Video processing SoC

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Outline

- Position and Research targets of System LSI application group

- Activities for video processing SoC
  - Content based ME for MPEG and H.264
  - Video coding based on adaptive tree
  - Selective video encryption
  - Adaptive fast-forwarding

Faculties and research area

System LSI application group

Satoshi Goto

Application Area

Multimedia, Mobile, Ubiquitous

Takaaki Baba

High Level Design and Verification

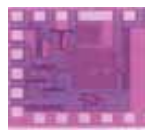
Takeshi Ikenaga

On-chip Memory and CAM

Takeshi Yoshimura

Shinji Kimura

Tsutomu Yoshihara



Logic Design Partitioning and Layout

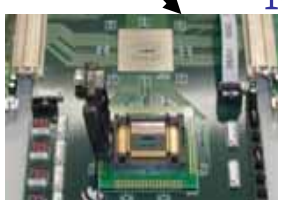
Takahiro Watanabe

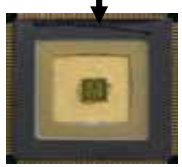
Yasuaki Inoue

Analog Circuit Design and Simulation

Integration of Digital / Analog, MEMS, Sensors and Micro Energy

Toshihiko Yoshimasu





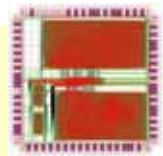
Noriyoshi Yamauchi

Research Target

Knowledge processing

Recognition, Data mining, ..

Security processing



Encryption, Virus detection, ..

Image processing

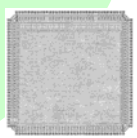


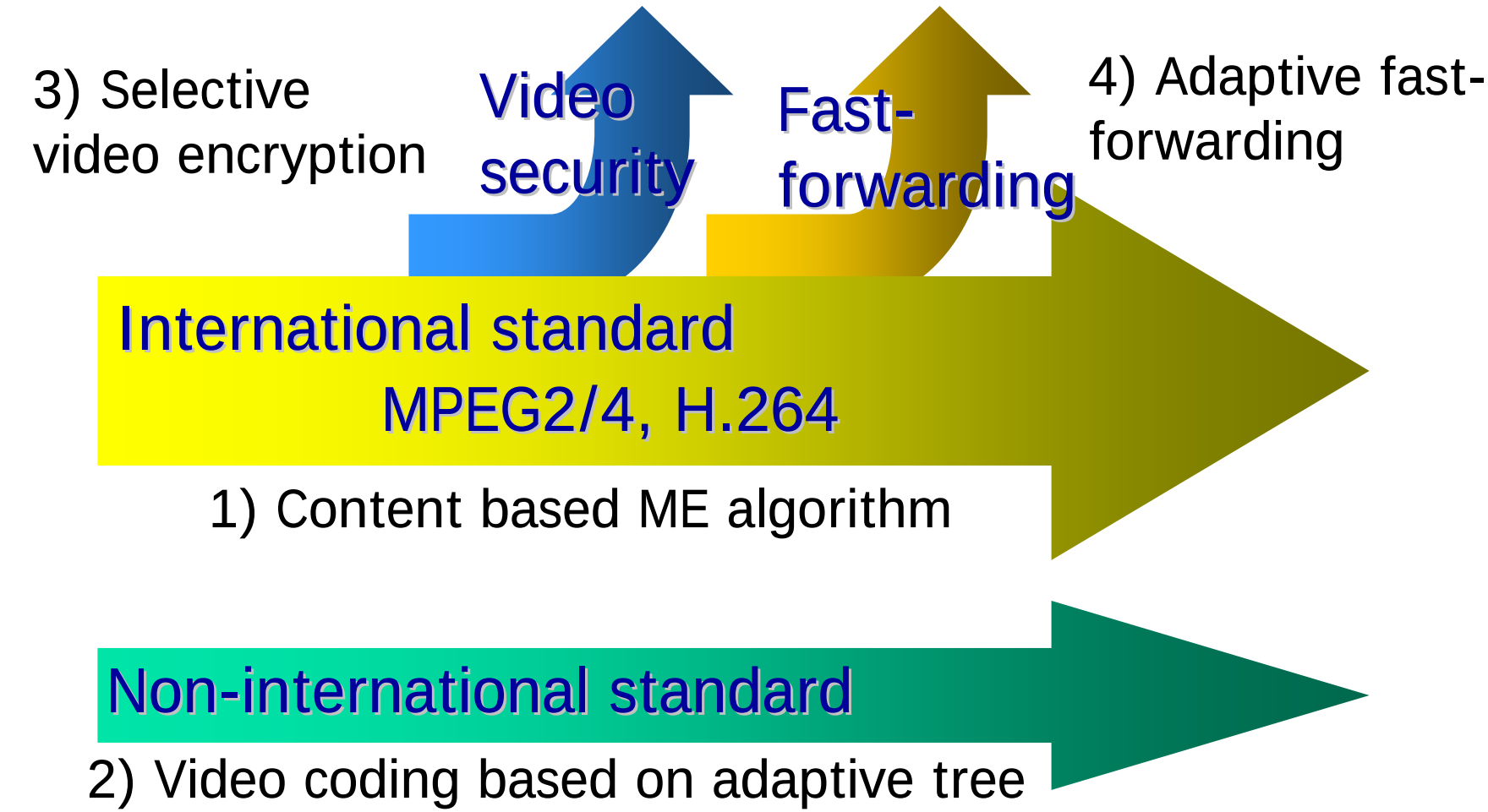
Image coding, Computer graphics, ..

