Qdeo™ Award-Winning Video Processing Suite for the Present and Future
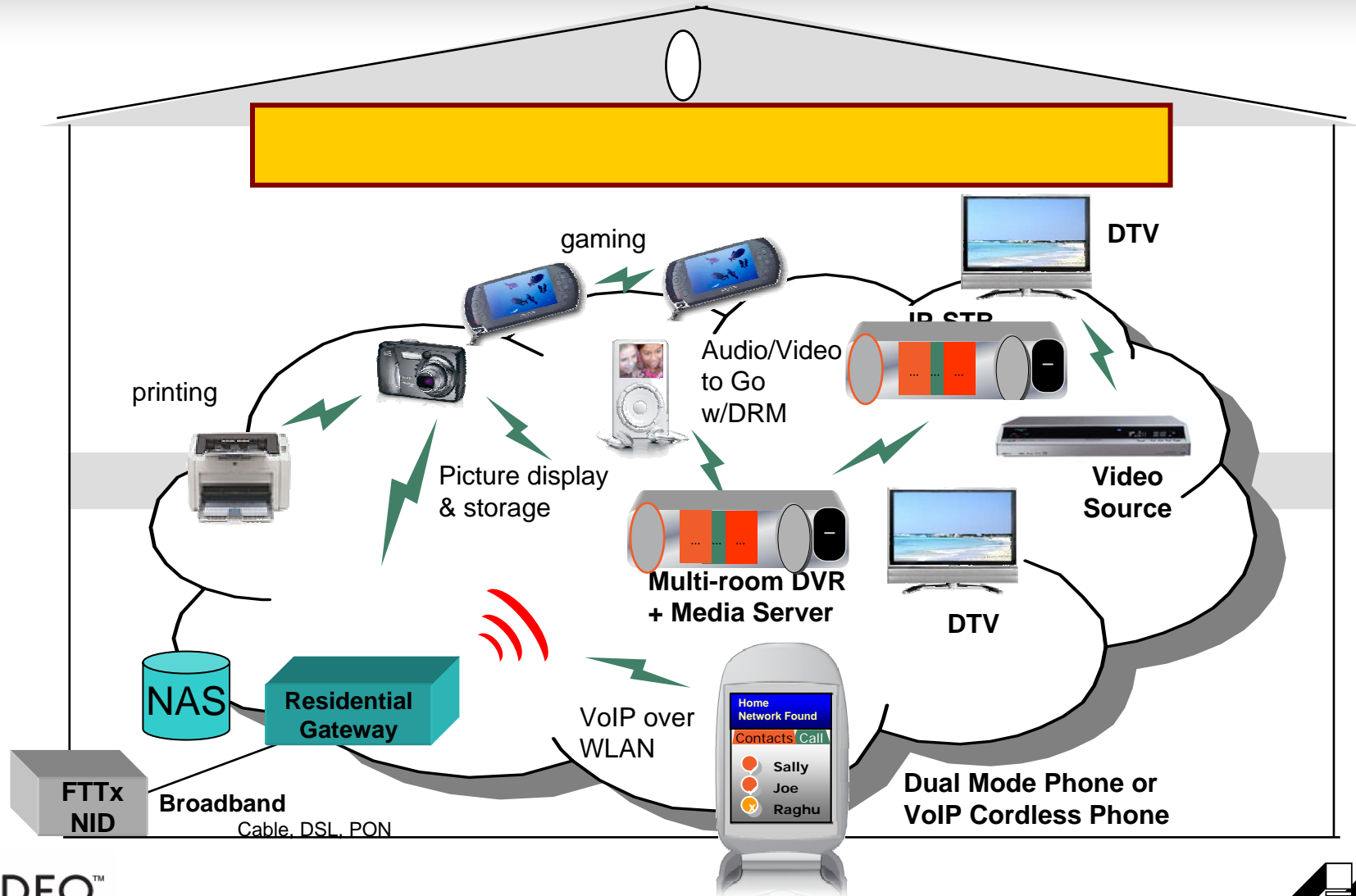
10th March 2009

Marvell Corporate Fact Sheet

- **One of Top 5 Fabless Semiconductor Companies in the World**
- **Industry leader in storage, communications, and consumer products**
- **Founded in 1995 and headquartered in Santa Clara, California**
- **Over 5,000 employees**
- **US $2.95B revenue in last fiscal year (FY09),**
- **Ships over 750M chips per year**
- **For further information see www.marvell.com**

Marvell's Consumer Vision:
Digital Connected Lifestyle - Any Appliance, Anytime, Anywhere

gaming

DTV

printing

Audio/Video to Go w/DRM

IP STB

Picture display & storage

Video Source

Multi-room DVR + Media Server

DTV

NAS

Residential Gateway

VoIP over WLAN

Home Network Found

Contacts | Call

Sally
Joe
Raghu

Dual Mode Phone or VoIP Cordless Phone

FTTx NID

Broadband
Cable, DSL, PON

QDEO™ BY MARVELL

MARVELL®
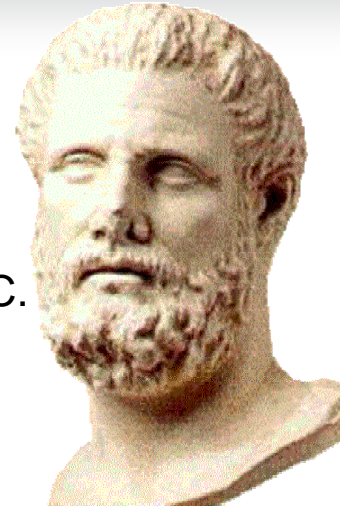
Introduction to Qdeo

MARVELL®

What is Qdeo?

