Designing an IP Surveillance Camera on a Single, Low-cost FPGA

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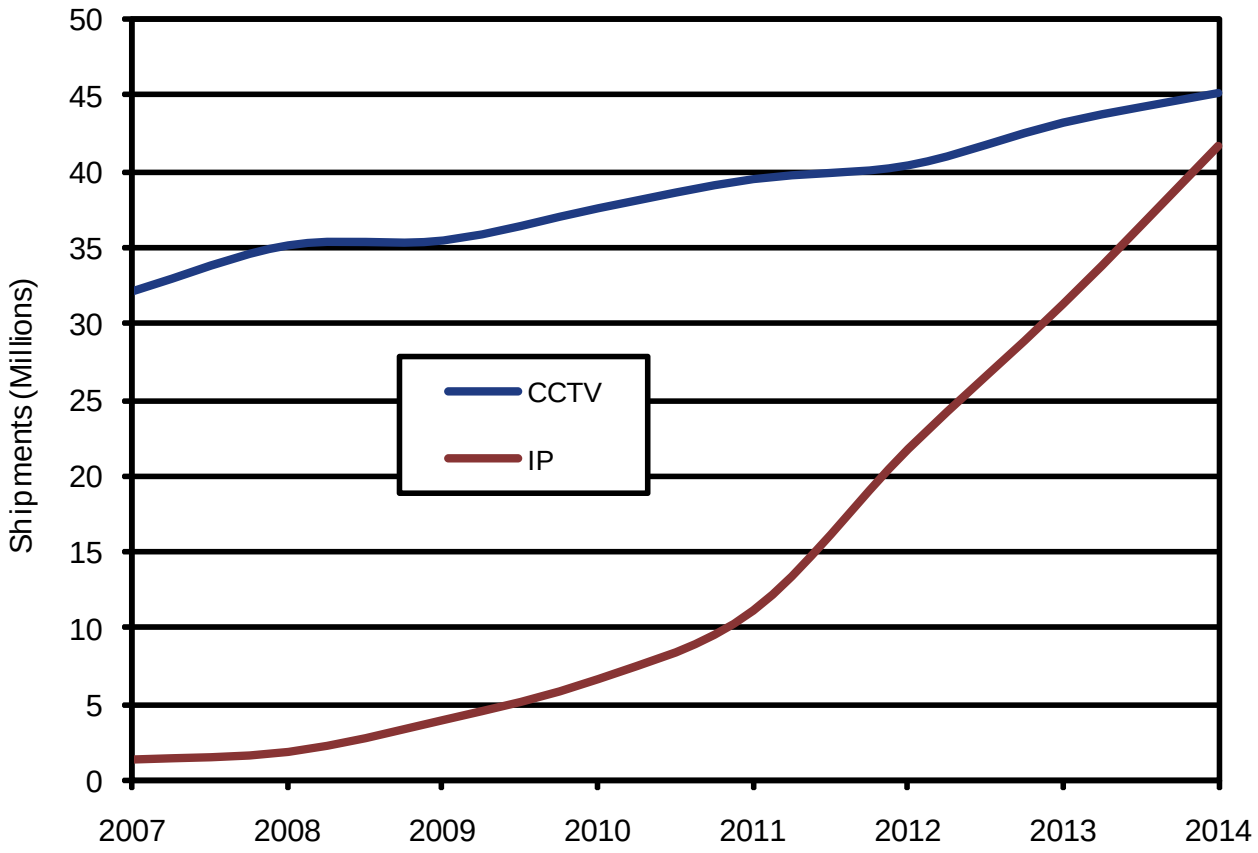
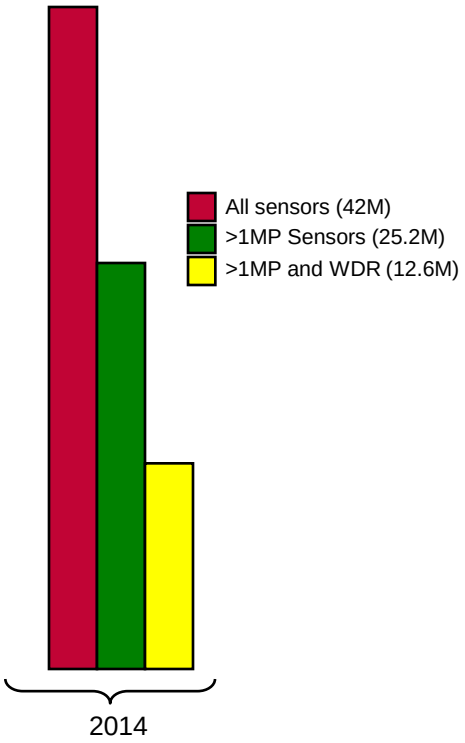
Market Trends in Video Surveillance

- Conversion from analog to digital
  - Driven by need for higher quality video, higher resolution, and more flexibility and features
- Conversion from SD to HD
  - HD video must be digital – this upgrade is symbiotic with the conversion of analog to digital
- Adoption of wide dynamic range (WDR) sensors
  - Digital cameras are now adopting a new class of image sensor that can operate in very low (and high) lighting conditions
- Introduction and adoption of analytics
  - Moving to digital means that video can be analyzed by machines instead of people
- More administration flexibility
  - Users value being able to add cameras on the fly, even wirelessly, and monitor and control the surveillance video from anywhere