Network processing

Error collection, Adaptive network, ..

Media ⟷ **Communication**

Activity map of video processing SoC



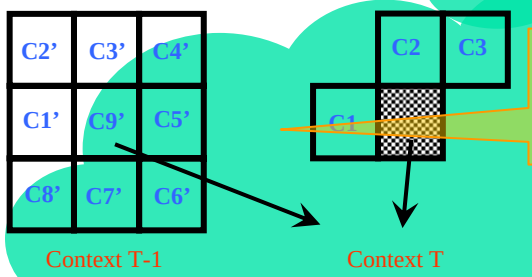
Content-based Motion Estimation with Extended Spatial-Temporal Analysis

1. Video Contents Identification

Recognition of different video nature

2. Content-based Adaptive Algorithm

Dynamic optimization of M.E strategy



Temporal-Spatial analysis on motion vector distribution

T-1		T	Motion type
High	→	High	CHAOS
Low	→	High	
High	→	Low	CRITICAL
Low	→	Low	SIMPLE

Motion type	Search strategy	
	Search Range	Search pattern
SIMPLE	N_{simple}	FS
CRITICAL	$N_{critical}$	FS
CHAOS	N_{chaos}	TSS

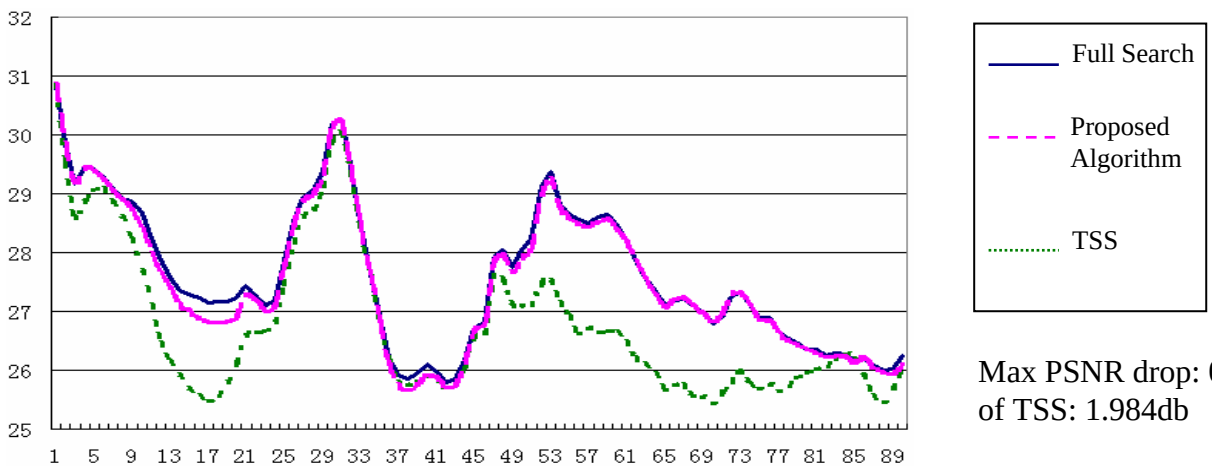
Shen Li, Yong Jiang, Takeshi Ikenaga, Satoshi Goto, "Content-based Motion Estimation with Extended Temporal-Spatial Analysis ", The 47th IEEE International Midwest Symposium on Circuits and Systems (MWSCAS2004), July 2004.