▶ Suite of QuietVideo^{TM} processing technologies that produce quiet and natural video free from noise and artifacts

"First, do no harm"

Attributed to Hippocrates, 400 B.C.

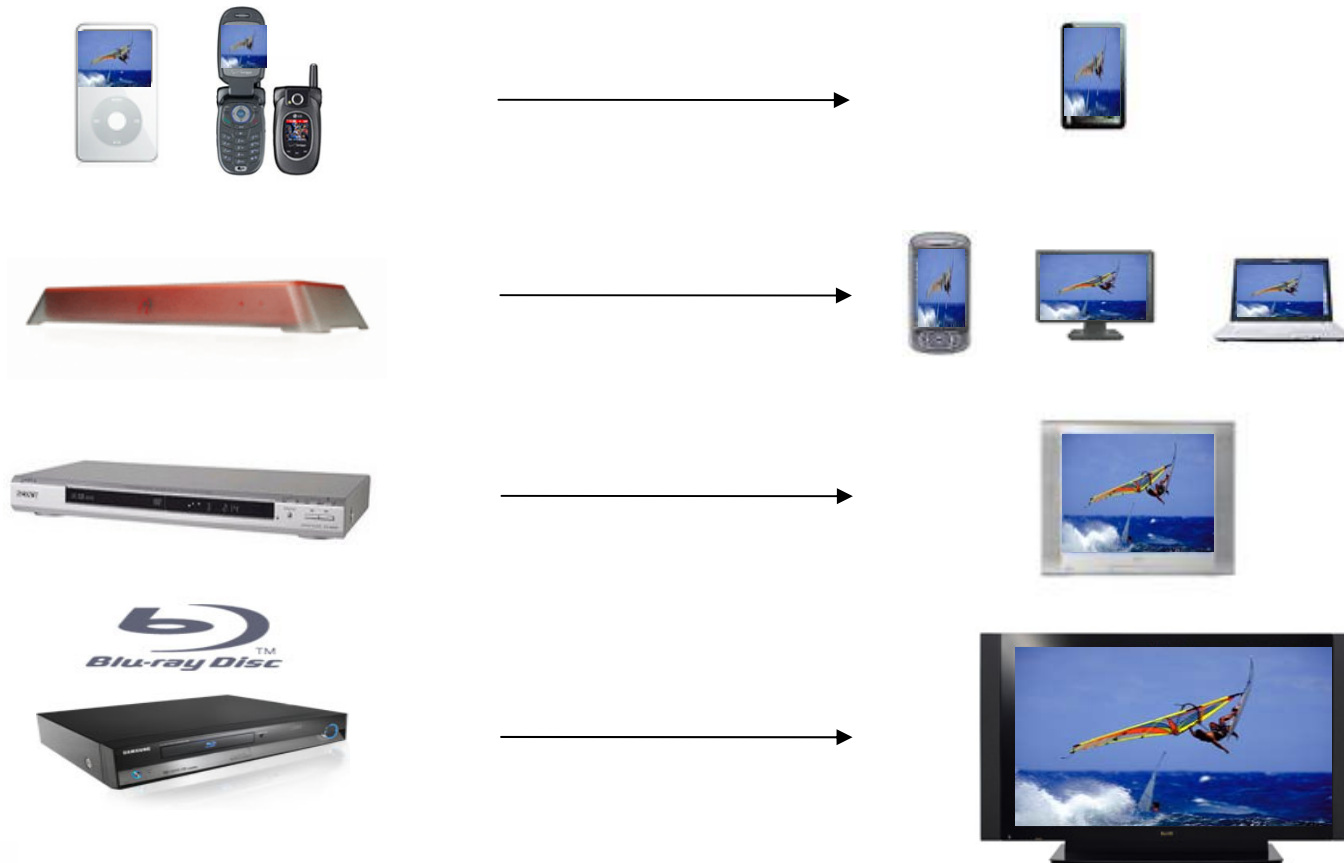▶ Qdeo processing includes three main stages:

Noise Reduction	Format conversion	Enhancement

▶ Qdeo processing can be applied to wide range of content and applications all the way from QVGA mobile or iTunes video all the way up to 4K x 2K

QDEO™ BY MARVELL

MARVELL®

Why Qdeo?

▶ Video sources are proliferating

▶ Multiple sources provide differently tailored viewing experiences

Why Qdeo?