IP Camera vs. Analog Camera Shipments

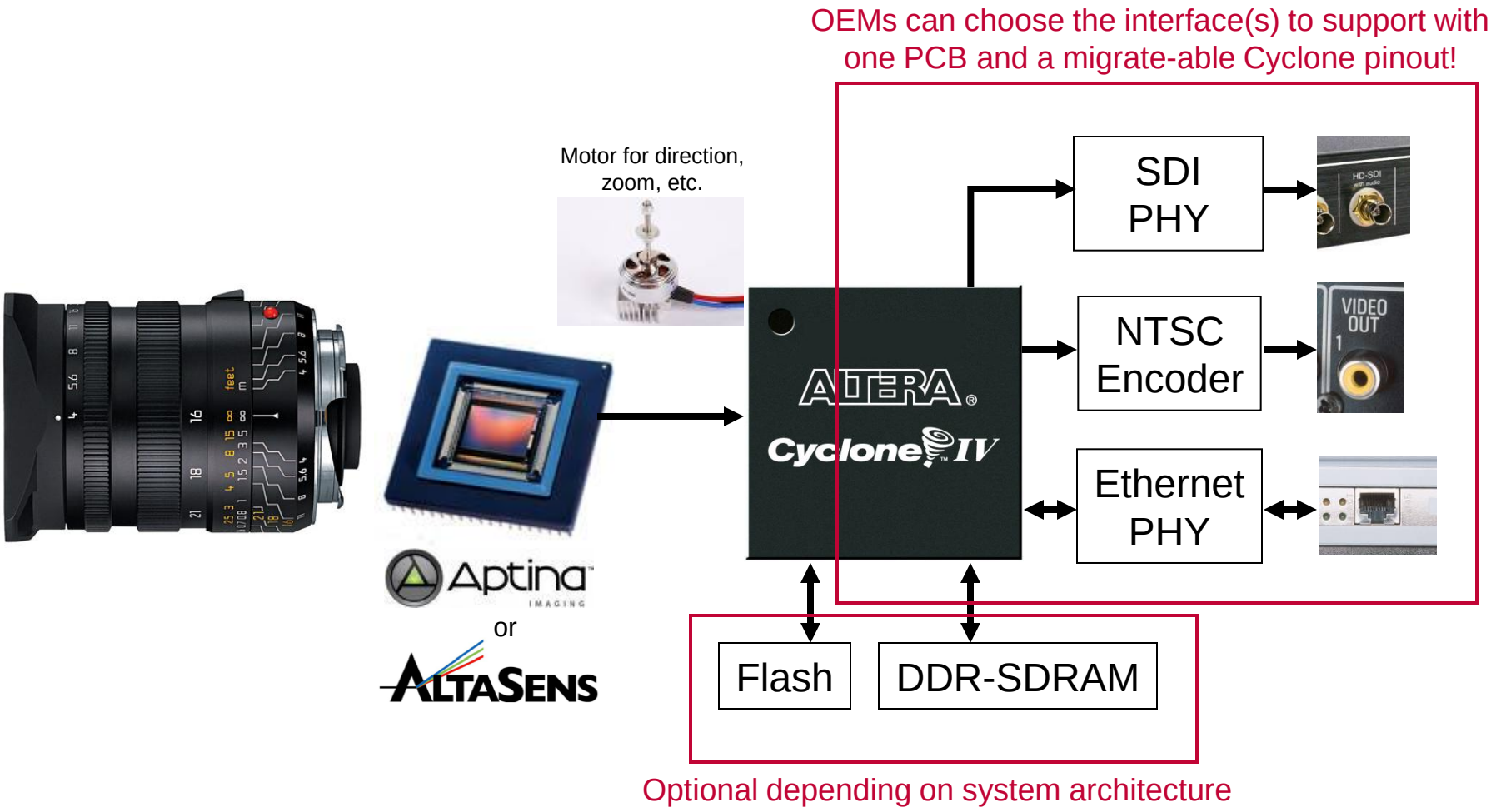
Video Surveillance Camera Shipments by Type
World Market, Forecast: 2007 to 2014