Evaluation Results

1. Computational Complexity in terms of No. Search points / block

	Akiyo	*Carphone*	*Foreman*	*Stefan*	*Football*
FS	961	961	961	961	961
TSS	33	33	33	33	33
Our Method	24.7	25.8	26.1	28.2	37.4

2. Visual quality in terms of PSNR

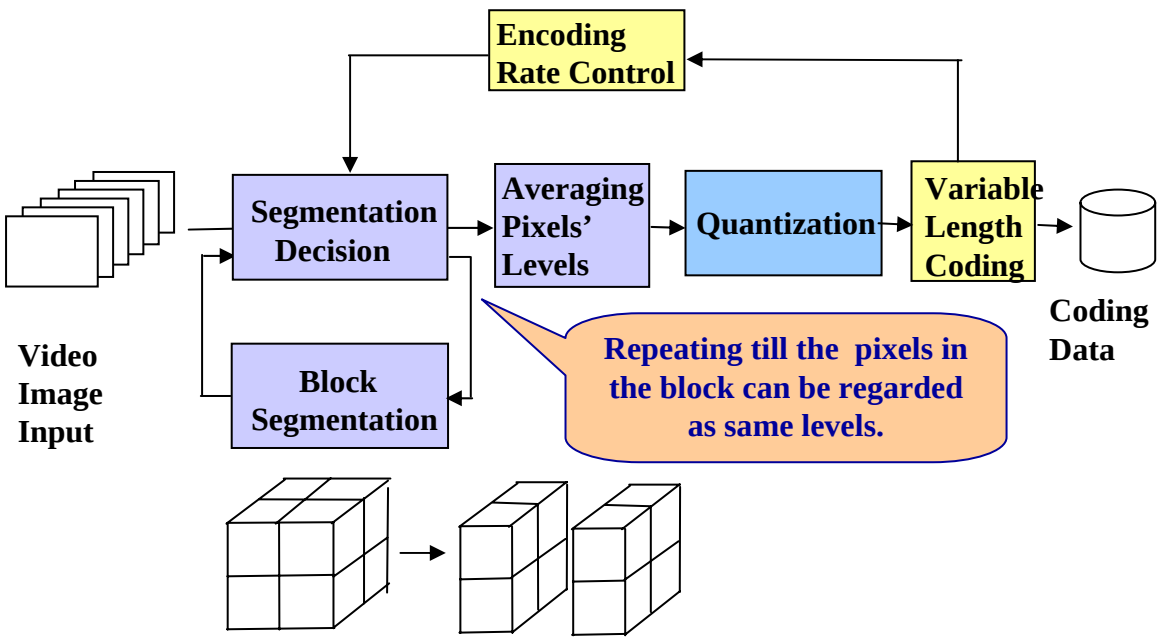


Max PSNR drop: 0.334db, while that of TSS: 1.984db

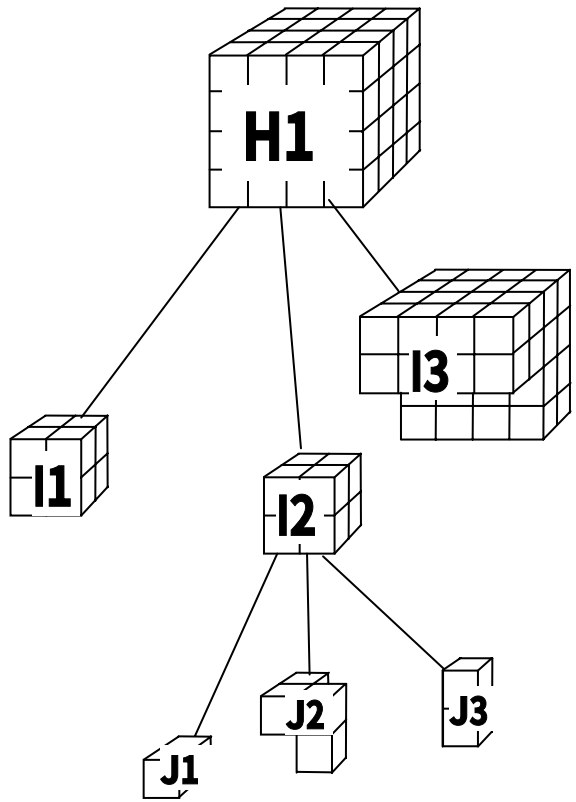
PSNR of Y plane, Stefan (CIF), 90 frames, 1024kbps.

Video Coding Algorithm Based on Adaptive Tree for Low Power Consumption