- **The consumer wants a consistent viewing experience**

Low resolution content, jaggies, low color depth

Very low resolution content, bad compression artifacts, lack of sharpness, low color depth

Standard resolution, compression artifacts, noisy video, lack of detail

HD resolution, video noise, mosquito noise, de-interlacing artifacts with low-angled edges, poor authoring

QDEO BY MARVELL

MARVELL

The Solution – QuietVideo^{TM} (Qdeo) Processing

- **New class of adaptive video format conversion technologies:**
  - Supports output from all video codecs
  - Handles all video resolutions, from QVGA to 1080p and higher
  - Complete set of noise and artifact reduction technologies
  - Per-pixel content adaptive deinterlacing and scaling
  - Comprehensive set of image enhancement techniques including texture, detail, edges, contrast and color
  - Provides a consistent immersive viewing experience for all types of content
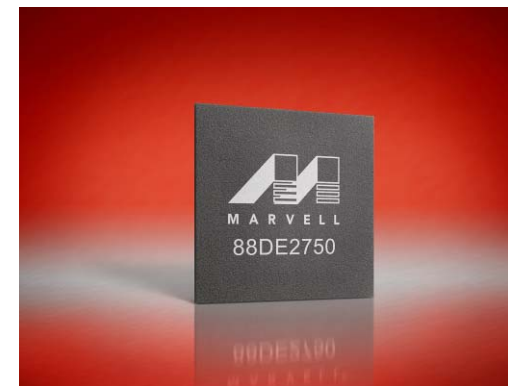
Marvell Kyoto Series

Qdeo Powered ICs

▶ <u>First Generation:</u> **88DE2710** ("Kyoto") Digital Video Format Converter

- Launched at CES 2007

▶ Qdeo Processing elements in DE2710 include:

- Compression Artifact Reduction
- 3D Video Noise Reduction
- 3D Deinterlacing
- Nonlinear scaling
- 2D Edge Enhancement
- Adaptive Contrast Enhancement
- Intelligent Color Remapping

▶ <u>Second Generation:</u> **88DE2750** ("Kyoto-G2") Digital Video Format Converter

- Launched at CES 2009
- Featuring Qdeo True Color and Natural Depth Expansion

Examples of Qdeo Technology

MARVELL®

Qdeo 3D Video Noise Reduction (VNR)

With White Gaussian Noise

White Gaussian Noise Reduced

Per pixel motion-adaptive 3D Video Noise Reduction (VNR) for HD and SD Video
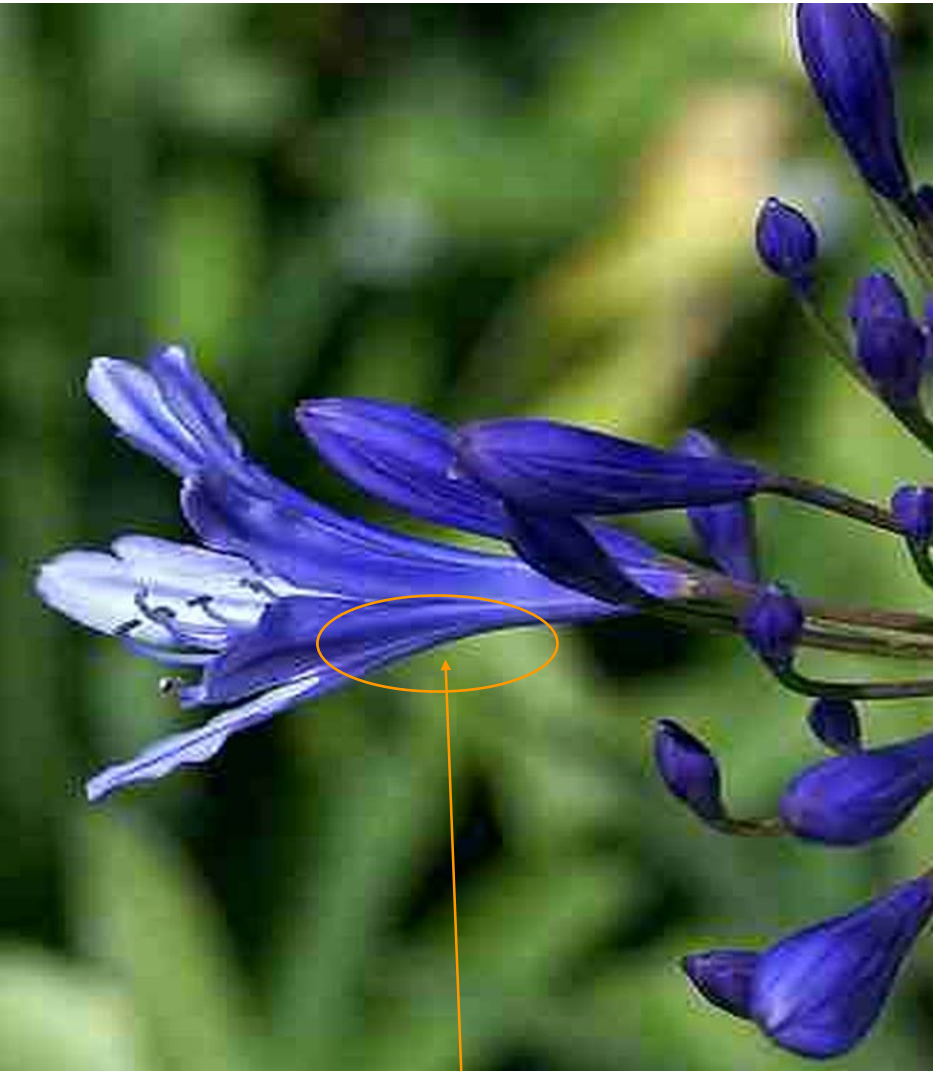
Qdeo Block Noise Reduction (BNR)

