n is Available)? getMemReq(n) : MR_Offline;
MR_Current ← frameMemReq(MR_Left, MR_Right, MR_Top, MR_Down);
list<MBGroups> G ← getMBGroups(f); // combine MBs in Groups
For all g ∈ G
   MR_Group ← reAdjustMemReq(g, MR_Current, E_MissGroup);
   list<Sectors> PS ← setSleepModes(S_Total, S_Sector, MR_Group);
   For all mb ∈ g
      {E_MissGroup, E_LeakGroup, memUsed_MB} ← performSearch(); // perform
      ME and DE search and log memory requirements of the current MB
      MR_Current ← mbLevelPowerGating(PS, memUsed_MB);
   End For
End For
MR ← computeMemStatistics(PM_3, PM_2, PM_1);
return MR;
END
```

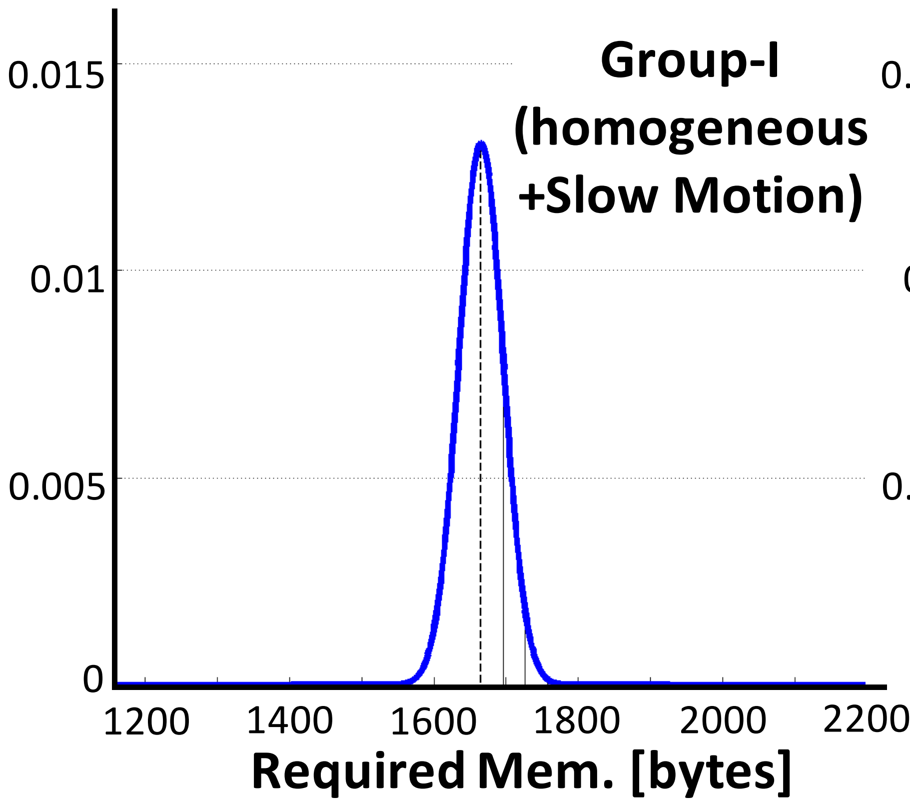
$$MR_{Current} = [(MR_W * d_W + MR_E * d_E) * \alpha + (MR_N * d_N + MR_S * d_S) * \beta] / 4$$