New Video Encoding for Low Power Consumption



Adaptive Tree



Seiichiro Hiratsuka, Satoshi Goto, Takaaki Baba, Takeshi Ikenaga, "Video Coding Algolithm Based On Adaptive Tree for Low Power Consumption", 2004 IEEE Asia-Pacific Conference on Circuits and Systems (APCCAS2004), Dec. 2004.

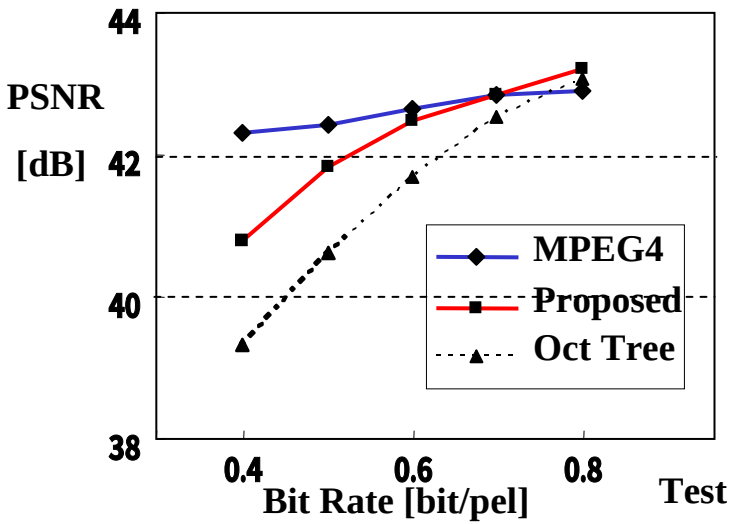
Evaluation Results

Encoding Time

(Pentium 4 2.4GHz)

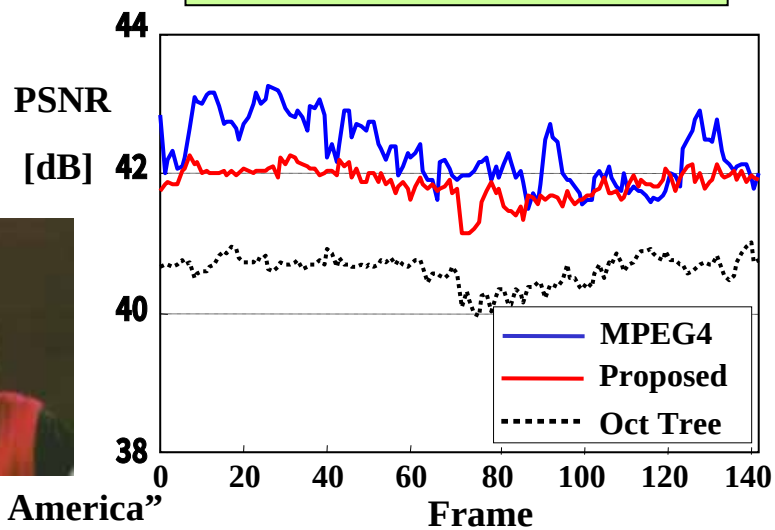
MPEG-4 TM5 (Microsoft Version)	65.7 msec/frame
Proposed Method	5.5 msec/frame
Oct Tree Method	4.6 msec/frame

