Security Level:

WORKSHOP ON FUTURE VIDEO CODING (APPLICATIONS):

CHALLENGE AND REQUIREMENTS FOR THE SURVEILLANCE VIDEO

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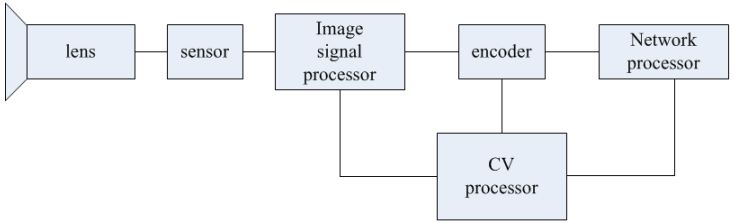
Hisilicon – a Huawei Subsidiary

- **Huawei**
  - A global company with business in communication device, enterprise, and consumer products, revenue in 2015 is expected to exceed $50 billions
  - Seeing skyrocket growth of video in its communication pipes, is shifting the strategic services from voice, to data, and to video centric.
- **Hisilicon – a Huawei subsidiary**
  - Focus on the ASIC solutions for the applications in cellular network equipments, networking, consumer electronics, and home communication terminals.
  - Started the Codec silicon solutions since 2003. Its video technology and solutions have been used in smart phones, video conference systems, digital TV, set-top box, and surveillance systems,
  - One of the earliest companies to embrace the newest HEVC into applications. The first SoC provider to bring HEVC encoder and decoder into the surveillance market(2014).

Codec in Surveillance Applications

- 3 major product forms
  - DVR (digital video recorder)
  - NVR (network video recorder)
  - IPC (IP camera)
- Global markets(industrial/commercial)
  - 150 million units in 2014
  - 50% annual increase for IPC demand
  - Over 400 million units in 2020

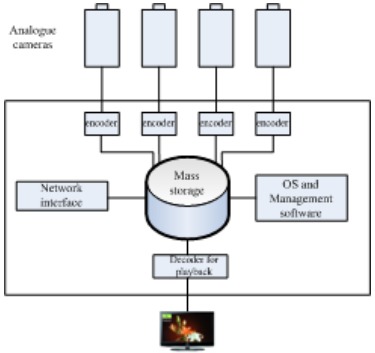
IPC system



- ISP and encoder integrated
- May contain powerful CPU for video analysis
- Output encoded streams

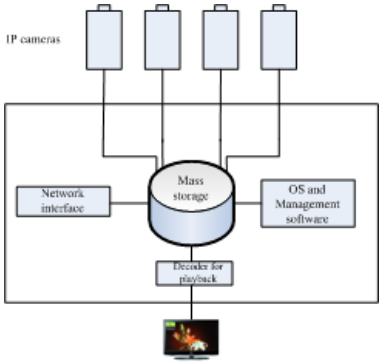
DVR system

- Receive analogue camera inputs
- Array of encoders
- Storage and services
- Decoder and playback
- Video analysis tools



NVR system

- Receive encoded stream inputs
- Storage and services
- Decoders and playback
- Video analysis tools



Challenges and Requirements in Surveillance Video (1) – 24/7 recording

Mass surveillance data in the Digital Universe:

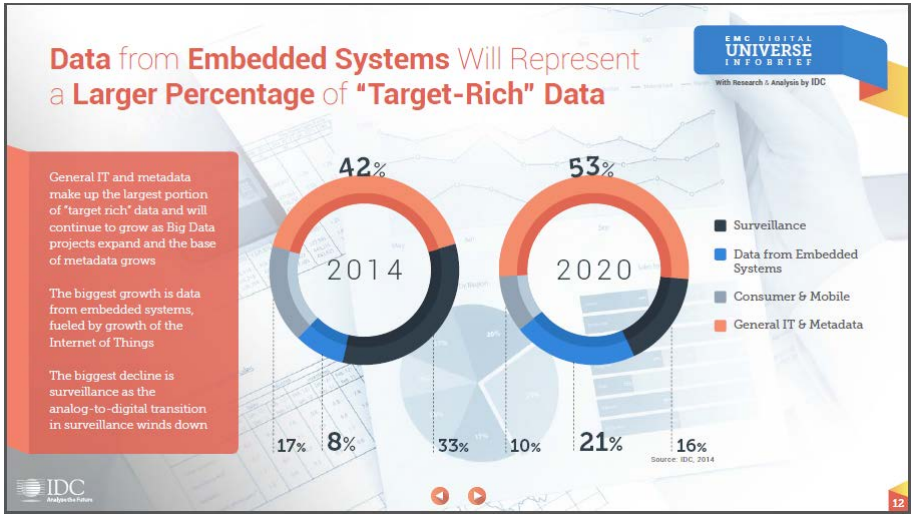
- According to IDC, surveillance data grow from 1.45ZB in 2013 to 7.0ZB in 2020.
- "The Telegraph" : "The British Security Industry Authority (BSIA) estimated there are up to 5.9 million closed-circuit television cameras in the country, including 750k in sensitive locations such as schools, hospitals and care homes, estimated one camera for every 11 people in the UK" .
- Wikipedia: "the government of China has installed over 20 millions surveillance cameras across the country. Officials said that in 4 years up to 2012, 100,000 crimes has been solved with the aid of cameras" . The market could grow 15% annually, cited by Wall Street Journal.