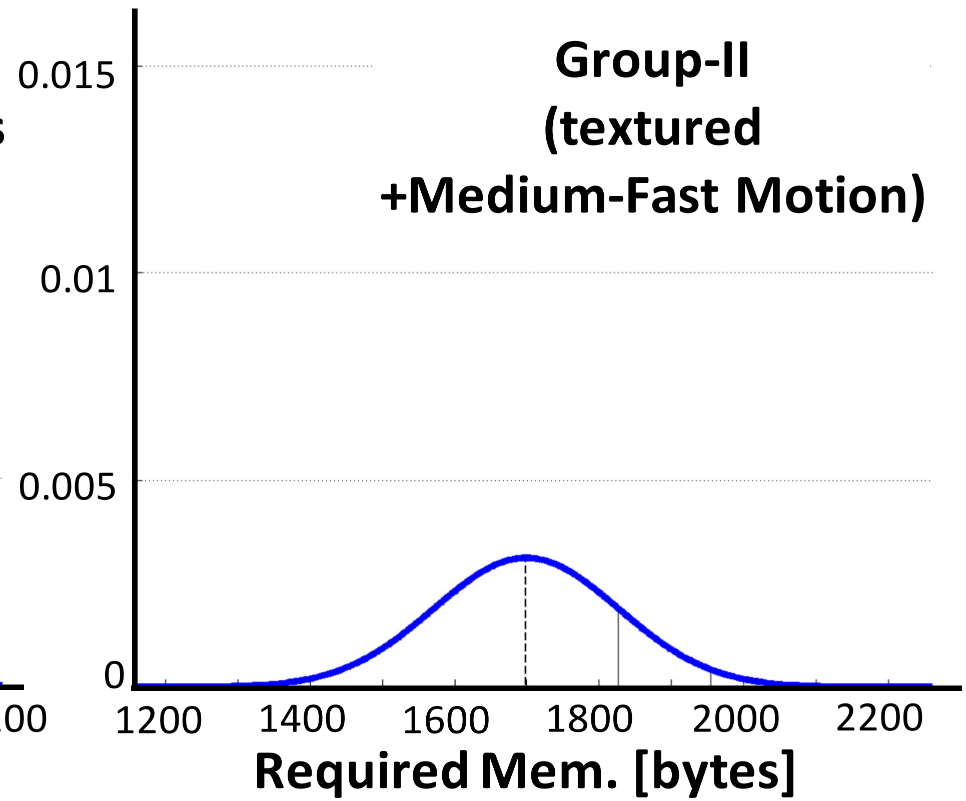
Application-Aware Memory Usage Prediction



- *MR* **=** *{PM₁, PM₂, PM₃}*
- Assuming a Gaussian distribution:
  - $PM_1 \leftarrow F(\mu+\sigma; \mu, \sigma^2) - F(0; \mu, \sigma^2) \approx 0.84$
  - $PM_2 \leftarrow F(\mu+2\sigma; \mu, \sigma^2) - F(0; \mu, \sigma^2) \approx 0.975$
  - $PM_3 \leftarrow$ *Maximum Memory Requirement*

Effect of Macroblock Properties on Memory Usage Distribution

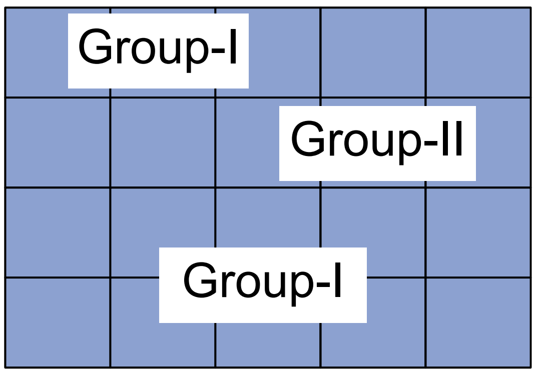




$$Group = \begin{cases} if\,(SAD_{MB} > TH_{SAD} \;\&\; Var_{MB} < TH_{Var}) & Group = I \\ Else, \quad Group = II \end{cases}$$

Macroblock-Group Level Power Management

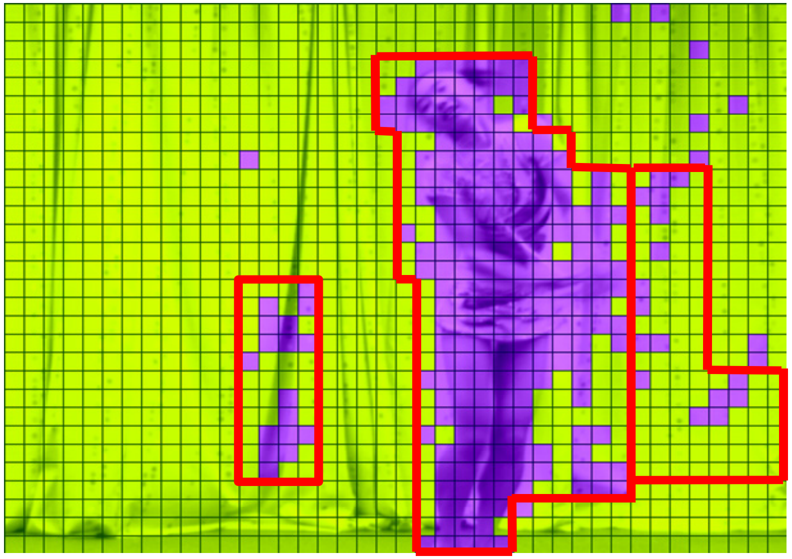
Macroblock Group-Level

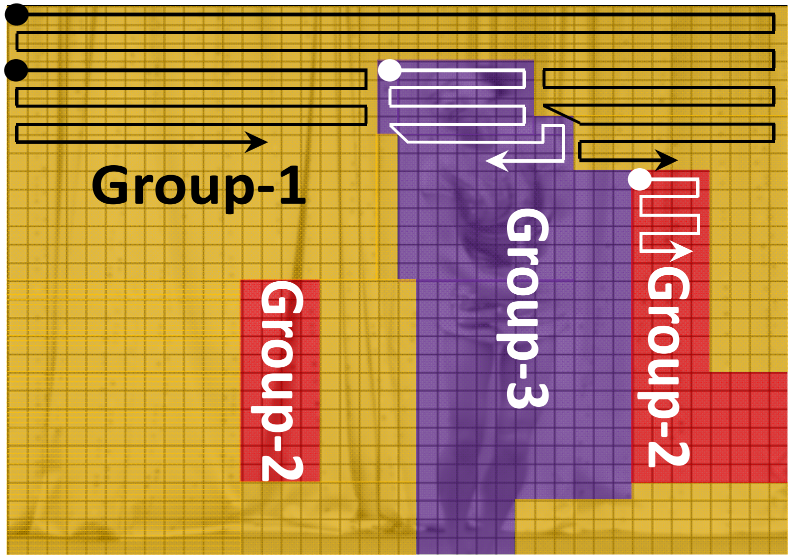