Rate-Distortion



Test Sequence "Miss America"

Frame Image Quality



Selective Video Encryption Scheme for MPEG Compression Standard

Video Conference

Channel

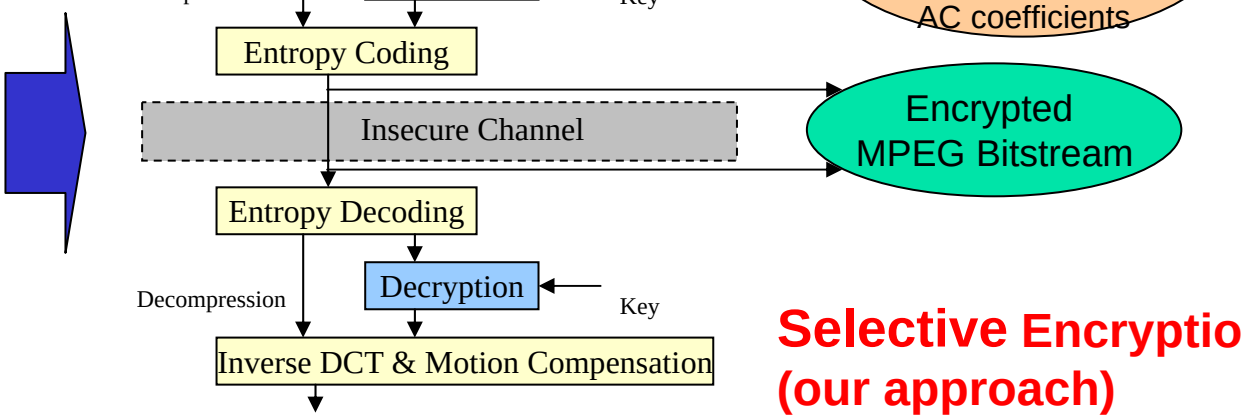
Video Surveillance

Bitrate:

Raw video data: 30-100Mb/s

MPEG1: 1.5Mb/s
MPEG2: 16Mb/s
MPEG4: 32-384Kb/s

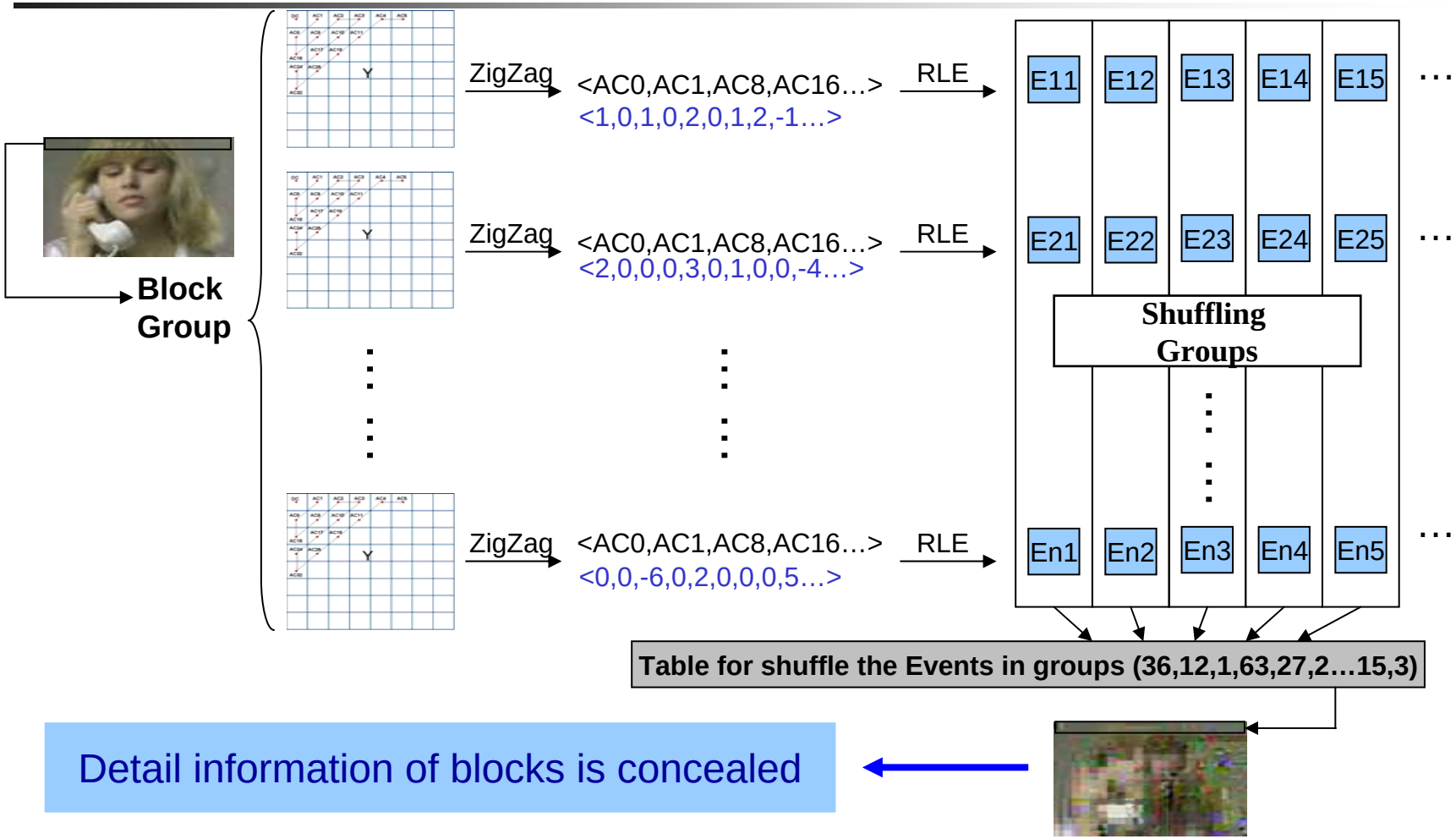
DES / AES



Full Encryption (conventional)

Selective Encryption (our approach)

Event Shuffle



Gang Liu, Satoshi Goto, Takaaki Baba, Takeshi Ikenaga, "No Bit Overhead MPEG Video Scrambling based on Event Shuffle in Frequency Domain", IEEE Asia-Pacific Conference on Circuits and Systems (APCCAS2004), Dec. 2004.

Evaluation results

Evaluation result of processing time

Video Sequence	MPEG encoding Time(ms)	Event Shuffle (proposed method)			Block Shuffle		Subband Shuffle	
		Group Number	Time(ms)	Overhead	Time(ms)	Overhead	Time(ms)	Overhead
”Carphone”	6906	2831	15.09	0.22%	29.30	0.42%	48.03	0.70%
”Susie”	8407	2923	15.10	0.18%	28.56	0.34%	47.80	0.57%
”Foreman”	7343	4065	21.24	0.29%	28.27	0.38%	47.95	0.65%
”Salesman”	4985	4410	23.09	0.46%	29.30	0.59%	48.03	0.96%

Evaluation result of Bit overhead

Scramble Method	**File Size (Byte)**	**Bit Overhead (%)**
No Scramble	**165,617**	**0**
Event Shuffle(ours)	**165,617**	**0**
Sub band Shuffle	**198,409**	**19.8**
Block Shuffle	**259,025**	**56.4**

Sample video sequences of a surveillance camera

6X fixed-speed fast-forwarding (20sec)