With Block Noise

Block Noise Reduced

Per pixel Block Noise Reduction (BNR) for HD and SD Video

Qdeo Block Noise Reduction (BNR) & Mosquito Noise Reduction (MNR)

With Mosquito Noise

Mosquito Noise Reduced

Per pixel BNR and MNR for HD and SD Video

Qdeo Vector Interpolation

Per-pixel Edge-Adaptive Interpolation for HD and SD Video

Qdeo 2D Edge Enhancement

Per-pixel 2D Edge Enhancement for HD and SD Video

Qdeo Natural Depth Expansion: BEFORE

Full-HD (1920 x 1080) Image BEFORE Natural Depth Expansion

QDEO™ BY MARVELL

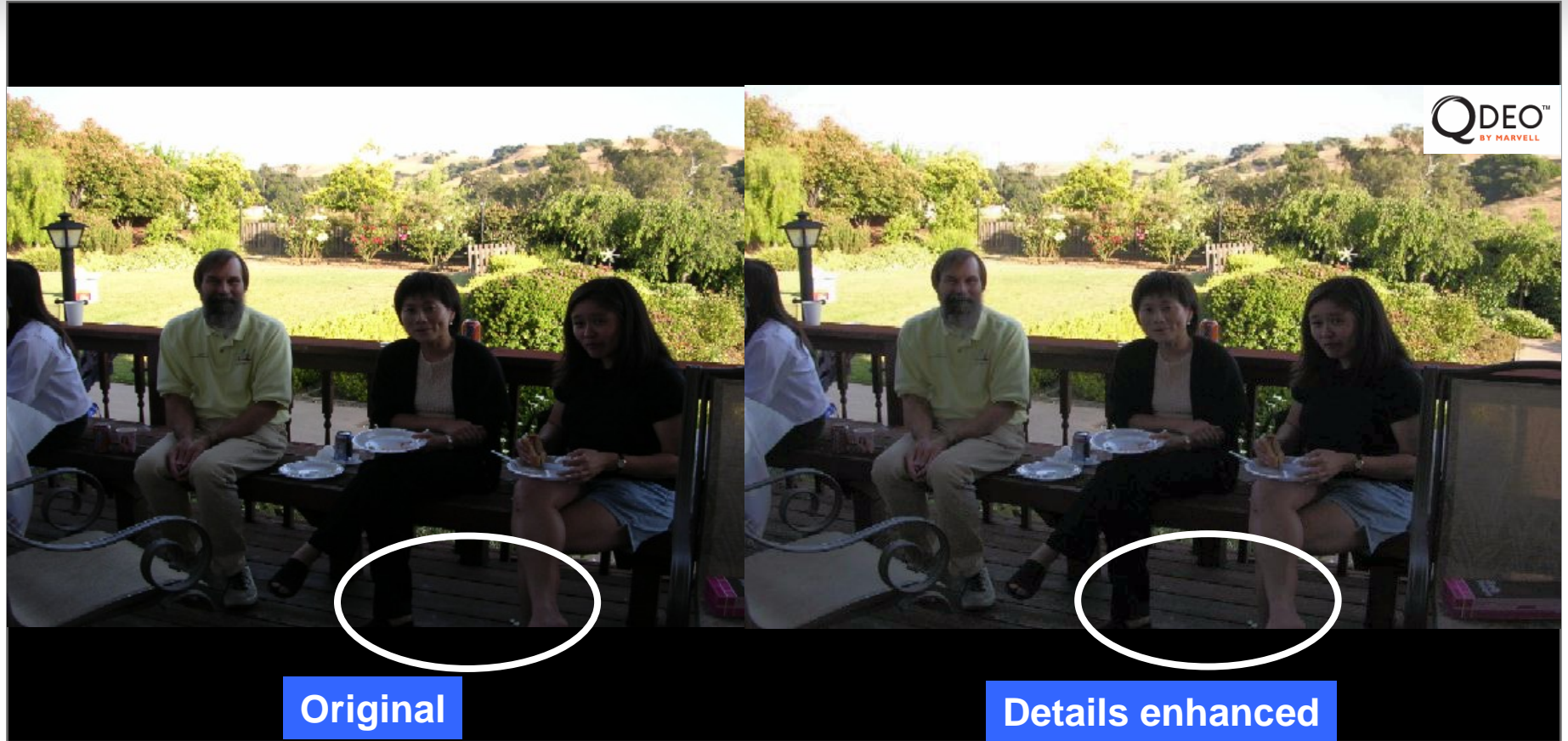MARVELL®

Qdeo Natural Depth Expansion: AFTER

Increased detail provides super-resolution effect

Crisp object edges provide sensation of depth

Full-HD (1920 x 1080) Image AFTER Natural Depth Expansion

QDEO™ BY MARVELL

MARVELL®

Qdeo Locally Adaptive Contrast Enhancement (ACE)