Multiples of bytes V·T·E

Decimal			Binary		
Value	Metric		Value	IEC	JEDEC
1000	kB	kilobyte	1024	KiB kibibyte	KB kilobyte
1000^2	MB	megabyte	1024^2	MiB mebibyte	MB megabyte
1000^3	GB	gigabyte	1024^3	GiB gibibyte	GB gigabyte
1000^4	TB	terabyte	1024^4	TiB tebibyte	–
1000^5	PB	petabyte	1024^5	PiB pebibyte	–
1000^6	EB	exabyte	1024^6	EiB exbibyte	–
1000^7	ZB	zettabyte	1024^7	ZiB zebibyte	–
1000^8	YB	yottabyte	1024^8	YiB yobibyte	–

Orders of magnitude of data

Courtesy to IDC



Massive surveillance video, specific consideration in compression efficiency is required.

Challenges and Requirements in Surveillance Video (2) – low bit rates

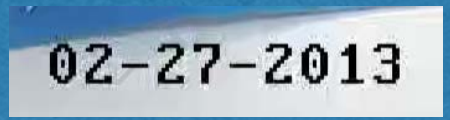
Typical bit rates – for single P reference frame, GOP is 2 seconds.

	AVC				HEVC				Future			
	Ultra low	Low	Med	High	Ultra low	Low	Med	High	Ultra low	Low	Med	high
1080p30	<< 2 Mbps	2 Mbps	4 Mbps	8 Mbps	<< 1 Mbps	1 Mbps	2 Mbps	4 Mbps	<< 500K bps	500K bps	1 Mbps	2 Mbps
4Kp30		6 Mbps	12 Mbps	24 Mbps		3 Mbps	6 Mbps	12 Mbps			3 Mbps	6 Mbps
4Kp60												

At low bit rates, artifacts are much more prominent, causing disturbing viewing experience

As being seen in HEVC, achieving superior subjective picture quality in low bit rates is very challenging

- **Ringing artifact**
- **Block and Pattern**
- **Trailing/ghost**



Ringing

Pattern

Trailing

While compression efficiency is required for low bit rates, artifacts should be confined.

Challenges and Requirements (3) – noisy and low light conditions

Video from different sensors and lens

IR sensors

- Low dynamic range
- No color
- Noisy

RGBIR sensors

- Low cost sensor for RGB and IR
- Interference

Fish eye lens

- Deformed format
- Irregular motion

Under extremely low light condition, video is very noisy

Noisy video

- Original video captured under the extreme low light condition is very noisy. Light source could be as low as 0.01 lux (1 lux is one candle light) using regular sensor
- Noisy video causes significantly unpleasant visual artifacts due to large transform sizes (some claimed that HEVC performed worse than AVC under the noisy condition, even at the same bit rate).
- Noisy video significantly reduce the compression efficiency. Considerable amount of residual noise may still present at the input of the encoder even though Noise reduction technologies have be applied.

Noise could significantly impact the compression efficiency, causing artifacts.

Challenges and Requirements (4) – subjective video quality assessment

Subjective video quality vs. objective metrics

RDO using perception based metrics

Fixed QP video quality assessment

- PSNR does not reflect the video quality well, specially in the low bit rates
- How to "translate" the subjective video quality assessment into the objective video quality metrics
- How to "measure" the unpleasant artifacts which could occur locally but have significant impact for the overall video quality
- The averaged objective picture quality metrics may not reflect the video quality requirement – in the video industry, "impulse" bad picture quality may override the overall picture quality gain.

video quality assessment under the rate control

- Rate control is not only for controlling rate, also an efficient way to improve subjective video quality.
- Under the low bit rate conditions, the video quality is very sensitive to the bit rate control at the block level.
- Rate control with video quality assessment should be implemented in the reference model.

Objective metrics other than PSNR is required to reflect better subjective video quality.

Challenges and Requirements (5) – video analysis and intelligent coding

The advance of the computer vision and its association with the video coding technology becomes a trend for the intelligent use of video data.

There could be two folds in using the video analysis

How to use the video analysis results to improve the coding efficiency

- Object detection (tag, face, etc.)
- Intelligently allocate bits in the regions of interest
- Improve the subjective video quality

Computer vision

- Use the decoded video for the video analysis, therefore certain encoded quality is required.
- Video synopsis, another form of "video compression"
- Descriptive "video compression"

Video analysis can be used to aid the subjective video quality.

Challenges and Requirements (6) – efficient use of background information

Significant amount of the surveillance use cases have fixed background without change for a long period of time.

Use the background info to improve the compression efficiency

- Most surveillance video are captured by fixed mount cameras, with non-moving background
- Long-term reference and/or background modeling is effective in reducing bit rate
- Further tools could be leveraged to improve the compression efficiencies.

Background information could be useful for further improving the compression efficiency for typical surveillance video.

Challenges and Requirements (7) – WDR, DRC, and HDR

Surveillance video is not for entertaining, but HDR feature is still desired.

- N → 1 WDR sensor to generate content with high dynamic range
- Expect to see details in the small dark areas in the bright background
- HDR activities in the standard bodies are closely followed.

WDR sensors and DRC technologies improve picture quality in low-light and HDR scenes.

Thank you

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