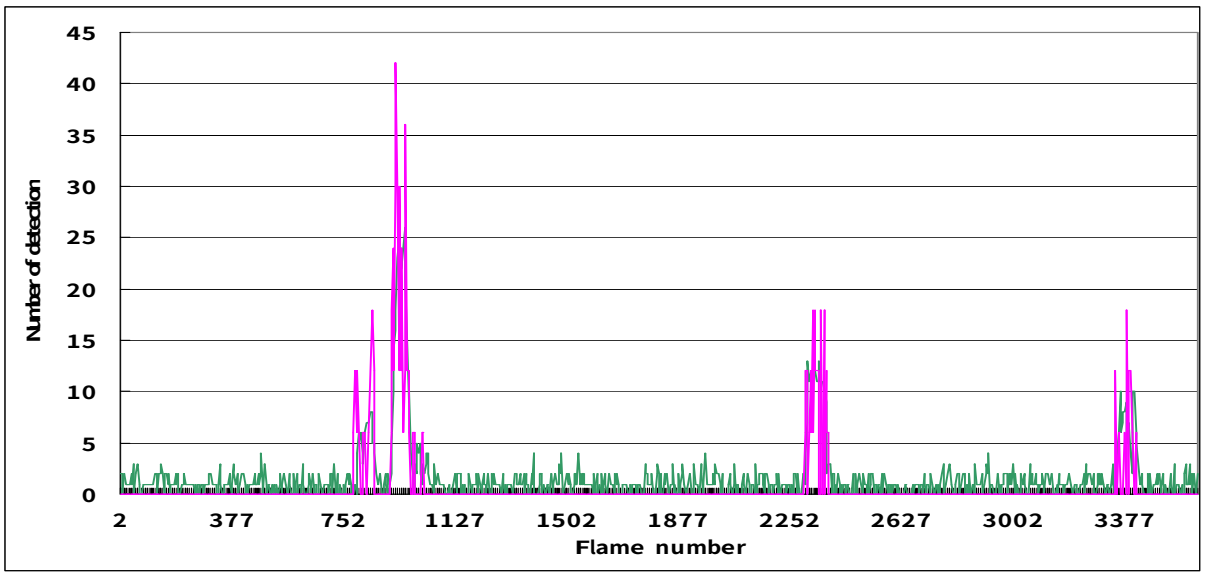
Proposed adaptive fast-forwarding (14sec)

Sample video sequences of a camcorder

5X fixed-speed fast-forwarding (54 sec)

Proposed adaptive fast-forwarding (47 sec)