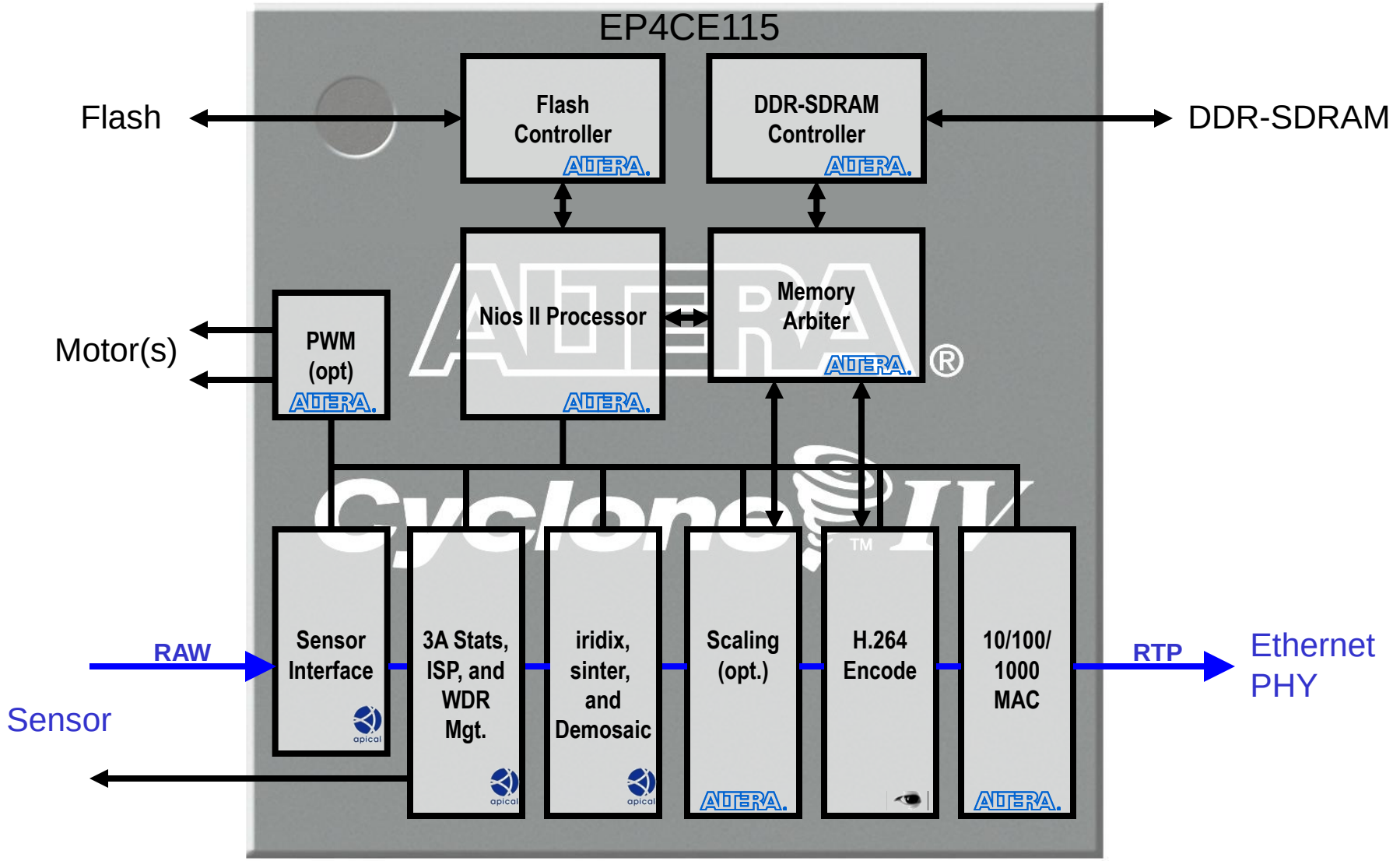


Source: ABI Research

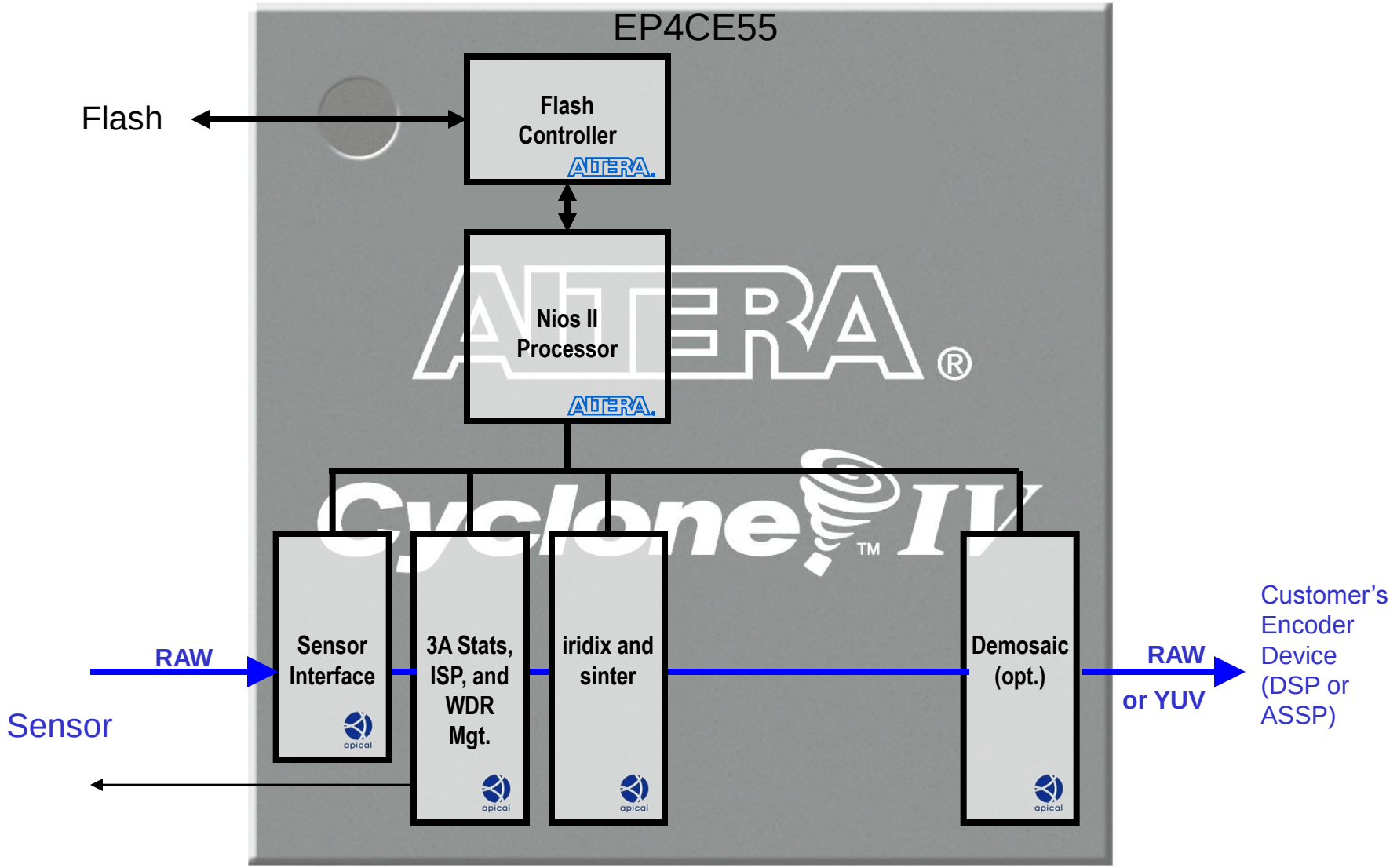
IP / CCTV Camera System Block Diagram



Reference Design #1: Full IP Camera on FPGA



Reference Design #2: FPGA WDR "Front End"



Video Surveillance IP and Partners

SDI, Triple Speed MAC,
Video IP Suite, PCIe IP, Nios II
Processor, Memory Controllers,
LCD Controllers, Bit Blitter IP,
Fisheye Correction IP,
Panoramic Video Stitching IP
www.altera.com

Image Sensor Pipeline IP,
Wide Dynamic Range Sensor IP,
Iridix Local Contrast IP
www.apical-imaging.com

H.264 Encoder IP
www.ocean-logic.com

Eyelytics
H.264 Encoder IP
www.eyelytics.com

Jointwave
H.264 Encoder IP
www.jointwave.com

Eutecus
Surveillance Analytics
www.eutecus.com

2D and 3D Graphics IP
www.tesbv.com

PATA IP
www.evatronix.pl

HMI Toolflow
www.altia.com

Eureka Technology
SD/SDIO Host Controller IP
www.eurekatech.com

SATA IP
www.intelliprop.com

USB Host, Device, and OTG IP
www.ifi-pld.de