Original

Details enhanced

Local adaptivity allows stretching of dark regions without impacting lighter ones
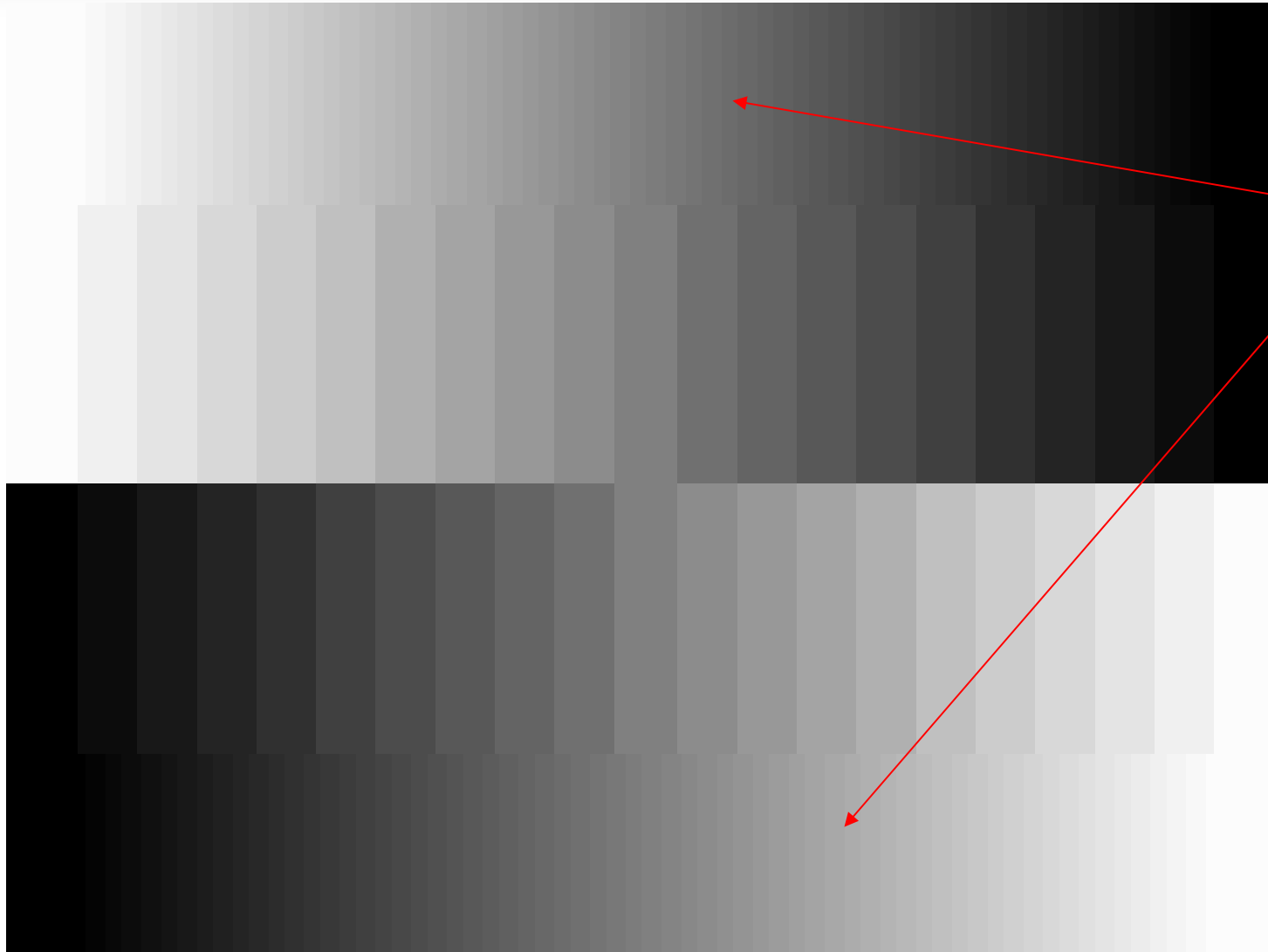
Qdeo Intelligent Color Remapping (ICR)

Intelligent color remapping enables vivid color without clipping or hue shifts while maintaining correct flesh tone