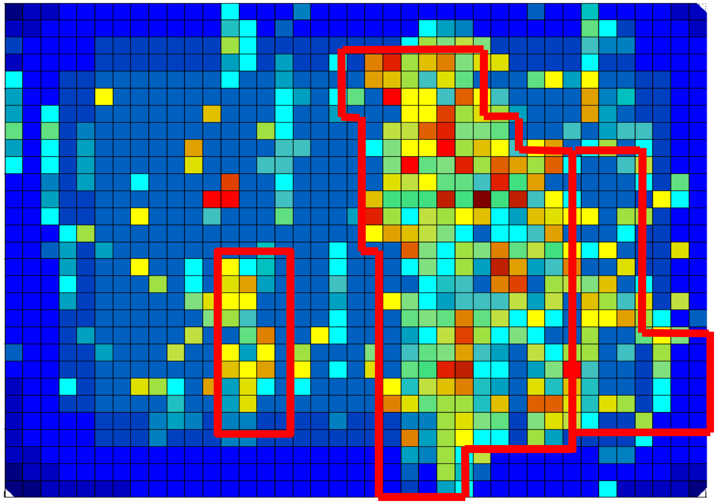

```
ApplicationAwarePowerManager(dir, v, f, S_Total, S_Sector, MR_Offline)
BEGIN
list<NeighboringFrames> N ← getNeighboringFrames(dir, v, f);
∀n ∈ N   MR_n ← (n is Available) ? getMemReq(n) : MR_Offline;
MR_Current ← frameMemReq(MR_Left, MR_Right, MR_Top, MR_Down);
list<MBGroups> G ← getMBGroups(f); // combine MBs in Groups
For all g ∈ G
   MR_Group ← reAdjustMemReq(g, MR_Current, E_MissGroup);
   list<Sectors> PS ← setSleepModes(S_Total, S_Sector, MR_Group);
   For all mb ∈ g
      {E_MissGroup, E_LeakGroup, memUsed_MB} ← performSearch(); // perform
      ME and DE search and log memory requirements of the current MB
      MR_Current ← mbLevelPowerGating(PS, memUsed_MB);