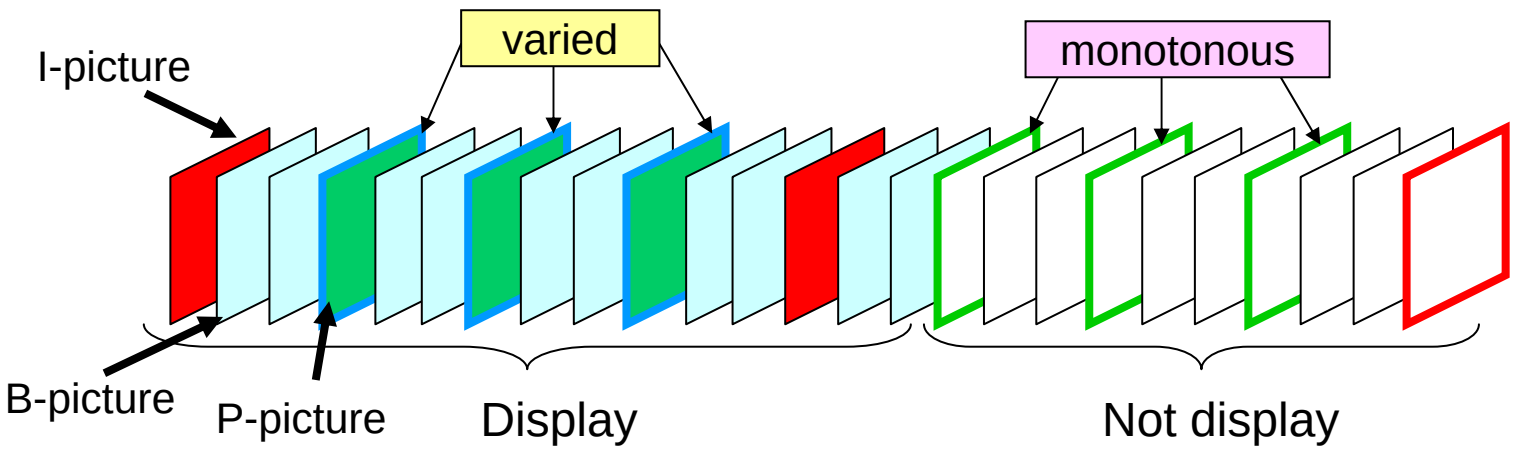
Adaptive fast-forwarding algorithm



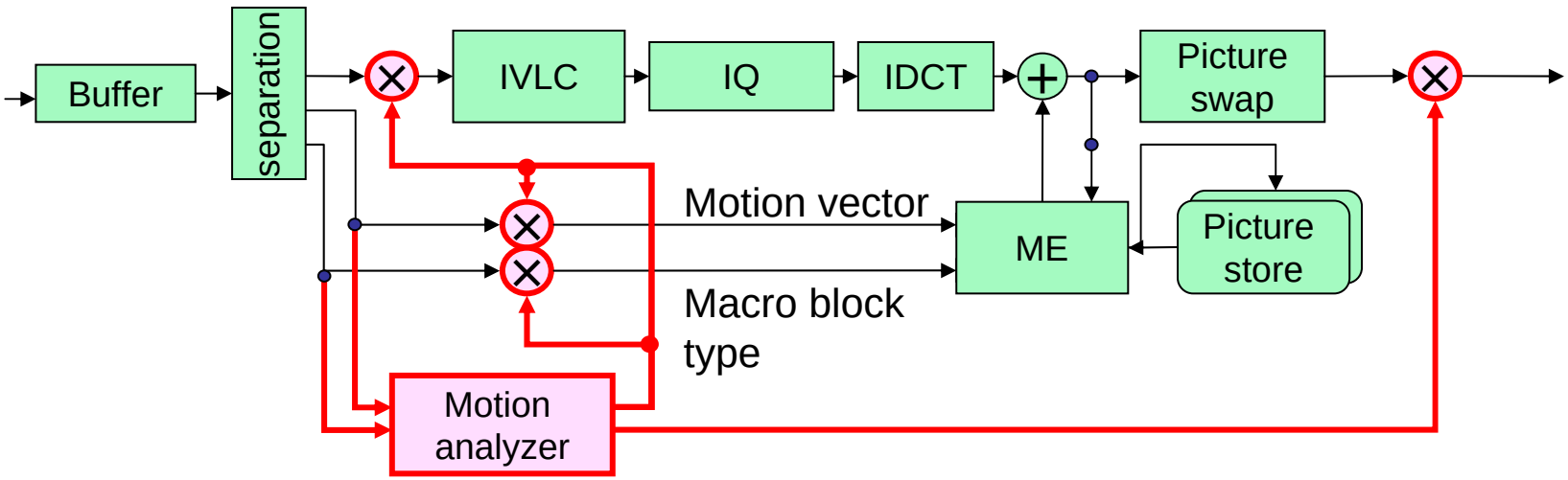
# of motion vector

# of intra block (macro block type)

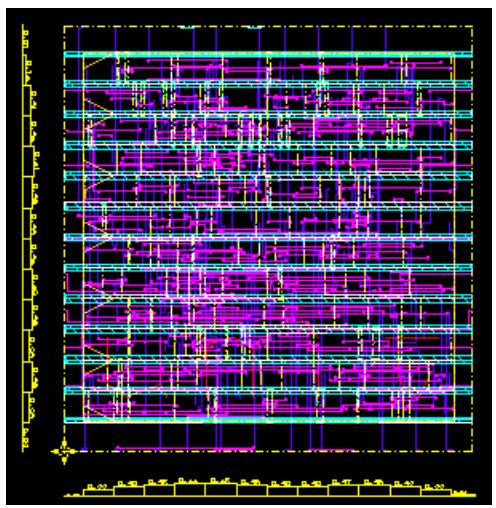
Motion analysis



Hardware evaluation



Process technology：	ROHM 0.35μm
Synthesis tool：	DESIGN COMPILER (synopsys)
Back-end tool：	Apollo(synopsys)
Number of Gate：	502 gates
Area：	0.2×0.2mm^2
Clock frequency：	457MHz



Summary

- System LSI application group challenges to develop various kinds of video processing Soc as well as security and network processing SoCs
- Activities for video processing SoC
  - From MPEG to H.264
  - From standard to non-standard video coding
  - From video coding to value-added new function (encryption, fast-forwarding, ..)