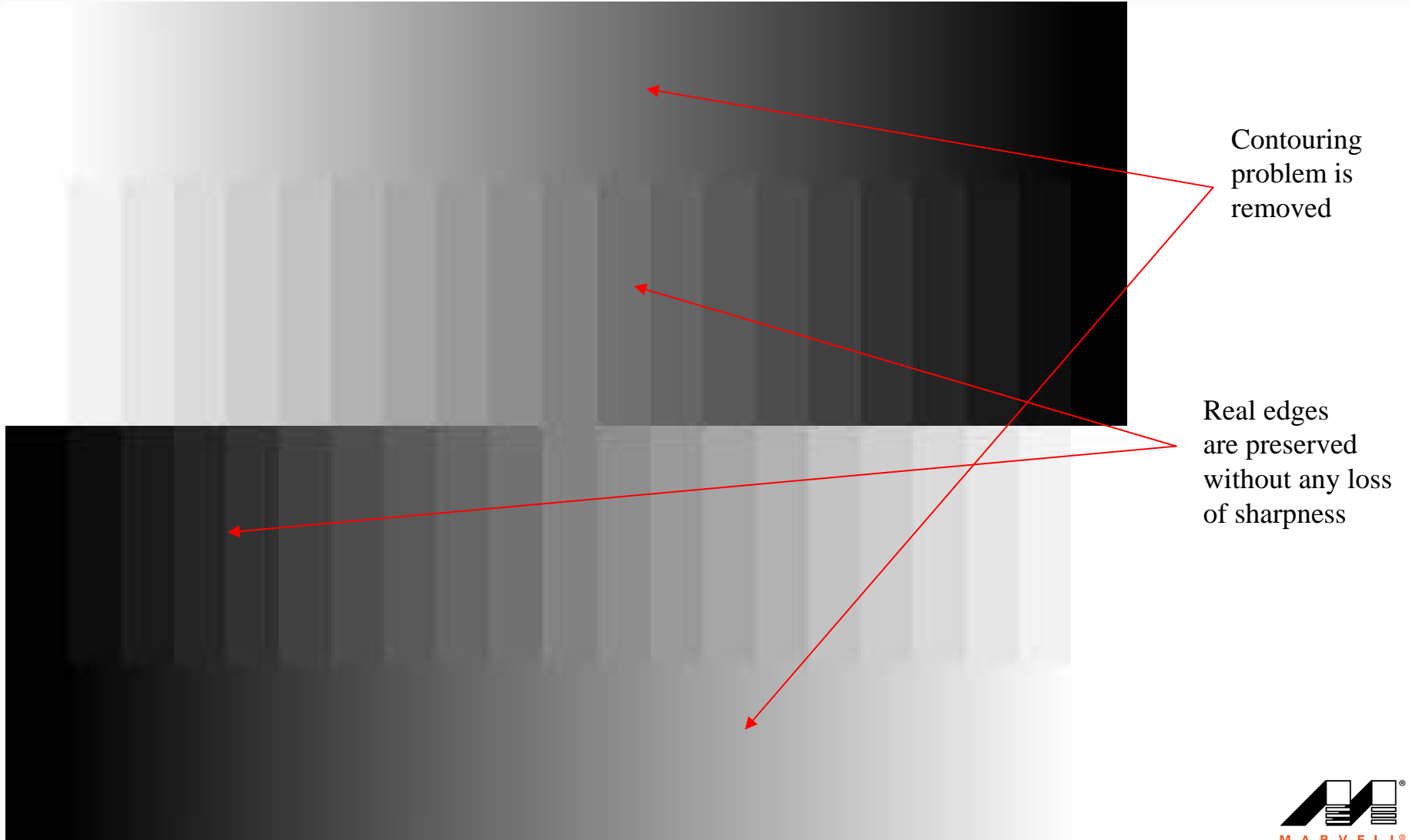# Qdeo True Color - Example 1: <u>BEFORE</u>

256 gray shade ramp pattern

Contouring in original 8-bit data

Qdeo True Color - Example 1: <u>AFTER</u>

Output after Qdeo True Color – 8-bit content is adaptively expanded to use full dynamic range of 10/12 bit displays