   End For
End For
MR ← computeMemStatistics(PM_3, PM_2, PM_1);
return MR;
END
```

$$N_{Group} > \begin{cases} E_{wakeup} / E_{Leak} & \text{If } S_1 \text{ or } S_2 \\ (E_{wakeup} + E_{MissGroup}) / E_{Leak} & \text{Else} \end{cases}$$

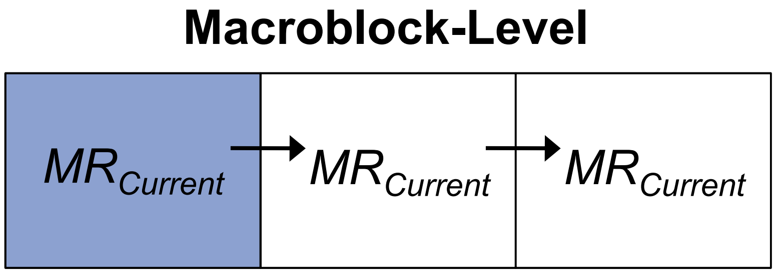
Computation Reordering



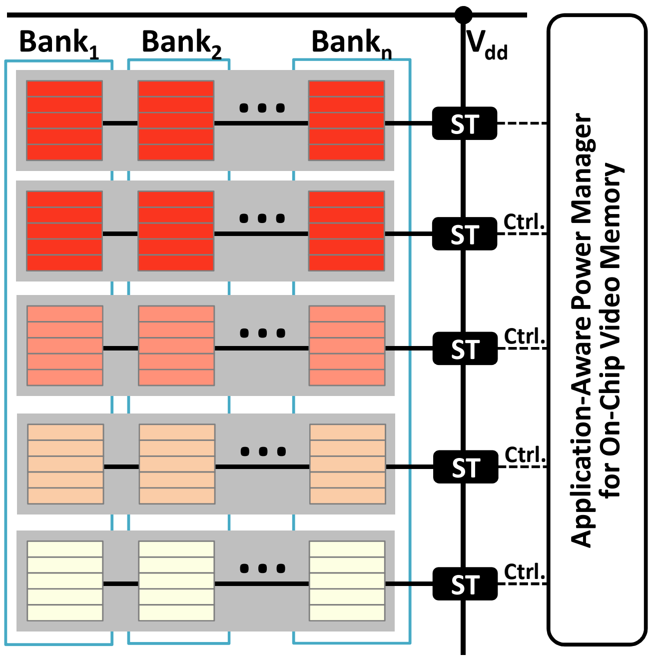




Macroblock-Level Power Management



- Switch only between ON S_0 and state-retentive S_1 and S_2

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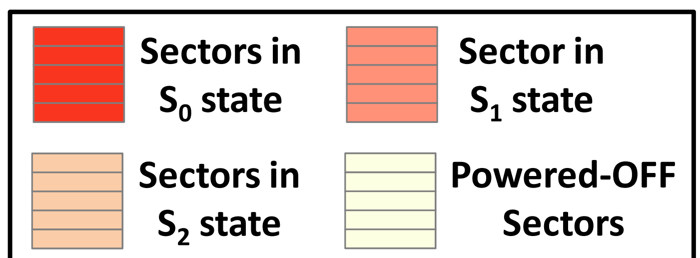
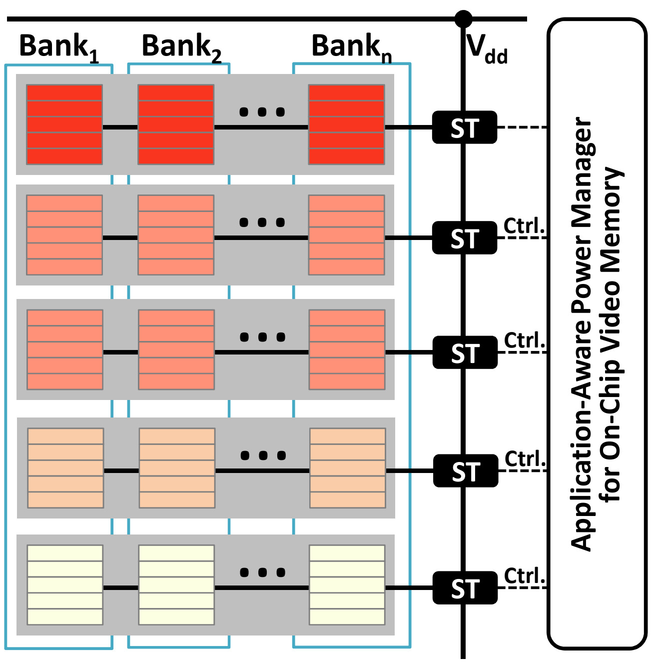


Macroblock-Level Power Management

Macroblock-Level

- Switch only between ON S_0 and state-retentive S_1 and S_2