Image Processing IP: Analytics

- Altera teams with Eutecus, Inc. to implement high-quality video analytics on FPGAs

- Analytics IP is applicable for industrial surveillance and machine vision applications:
  - People tracking and counting
  - Detection of abandoned / stolen objects
  - Monitoring entrance into forbidden zones
  - Loitering
  - Movement in prohibited directions
  - Defect / orientation item inspection

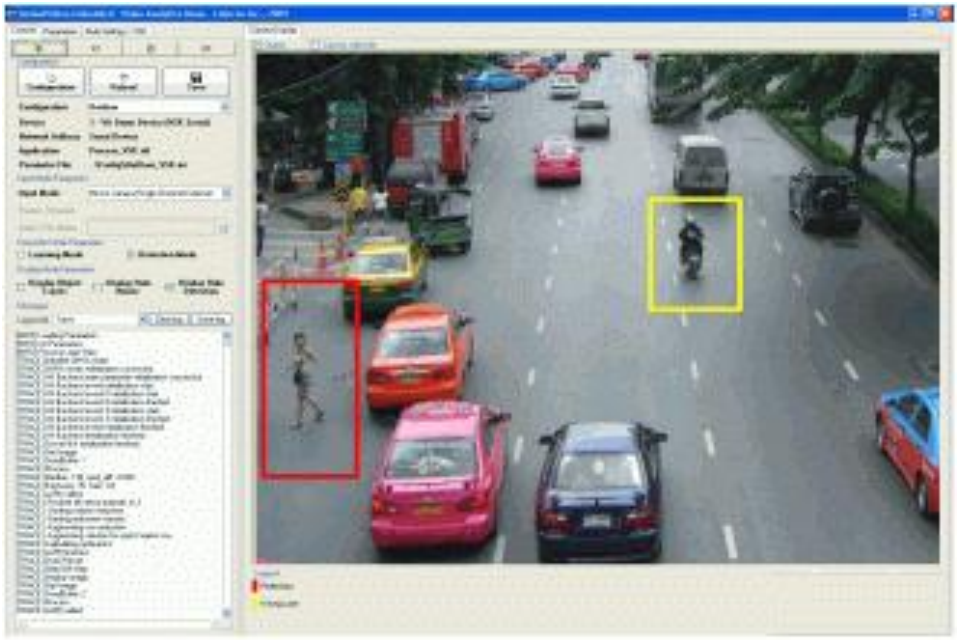


Image Processing IP: Fisheye Correction

- A real-time image processing solution that:
  - Interfaces to a video camera with a wide-angle lens
  - Corrects the wide-angle lens' "fisheye" image to an orthogonal "50 mm-like" view
  - Displays the resultant image on a TFT LCD
- Solution value:
  - Allows inexpensive cameras with large fields of view to be used
  - Corrects distortion, but still allows viewer to see a large field of view
- Applications:
  - Automotive backup cameras, side cameras
  - Industrial video surveillance cameras