Contouring problem is removed

Real edges are preserved without any loss of sharpness

MARVELL®

Qdeo True Color - Example 2: <u>BEFORE</u>

8-bit image from DVD/Blu-ray

Contouring in original 8-bit data

Qdeo True Color - Example 2: <u>AFTER</u>

Output after Qdeo True Color – 8-bit content is adaptively expanded to use full dynamic range of 10/12 bit displays
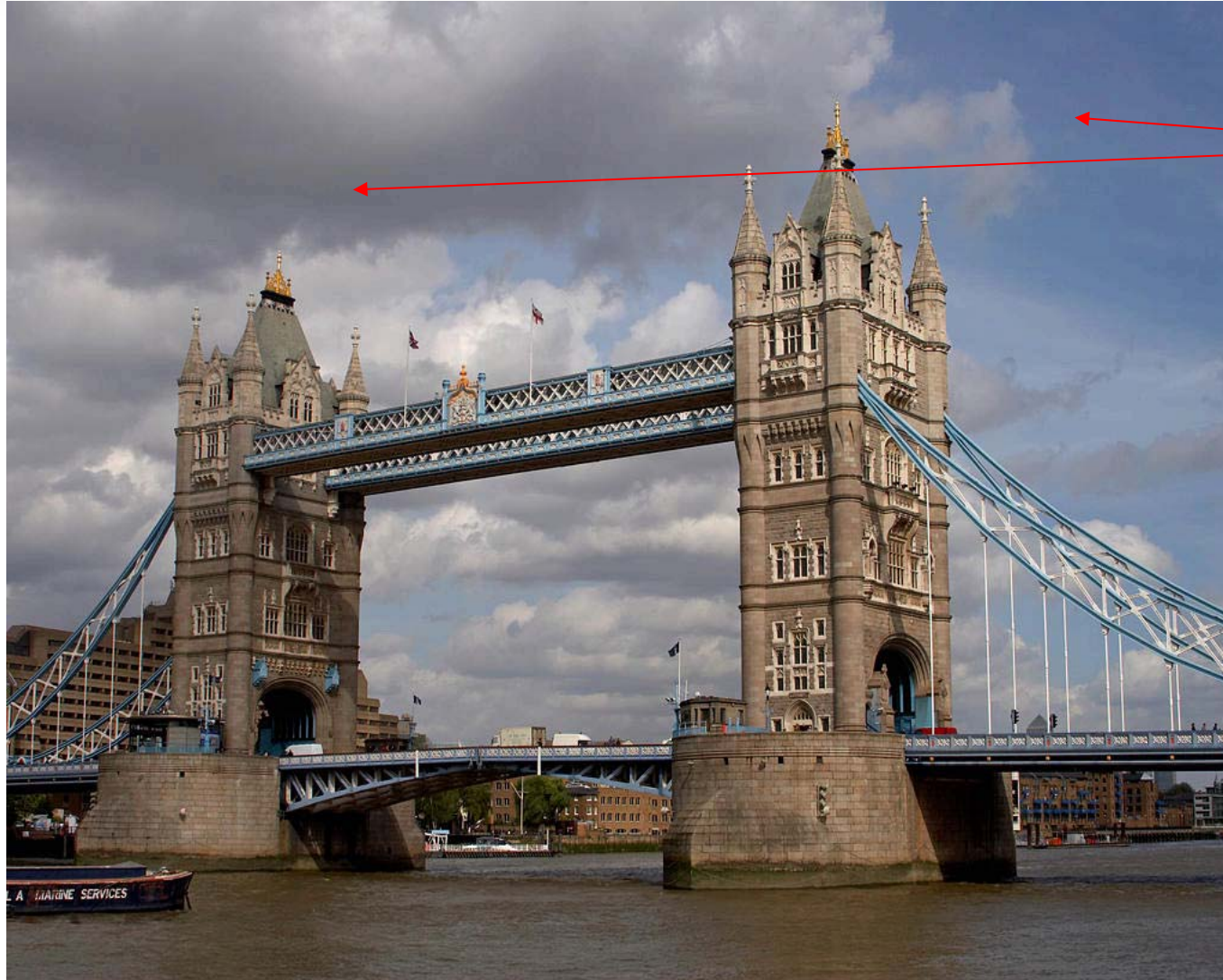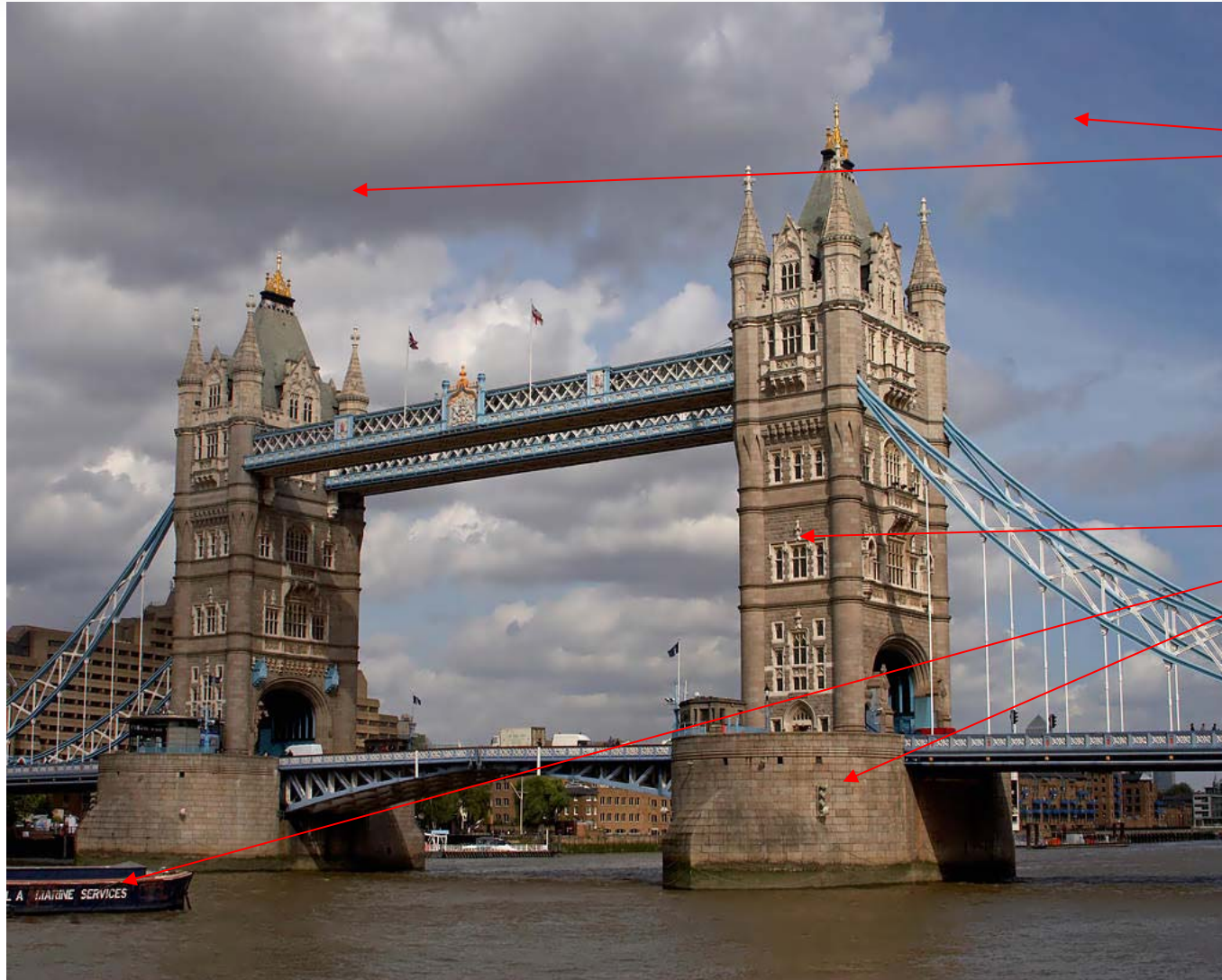