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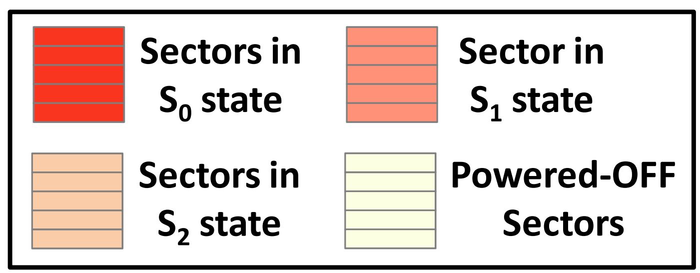
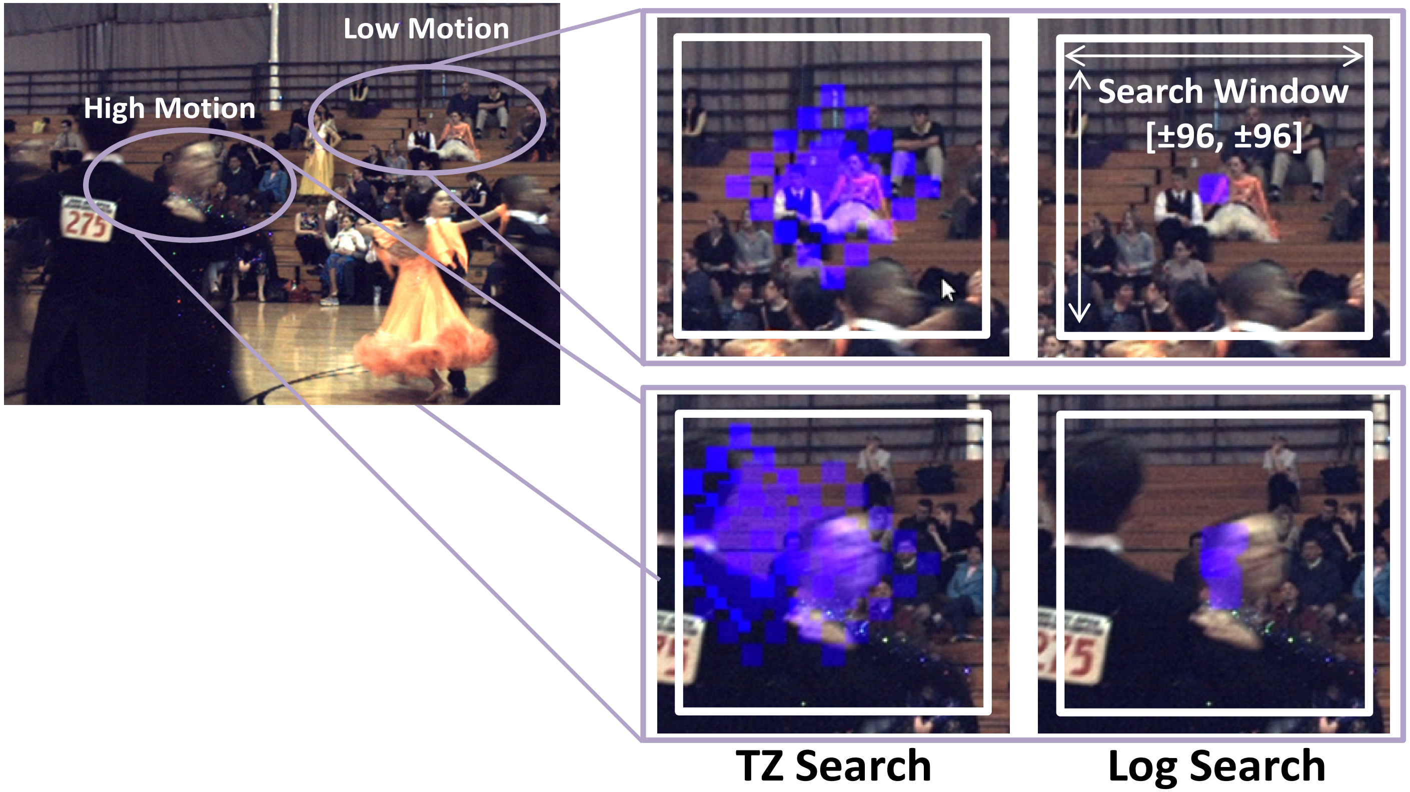


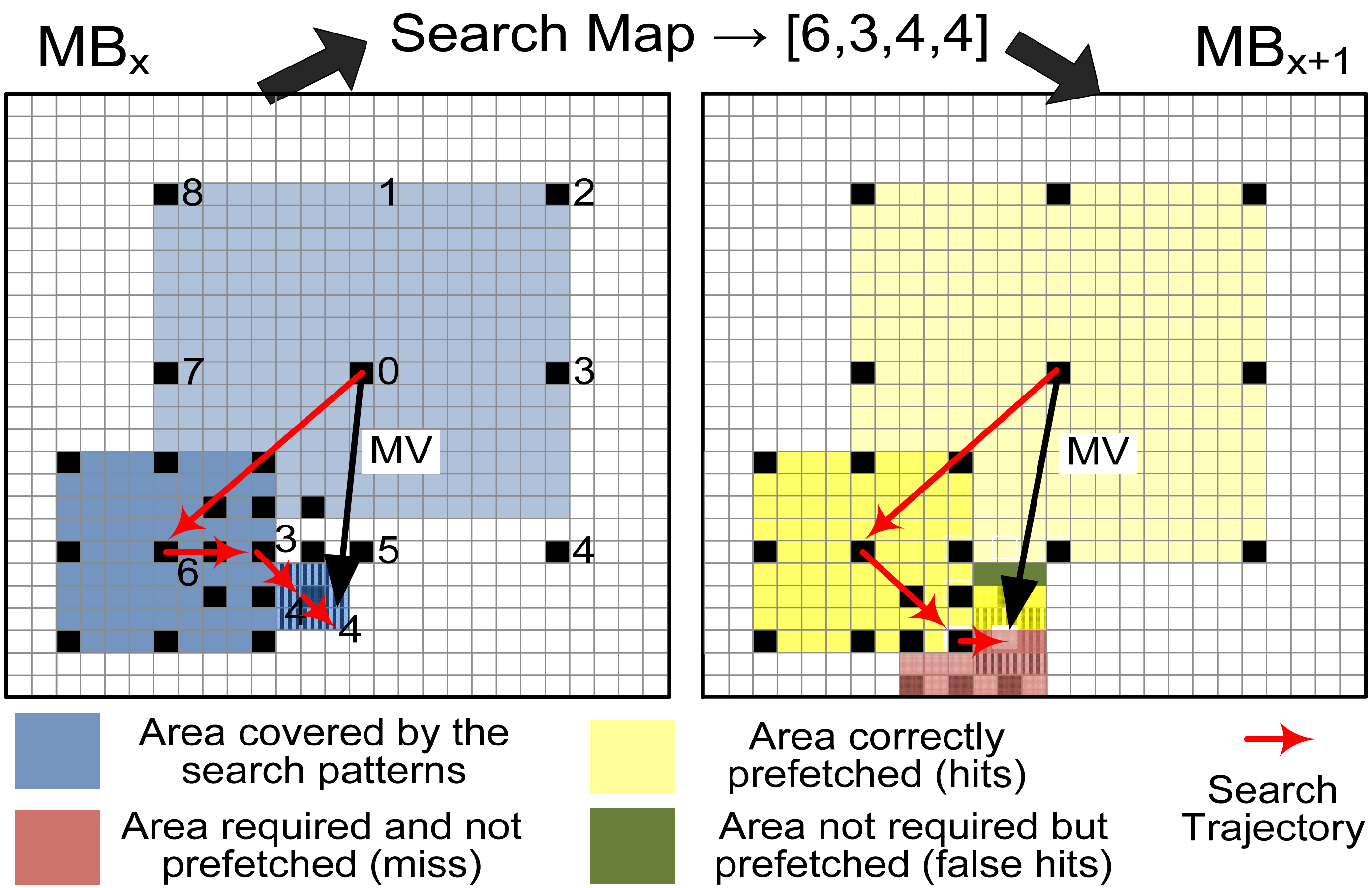
Dynamic Expanding Search Window

- The usage of search window samples depends on the MB characteristics, search direction and search pattern

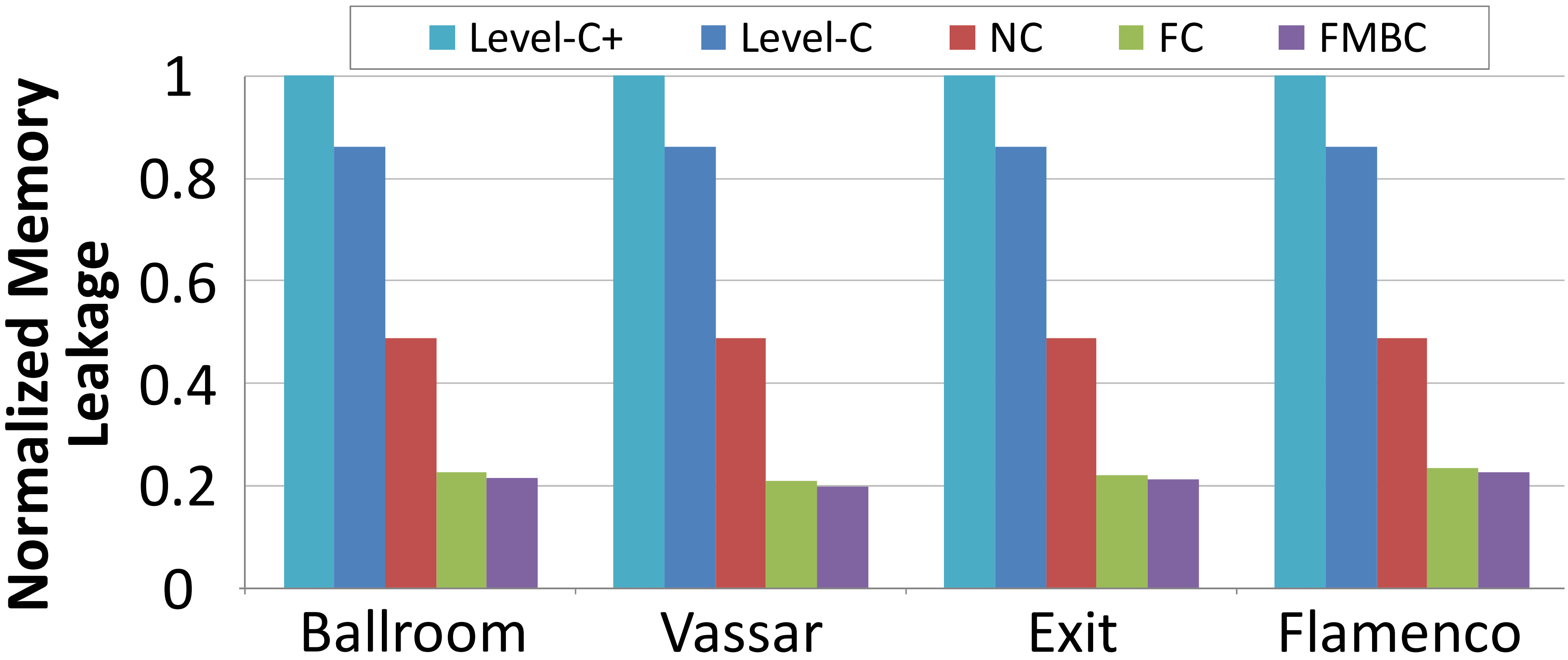


Dynamic Expanding Search Window

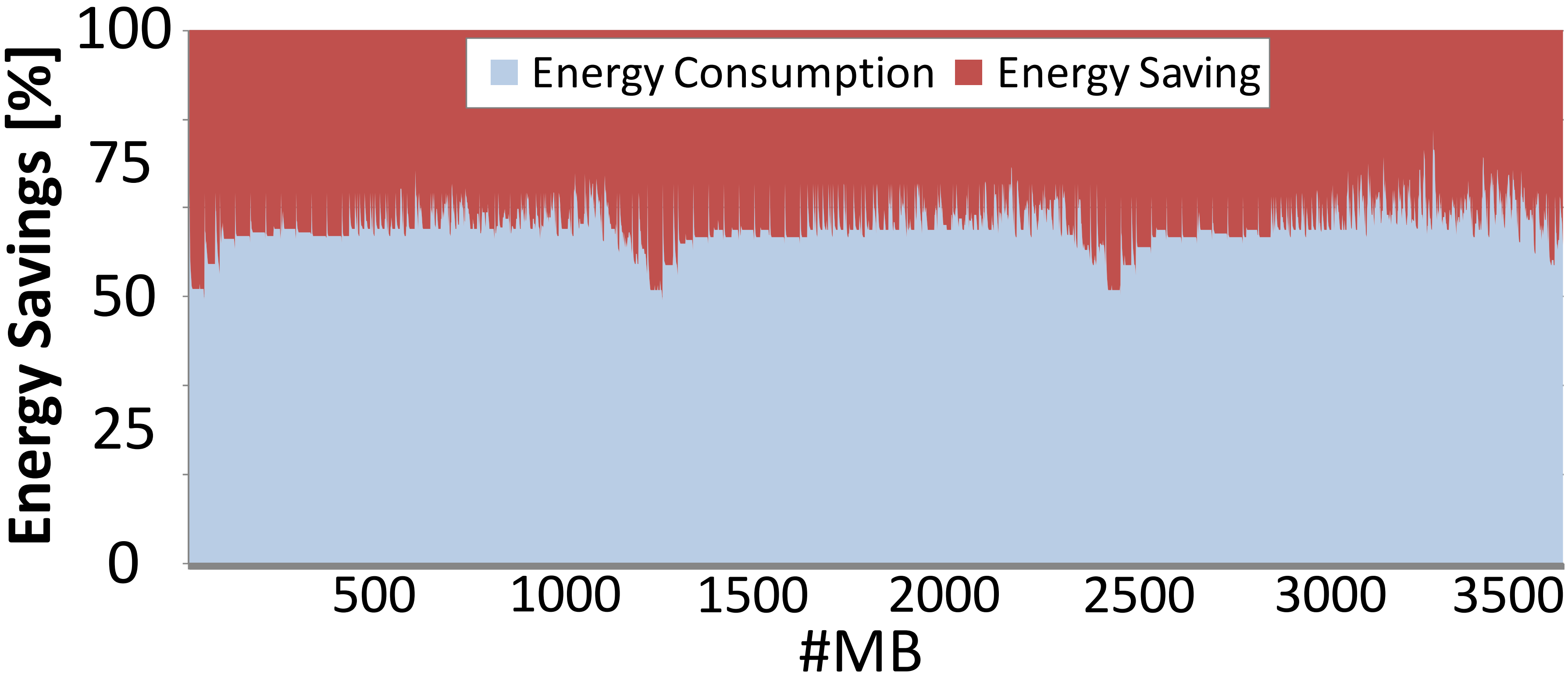
- Search window-based → Dynamic expanding window



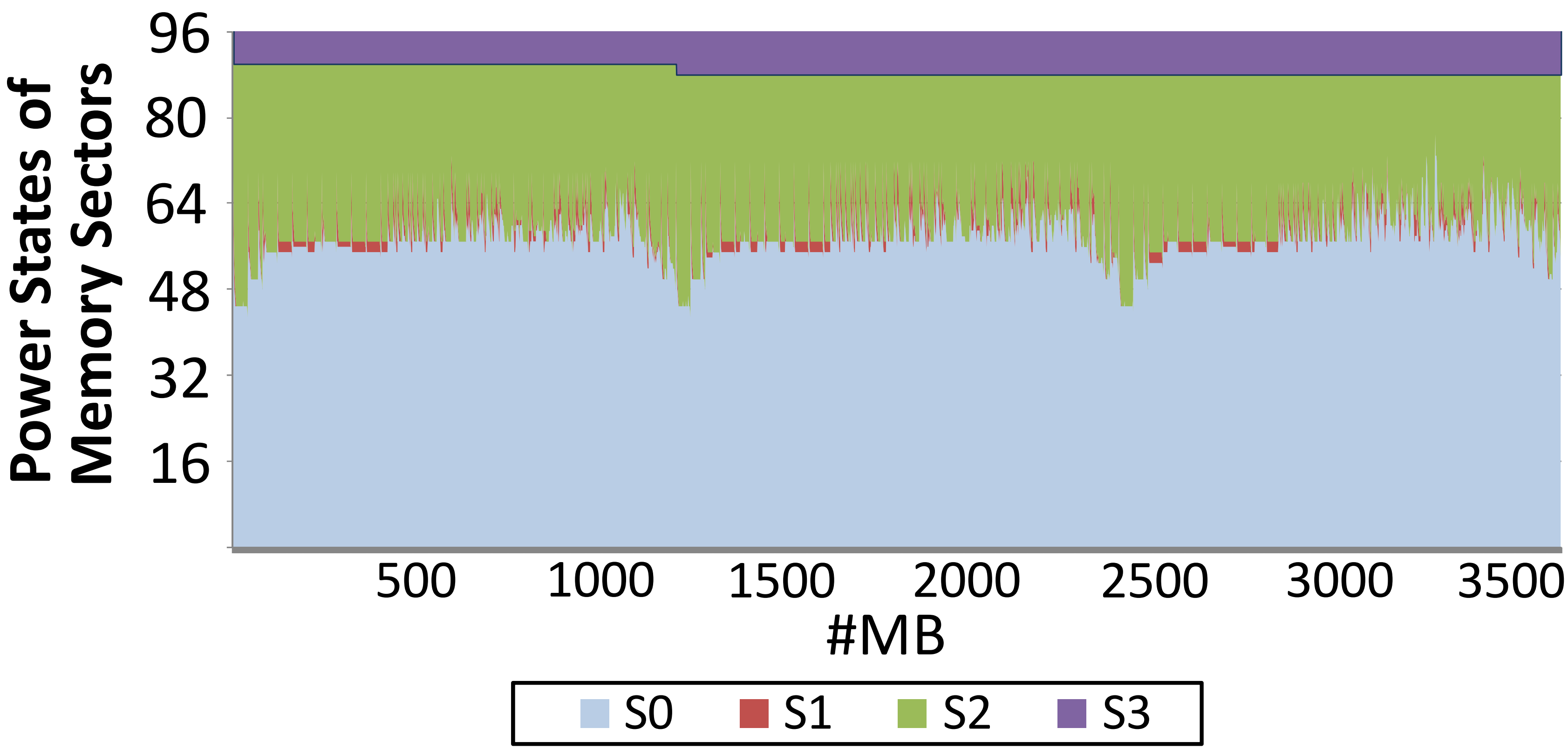
Normalized Leakage Savings



Results on Leakage Savings

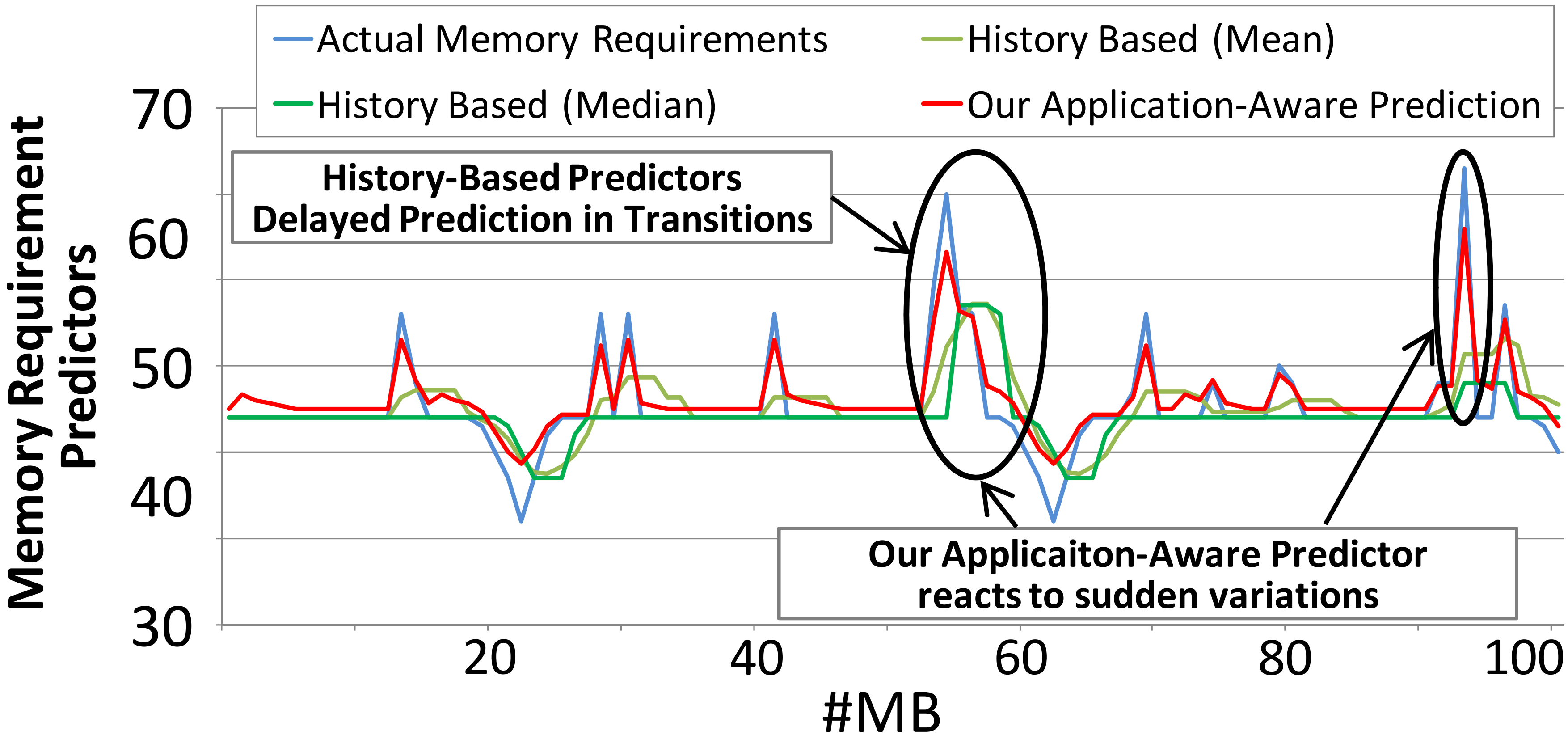


Results on Leakage Savings

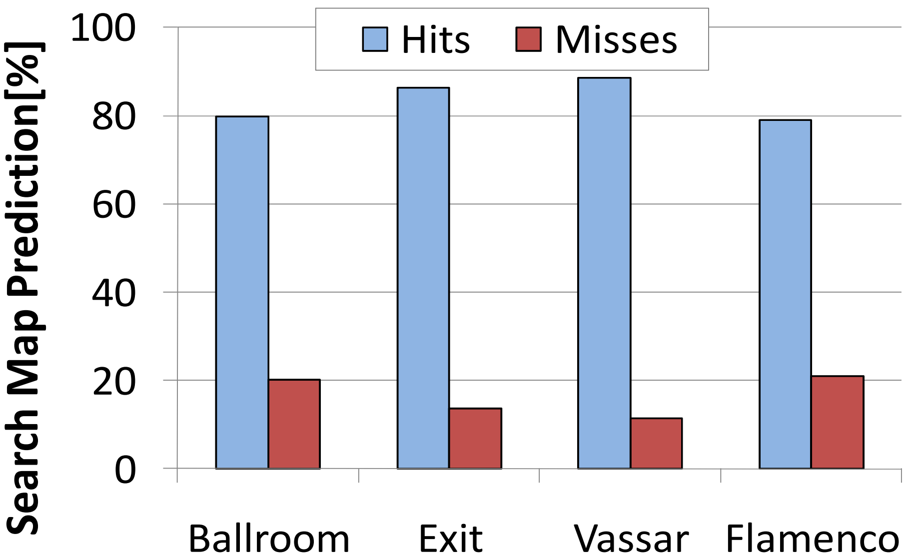


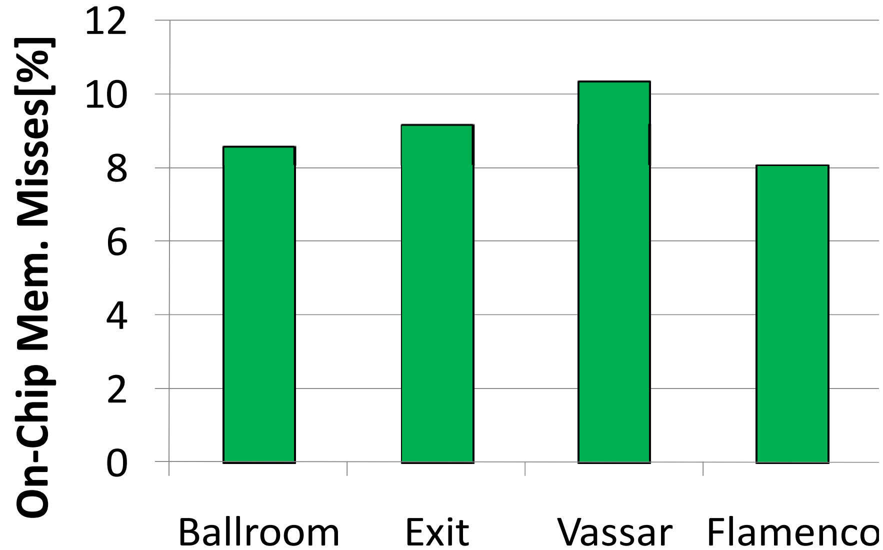
- S_3 is defined at frame level → non-state retentive