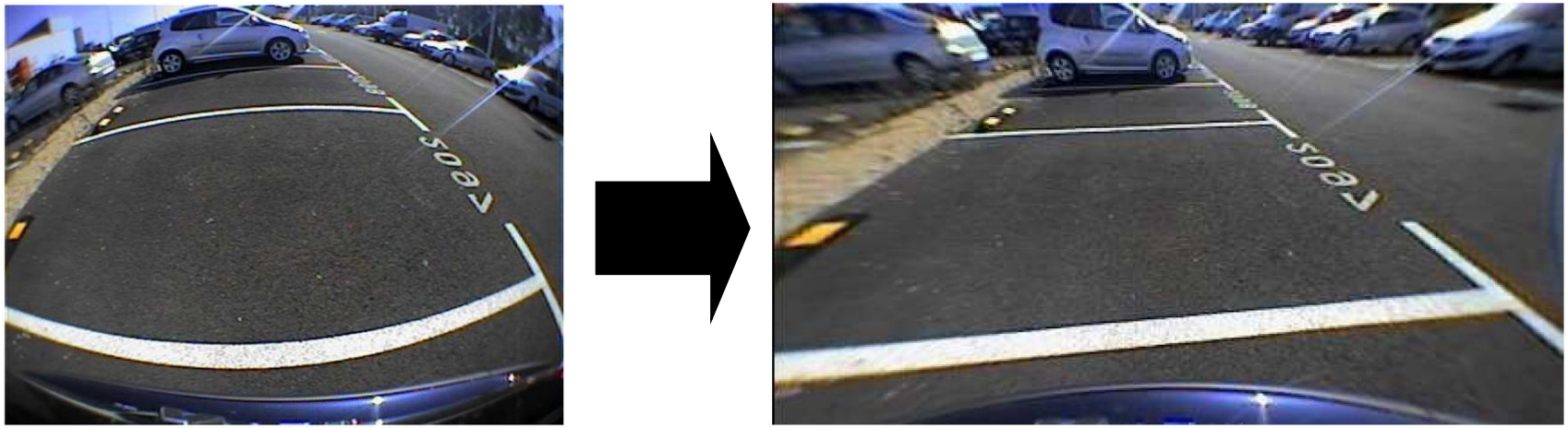


Image Processing IP: Stitching

- A real-time image processing solution that:
  - Automatically aligns and combines video camera images horizontally to form a panoramic image
  - Includes fisheye correction
  - Displays the resultant image on an external DVI monitor
- Solution value:
  - Allows >180° field of view to be constructed using inexpensive cameras
  - Eliminates need to “switch” or “tile” camera images on a single display
- Applications:
  - Automotive “bird’s eye view” cameras
  - Industrial DVRs for video surveillance

Other IP: HMI and Encryption

- 2D graphics
  - Add animations (blitters) or vector graphics to on-screen displays on DVRs and cameras
  - Custom HMIs / GUIs on DVRs
  - Alpha blending on DVRs instead of PIP or POP

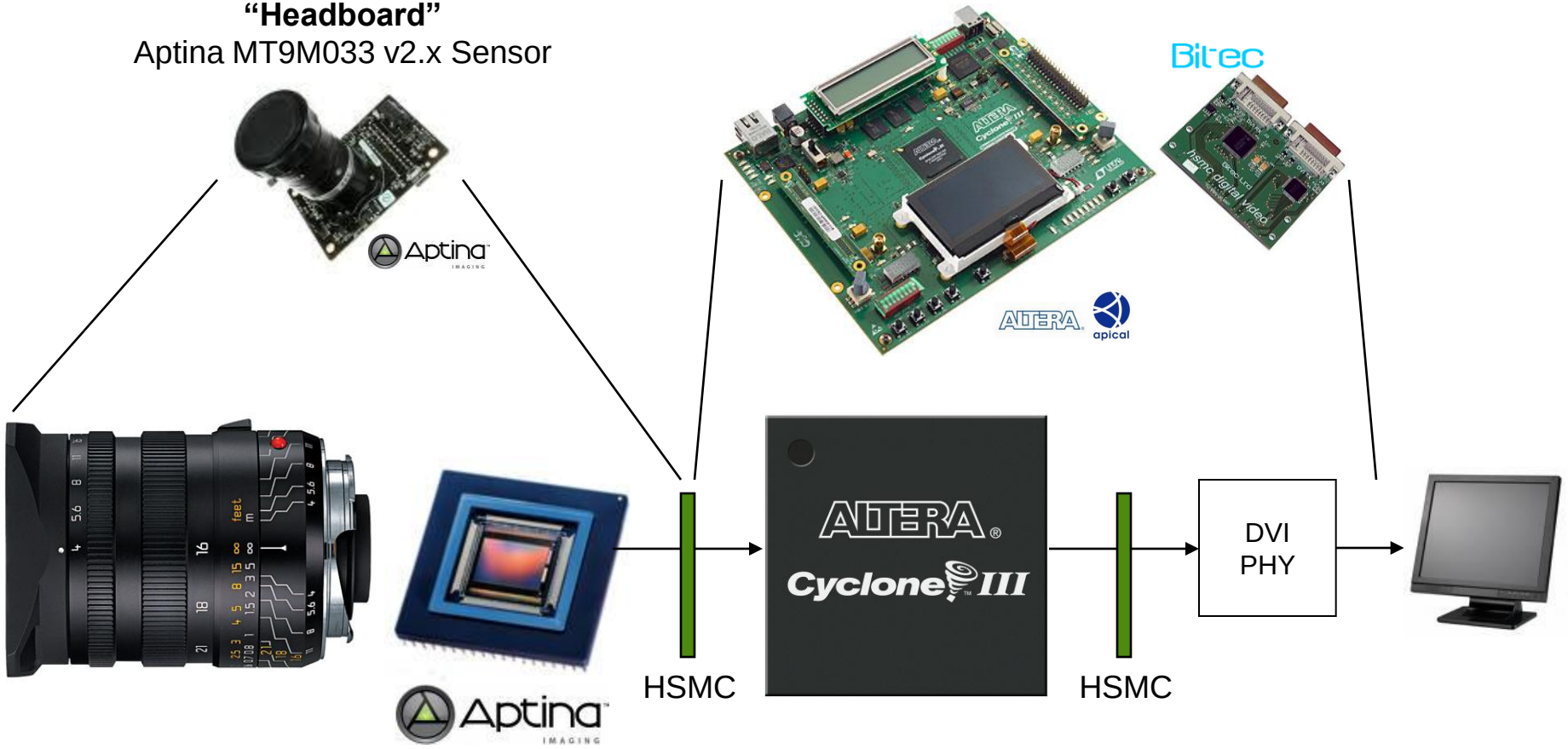
- Encryption / decryption
  - Secure transmission of video and audio across IP networks
  - AES-256 encoding and decoding with secure key storage