Contouring is removed

All image detail is preserved

Applications of Qdeo Technology

Examples of Marque Customers/Products

▸ Marque customer with highly differentiated products ranging from $400 to $200K

Sony Blu-ray Player $2000

**Pioneer Elite AV Receiver $7000 &
Pioneer Elite Blu-ray Player $2200**

**Meridian 810 Reference
Video System $185K**

**Panasonic and Sharp Blu-ray recorders
$800 and up**

Examples of Industry Acclaim

Examples of Industry Acclaim for Qdeo

▶ Reiji Asakura, eminent digital media critic and vice chairman of the Society of Picture Quality Engineers in Japan

- "I have been deeply impressed by the Qdeo technology. The image quality it generates is excellent, with great detail and clarity, providing consumers with a first-rate experience."

▶ John E. Johnson, editor-in-chief, Secrets of Home Theater and High Fidelity

- "Consumers are acquiring their entertainment content from an increasingly wider range of sources. Qdeo processing excels in both delivering a quality high-definition video experience from low-resolution material and in rendering a stunning 1080p image from the latest blue-laser discs. I am really impressed!"

▶ Tom Norton, Home Theater Magazine – Dec. 07 online review of BH200 player

- "..Stunning image from Blu-ray and HD-DVD… Superb video processing makes this an excellent upconverting player….Qdeo video processing from Marvell is clearly the real deal"

▶ WHAT HIFI Magazine, Sept. 08 review of the Meridian 810 Reference Video System enabling a 10M pixel projector

- "..Marvell also makes some of the finest video processing algorithms on the planet"

Examples of Awards

▶ Qdeo Video Processing has received prestigious awards

- Marvell received the Secrets of Home Theater and High Fidelity *"Best of 2007 Video Processing Technology"* Award at the Consumer Electronics Show (CES) in January 2008 for its groundbreaking Qdeo technology
- This award recognizes Qdeo as the new gold standard in high-end video processing.

- Marvell 88DE2710, Featuring Qdeo Technology won EDN's *Innovation Award for 2007 for Outstanding Product Innovation in the category of "Multimedia ICs."*
- The Innovation of the Year awards recognize unique, state-of-the-art electronics products.

EDN'S 18TH ANNUAL INNOVATION AWARDS

Category: Multimedia ICs
WINNER: 88DE2710 video-format converter (Marvell)

Large-screen, high-resolution LCD, plasma, and other displays are all the rage. With the completion of the transition from NTSC (National Television System Committee) to ATSC (Advanced Television Systems Committee) only about a year away, they're about to get even hotter. Those displays handle ATSC feeds; high-definition content from cable, IPTV (Internet Protocol television), and satellite pipes; and Blu-ray and HD-DVD optical discs. But what about standard-definition DVDs, low-resolution material from Apple TVs or video-capable iPods, YouTube displays, and VHS decks? Marvell's 88DE2710 can handle all those formats. It provides high-quality rescaling, compression-artifact compression, 3-D video-noise reduction, 3-D adaptive deinterlacing, adaptive contrast enhancement, and intelligent color remapping. It also supports one high-definition-capable video output and one standard-definition video output.

Summary

▶ Qdeo video processing is an award-winning suite of technology based on QuietVideo principles that produces quiet and natural images free of noise and artifacts

  ▪ "First do no harm"

▶ Qdeo processing includes three main stages:

  ▪ Noise reduction

  ▪ Format conversion

  ▪ Enhancement

▶ Qdeo processing is highly adaptive and can be applied to a wide range of content and applications from low-resolution internet video all the way up to 4K x 2K

▶ Go to www.ClearlyQdeo.com for more information