- S_2 is preferred at MB- and MB Group-levels

Prediction Accuracy



Prediction Accuracy and Memory Misses

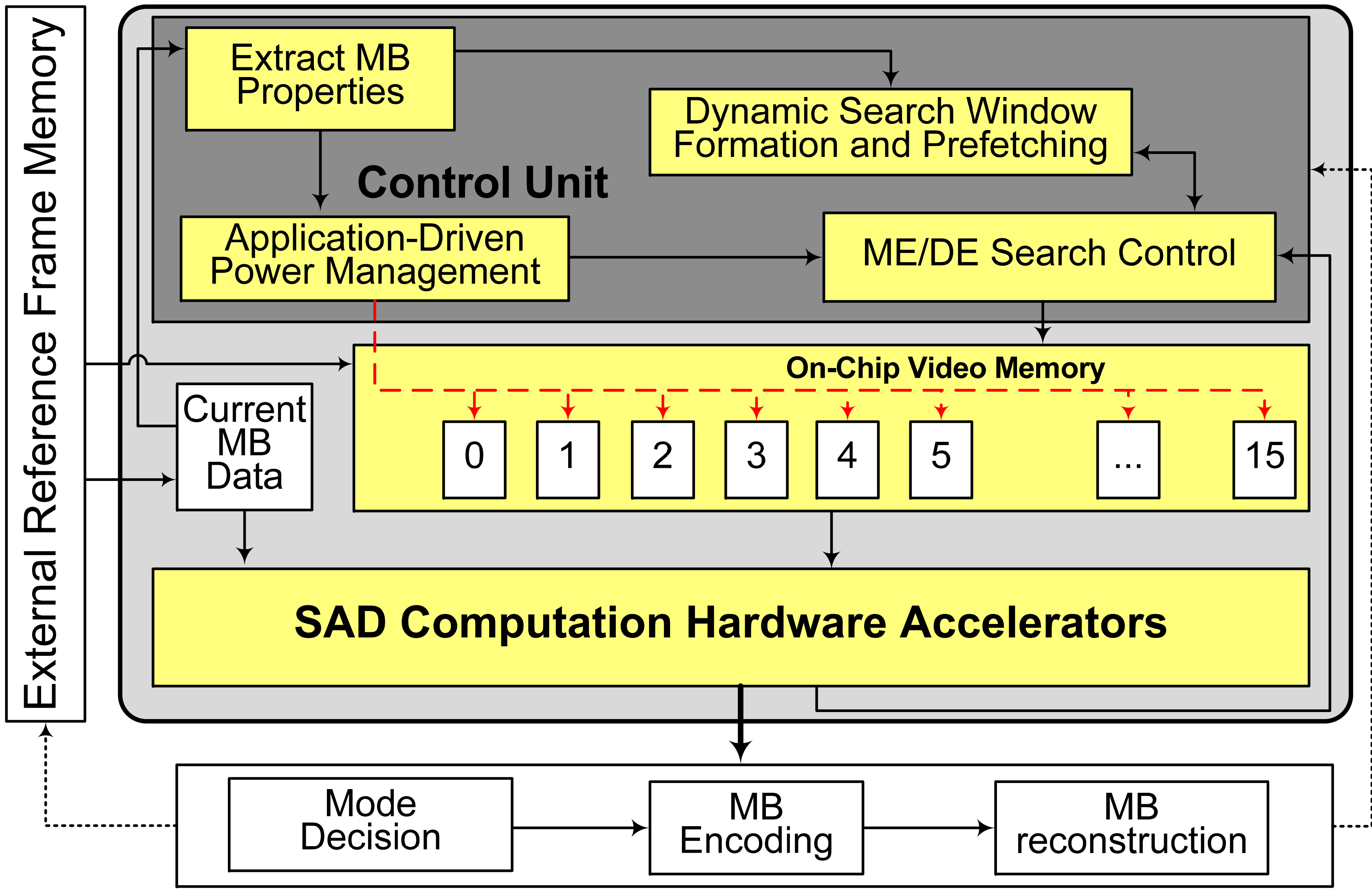




- ***Search map is more accurate for low motion/disparity (e.g., Vassar)***
- ***Hits > 80%***

- ***On-chip misses are higher in low motion sequences***
- ***The search pattern access only the center of the SW***
- ***Less overlapping between neighbor MB SWs***

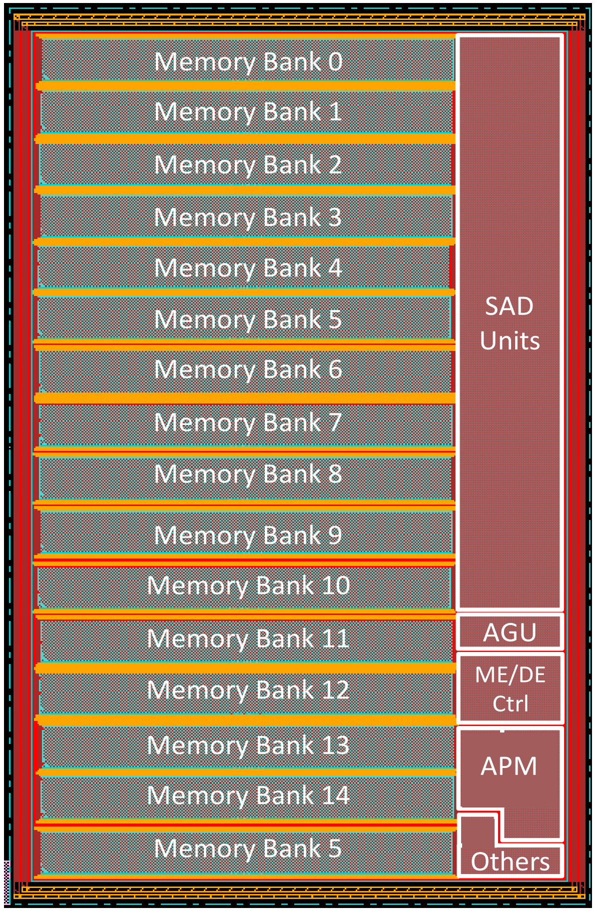
ME/DE Hardware Architecture



Hardware Results

- Our motion & disparity estimation hardware
  - 64x4-pixel SAD
  - 21 SAD trees
- Savings
  - 78% intra-chip power
  - 66% gate count

	Tsung@ICASSP'09	Architecture with our on-chip video memory