Loaner Demo / Evaluation System

Allows 720p60 video from the Aptina WDR sensor to be displayed on an external monitor

Existing Aptina "Headboard"
Aptina MT9M033 v2.x Sensor

Existing EP3C120 Kit + Bitec DVI Card



Partner Spotlight: Apical

Apical Company Overview

- Leading developer of image processing technology IP
- State-of-the-art products based on unique, sophisticated algorithms
- Solutions optimize images/video for different displays and different viewing conditions
- Apical's technology is found in many consumer and professional imaging devices on the market

Customers/Partners (announced)

ARM, DNP, MegaChips, Nikon, Olympus, Sony Ericsson, Panasonic, Samsung, Sony, Altera, TI Third Party Network Member DSP Texas Instruments, Xilinx, SNC, Sanyo, Fuji Television Network, Inc., QuickLogic, Sharp

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Apical's Awards

Popular Photography Camera of the Year 2007

Sony Alpha A100 awarded Camera of the Year 2006 for the camera that best refines or redefines photography – ~$850US-street, built-in stabilization for all lenses, 10 mp, dynamic range optimizer/plus, wireless flash control

iridix

2008 Mario Award TV Technology

HD-SDI broadcast processor based on *iridix* and *sinter*

Winner in Best New Product category, NAB 2008

apical SNC STORENET CORPORATION FUJI TELEVISION NETWORK, INC.

THE QUEEN'S AWARDS FOR ENTERPRISE: INNOVATION 2009

Highest UK Award for Innovation for developing *iridix* and integrating in over 50M devices

iridix

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Apical's Technical Focus

Preserve maximum information content and image quality between raw image capture and standard 8-bit output

With particular emphasis on:

- Natural imagery
- Preservation of local contrast
- Preservation of true colors
- Preservation of shadow and highlight information

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Key Value Propositions for Apical's ISP on FPGA

- **Highest image quality in the market**
  - Industry-leading dynamic range correction, noise reduction, demosaic etc.
- **Flexibility on FPGA to support different sensors**
  - WDR and standard CMOS/CCD
  - Different modes of operation (WDR vs. normal, full HD vs. 5MP/10fps)
- **Flexibility to support Apical's roadmap**
  - Can be upgraded with new core modules and to support new sensors as they become available
  - Short time to market, no re-spin costs

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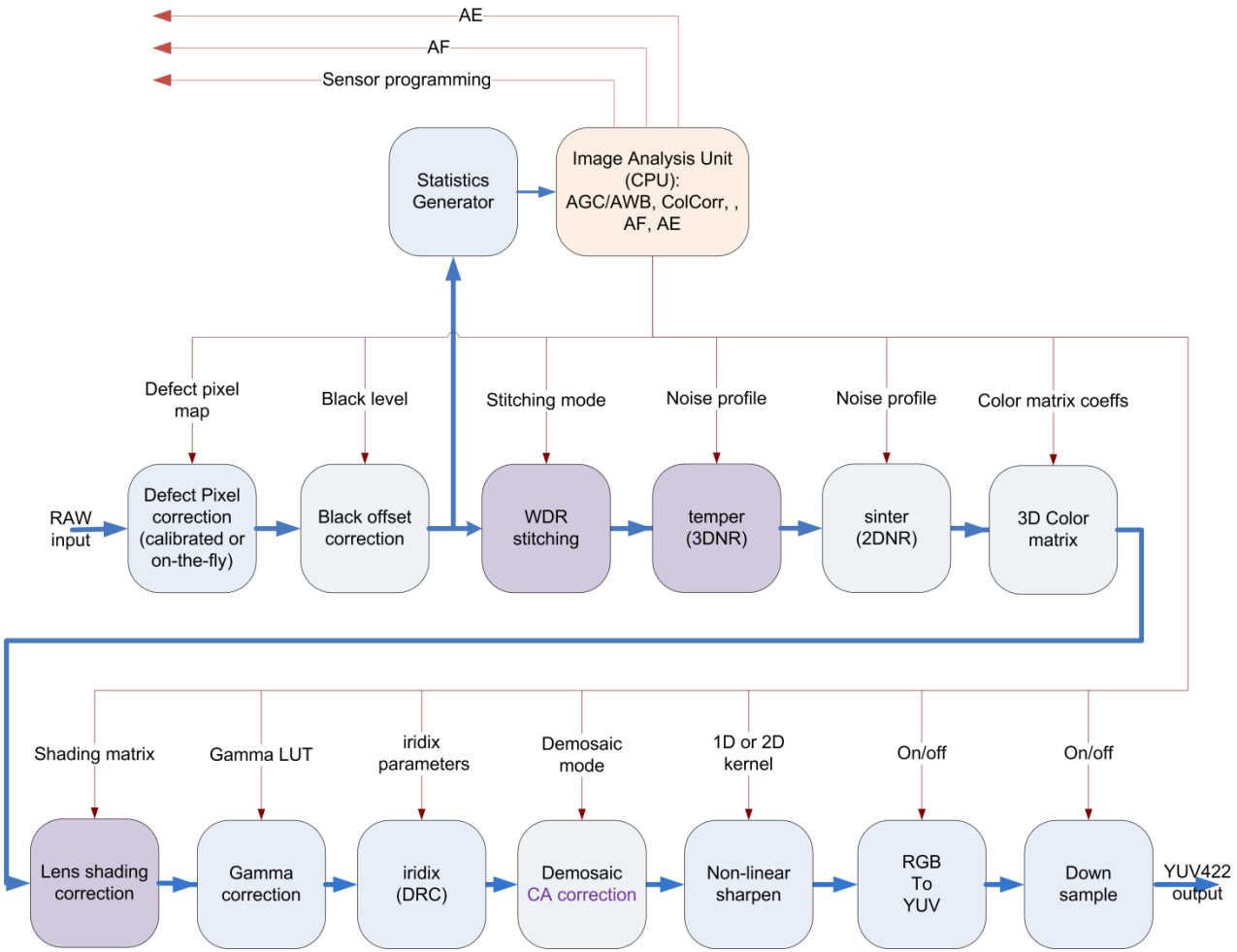
Apical's Complete WDR ISP



Description of Key Modules

Module	Description
Defect pixel correction	Removes “hot pixels” either using a pre-calibrated hot pixel map (preferred) or on the fly
Black offset correction	Establishes correct black level for Bayer data, required for correct operation of color matrix and iridix modules
WDR stitching	Sensor-specific module which reconstructs linear WDR Bayer data of up to 16 bpp from a non-linear WDR sensor raw format
temper	Motion-adaptive temporal (3D) noise reduction module, performing recursive averaging of multiple frames based on local object speed
sinter	Advanced spatial noise reduction based on adaptive kernels, separate treatment of chroma and luma noise, and anistropic filtering
3D color matrix	Full, high-precision 3x3 matrix color correction (controlled manually and/or via AWB module)
Lens shading correction	Lens shading correction based on a pre-calibrated lens shading matrix
Gamma correction	Arbitrary gamma curve based on input gamma look-up-table
iridix	Space-variant dynamic range correction engine based on human visual system model
Demosaic inc. CA correction	Anisotropic, non-linear color interpolation (demosaic) incorporating lens chromatic aberration correction
Non-linear sharpen	1D or 2D sharpening filter
RGB to YUV	Colorspace conversion module to YUV444
Down sample	YUV444 to YUV422 or YUV420 output
Statistics generator	Calculates a variety of regional and global image statistics for use by the IAU
Image analysis unit	Incorporates 3A modules (auto white balance, auto exposure, auto focus) based on image statistics and additional camera control functions