Technology	TSMC 90 nm Low Power LowK Cu	IBM ST 65 nm LPe, Low K, 7 metal layer
Gate Count	230k	102k
SRAM	64 Kbits	832 Kbits
Frequency	300 MHz	300 MHz
Power	265mW, 1.2v	57mW, 1.0v
Throughput	4-views 720p	4-views HD1080p



Publications

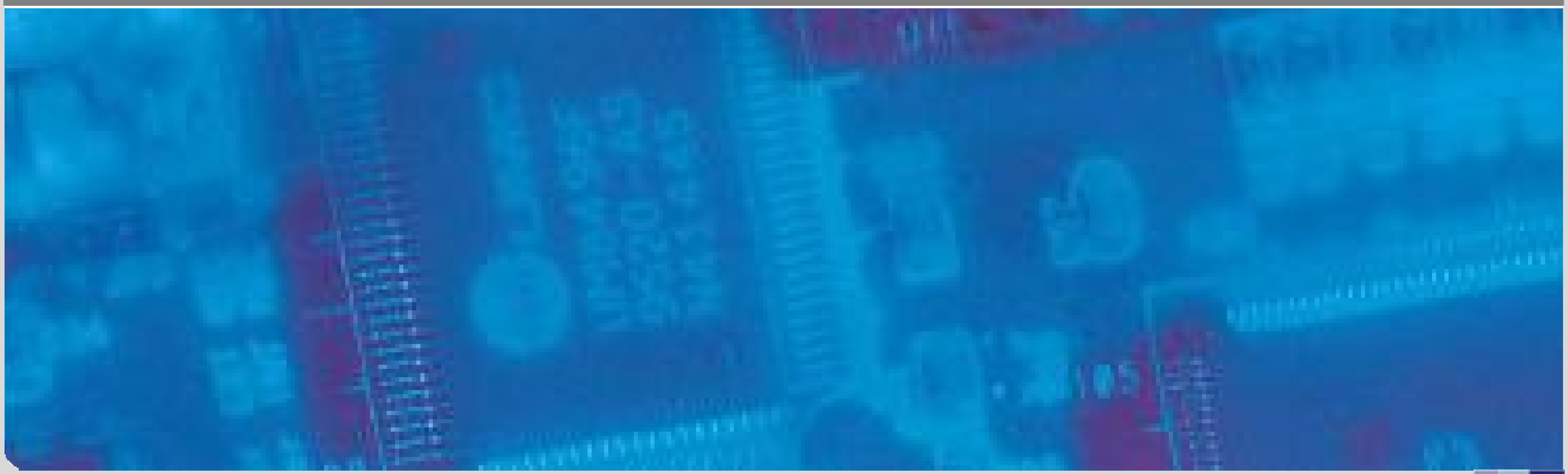
- M. Shafique, B. Zatt, F. Walter, S. Bampi, J. Henkel**, "***Adaptive Power Management of On-Chip Video Memory for Multiview Video Coding*"**, ACM/EDAC/IEEE 49th Design Automation Conference (DAC´12)**, San Francisco, United States (accepted).
- B. Vizzotto, B. Zatt, M. Shafique, S. Bampi, J. Henkel, "*A Model Predictive Controller for Frame-Level Rate Control in Multiview Video Coding*", **IEEE International Conference on Multimedia & Expo (ICME´12)**, Melbourne, Australia, 2012 (accepted).