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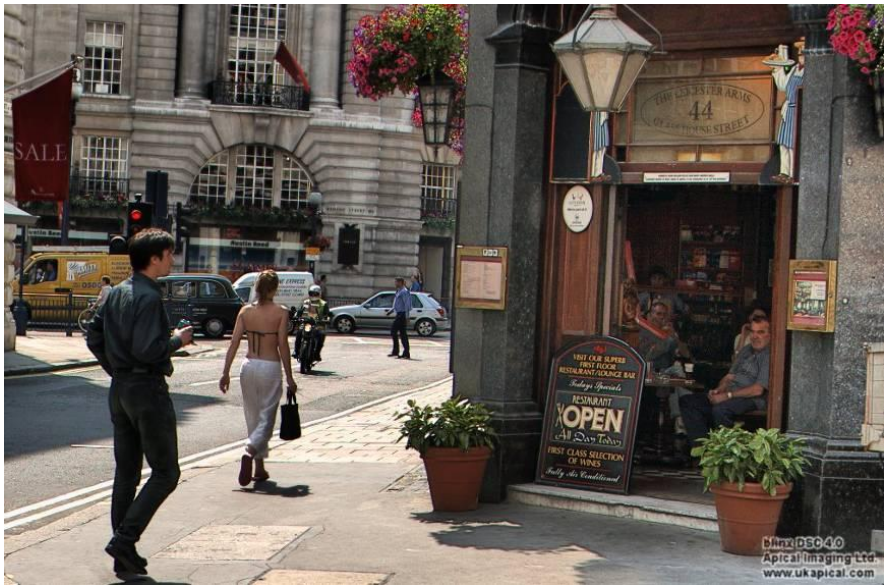
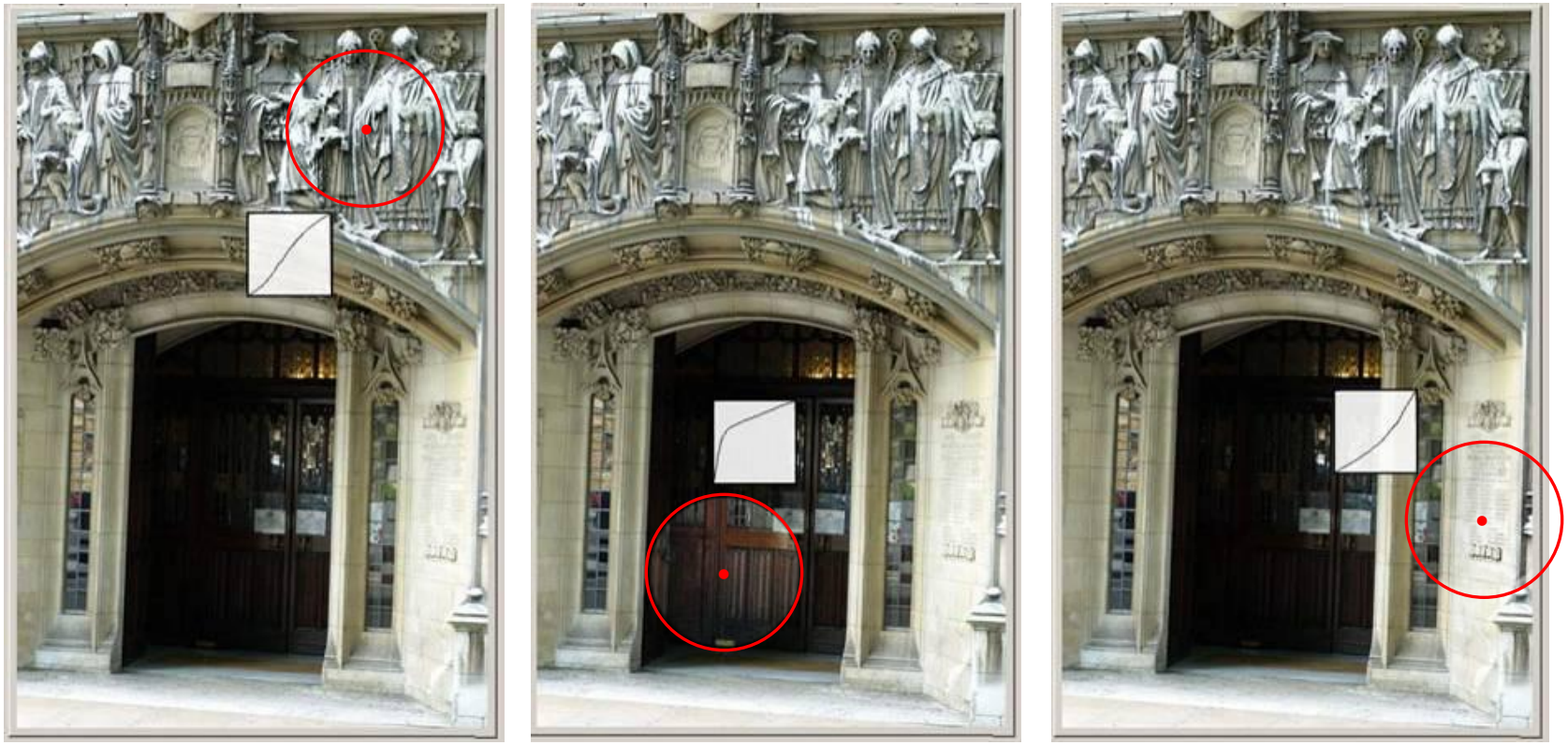
iridix DRC Processing



Up to 16 bits per color per pixel → 8 bits per color per pixel

Pixel-by-pixel Tone Curve Correction



- *iridix* automatically generates a **different tone curve for every pixel of every frame**

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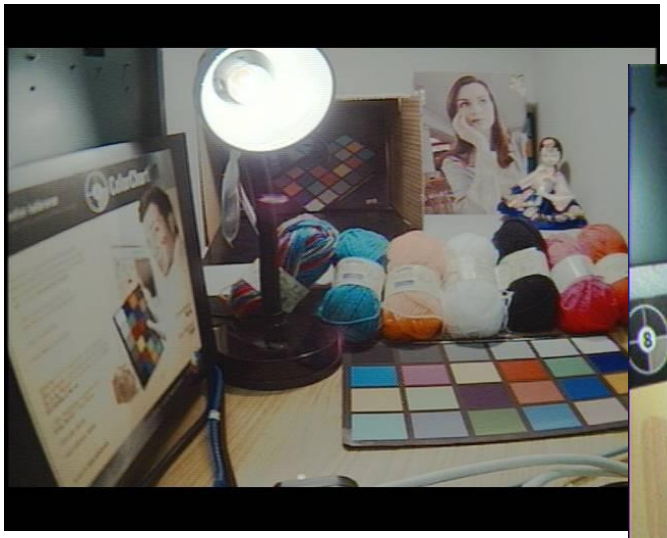
Performance of Apical's WDR ISP



Current market leader

Next-gen WDR sensor + iridix

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Altera Surveillance Resources

- www.altera.com/surveillance
  - 7-min. online demonstration video
  - Low-cost FPGA IP camera white paper
  - Altera and partner press releases
  - Link to full IP camera reference design page
  - Link to Altera's industrial partners
  - "Mail-to" link to request more information

- General industrial: www.altera.com/industrial

Thank You

To learn more, please visit
www.altera.com/surveillance