- M. Shafique, B. Zatt, J. Henkel, "*A Complexity Reduction Scheme with Adaptive Search Direction and Mode Elimination for Multiview Video Coding*", **29th Picture Coding Symposium (PCS´12)**, Krakow, Poland, 2012 (accepted).
- B. Zatt, M. Shafique, F. Sampaio, L. Agostini, S. Bampi, J. Henkel**, "***Run-Time Adaptive Energy-Aware Motion and Disparity Estimation in Multiview Video Coding*"**, ACM/EDAC/IEEE 48th Design Automation Conference (DAC´11)**, San Diego, United States.
- B. Zatt, M. Shafique, S. Bampi, J. Henkel**, "***A Low-Power Memory Architecture with Application-Aware Power Management for Motion & Disparity Estimation in Multiview Video Coding*"**, IEEE/ACM 48th International Conference on Computer-Aided Design (ICCAD´11)**, San Jose, United States.

Publications

- B. Zatt, M. Shafique, S. Bampi, J. Henkel**, "***Multi-Level Pipelined Parallel Hardware Architecture for High Throughput Motion and Disparity Estimation in Multiview Video Coding*", **IEEE/ACM 14th Design Automation and Test in Europe Conference (DATE´11),** Grenoble, France.
- B. Zatt, M. Shafique, S. Bampi, J. Henkel, "*A Multi-Level Dynamic Complexity Reduction Scheme for Multiview Video Coding*"**, IEEE 18th International Conference on Image Processing (ICIP´11)**, Brussels, Belgium, 2011.
- B. Zatt, M. Shafique, S. Bampi, J. Henkel, "*An Adaptive Early Skip Mode Decision Scheme for Multiview Video Coding*", **28^{th} Picture Coding Symposium (PCS´10)**, Nagoya, Japan, 2010.
- M. Shafique, B. Zatt, S. Bampi, J. Henkel, "*Power-Aware Complexity-Scalable Multiview Video Coding for Mobile Devices*", **28^{th} Picture Coding Symposium (PCS´10)**, Nagoya, Japan, 2010.

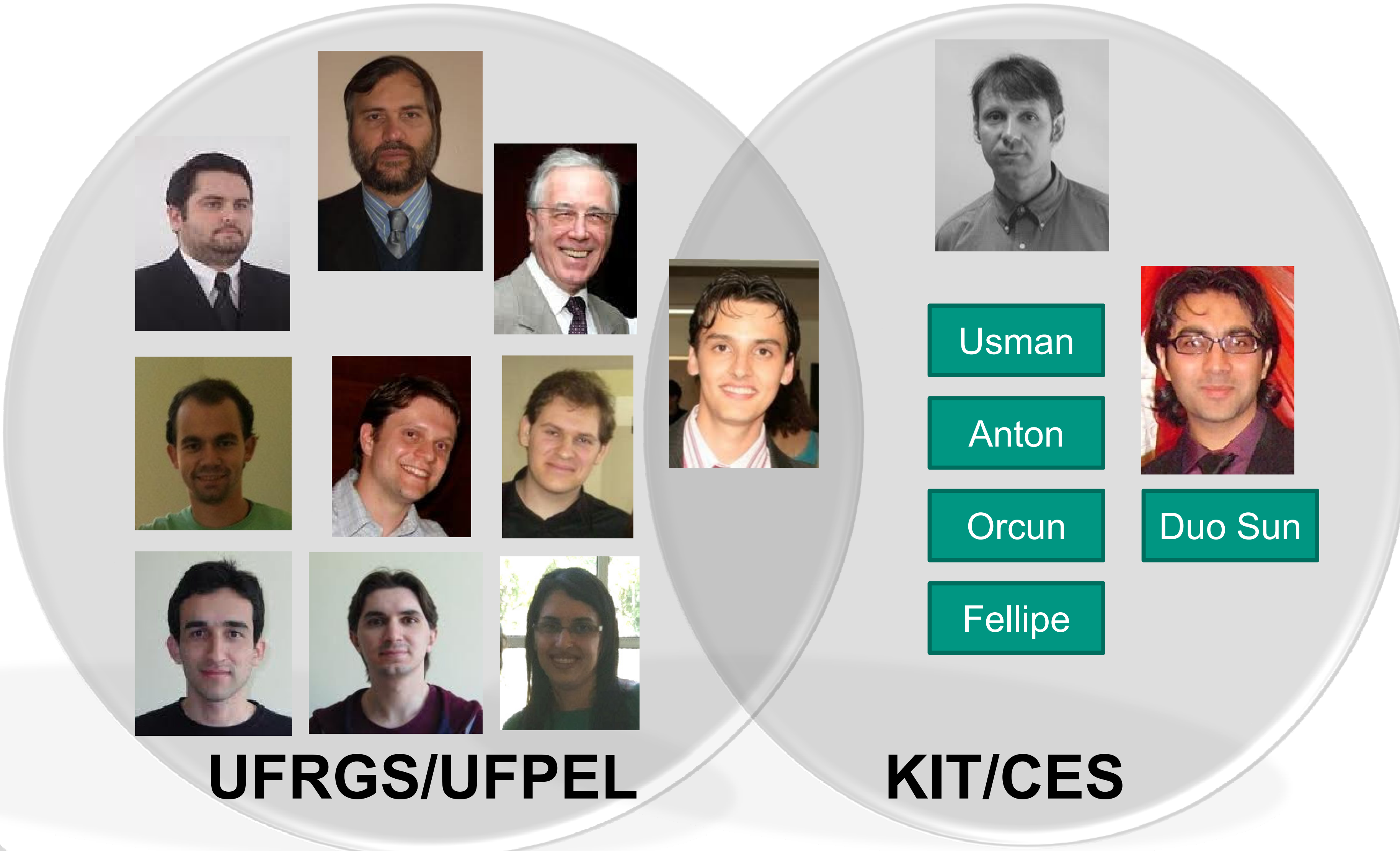
VideoArch^{3D}
CAPES/DAAD PROBRAL Project

CES – Chair for Embedded Systems



M. Shafique @ EMICRO, 26th April. 2012,
São Miguel das Missões, Brazil

VideoArch^{3D} Team



VideoArch^{3D} Team

- Coordinators
  - Jörg Henkel (KIT)
  - Sergio Bampi (UFRGS)
- Associated Professors
  - Altamiro Susin (UFRGS)
  - Luciano Agostini (UFPEL)
- Team Lead
  - Muhammad Shafique (KIT)
- Senior Members
  - Bruno Zatt (KIT/UFRGS)
- Students
  - M. Usman K. Khan (KIT)
  - Anton Ivanov (KIT)
  - Orcun Tüfek (KIT)
  - Fellipe Lima (KIT)
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  - Cláudio Diniz (UFRGS)
  - Bruno Vizzotto (UFRGS)
  - Felipe Sampaio (UFRGS)
  - Daniel Palomino (UFRGS)
  - Eduarda Monteiro (UFRGS)
  - Cauane Blumenberg (UFRGS)
  - Mateus Grellert (UFPEL)

VideoArch^{3D}

- Goals
  - Power-efficient real-time Multiview (3D) video encoding/decoding of high-resolution multiview videos;
  - Flexibility and Adaptivity:
    - Run-time changing scenarios (battery level, video properties)
    - Support for multiple video coding standards;
- Research Topics
  - Modeling 3D-Videos Properties and Computational Requirements
  - Specialized 3D-Multimedia Manycore Processor Architecture
  - Low-Power Algorithms and System Level Techniques
  - Scalable Distributed Resource Management
  - Complexity Reduction Techniques
  - Parallelization of Multiview Video Coding


Thank you for
Attention!