

Issues in Broadcast Delivery of 3D

Walt Husak

Director Image Technologies, Dolby Laboratories

Introduction

- Content producers are interested in 3D productions
 - 3D theater ticket prices are higher than 2D
 - The slate of 3D theatrical releases grows every month
- Display manufacturers want a new feature
 - HDTV is now mainstream
 - Most major manufacturers are showing 3D TVs
- Consumers are very interested in 3D content
 - Filling 3D theaters despite higher ticket prices
 - No negative audience feedback from theatrical releases

Content

- Theatrical

- 3D production costs are said to be 2x-4x 2D costs
- Additional costs quickly recovered in the theater

- Television

- Advertising revenues will not cover additional 3D production costs
- Additional infrastructure costs will be a serious challenge

- Content availability

- Dozen movies available; 15 additional movies this year
- Is this enough content to entice buying new equipment?

Marketplace

- Initially, 3D is likely to be a special event due to higher production costs without new ad revenues
 - VOD or PPV
 - Premium channels
- The incremental price of 3D displays over 2D displays will need to be low
 - Limited content will limit the price consumers will pay
 - Consumer must weigh cost vs. benefit
- 3D in the home theater; not in the bedroom or kitchen

What does an ideal solution look like?

- Consumers are encouraged to buy 3D TVs
 - With no 3D TVs in the home, no system is viable
- Uses current delivery infrastructure
 - Existing workflows with monitoring points
- Uses current set top boxes and infrastructure
 - Menus/closed captions/sub-titles work properly
- Extensible to full resolution displays

Requirements

- Use existing infrastructure without modifications
 - Major changes to equipment such as encoders and multiplexers will negatively influence adoption by distributors
- Current workflow needs to be preserved
 - Workflow changes will discourage widespread adoption
- Does 3D need 2D compatibility?
 - Scenes do not always translate well – movies are separate edits.
 - Does the producer favor 3D when it is a small audience?
 - How long will 3D be a niche market?

Potential Delivery Methods

- Frame Compatible
 - Side-by-side
 - Over/Under
 - Line Interleaved
 - Checkerboard

- 2D Compatible
 - Simulcast
 - MVC/Interrelated Views
 - 2D+DOT
 - 2D+Difference (TDVision)

Side-by-Side



- Frame Compatible
- Characteristics
 - Horizontal resolution reduction by 50%
 - Does not match any display pixel matrix
 - Easy to implemented in the production chain
 - Easy to implement in the terminal device

Over/Under



- Frame Compatible
- Characteristics
 - Vertical resolution hit by 50%
 - Does not match any display pixel matrix
 - Easy to implemented in the production chain
 - Easy to implement in the terminal device

Line Interleaved



- Frame Compatible
- Characteristics
 - Vertical resolution hit by 50%
 - Similar to over/under
 - Think of the difference between interlaced and PSF
 - Matches XPol and μ Pol pixel matrix
 - MPEG-4 AVC/H.264 tools limitation below 1080p60

Checkerboard

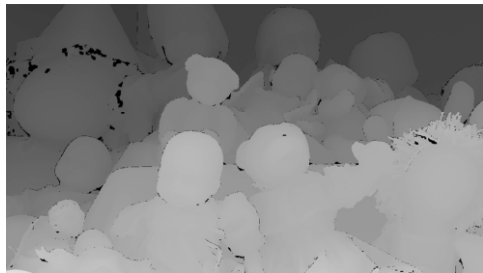


- Frame Compatible
- Characteristics
 - Horizontal and vertical resolution hit by 70%
 - Same resolution as 720p
 - Resolution loss is symmetric
 - Natively supported by DLP and Plasma
 - Installed base of 2 Million TVs
 - Slightly more difficult to implement

Common Characteristics of Frame Compatible

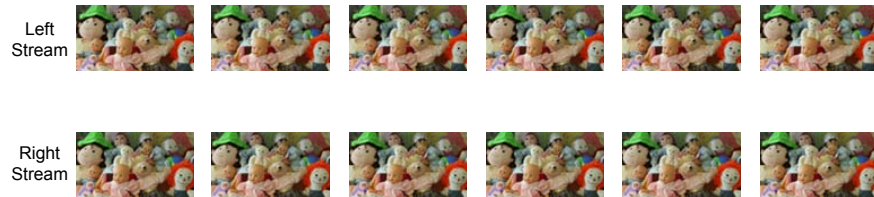
- All can be deployed right now
- All can be reformatted upon entry into the display
- Full resolution can be easily added using layering techniques
 - similar to JPEG2000 and AVC/SVC/MVC
- All frame compatible systems can be delivered from the network to the home including existing mezzanine level compression systems
- Standards impact is trivial

2D + Depth



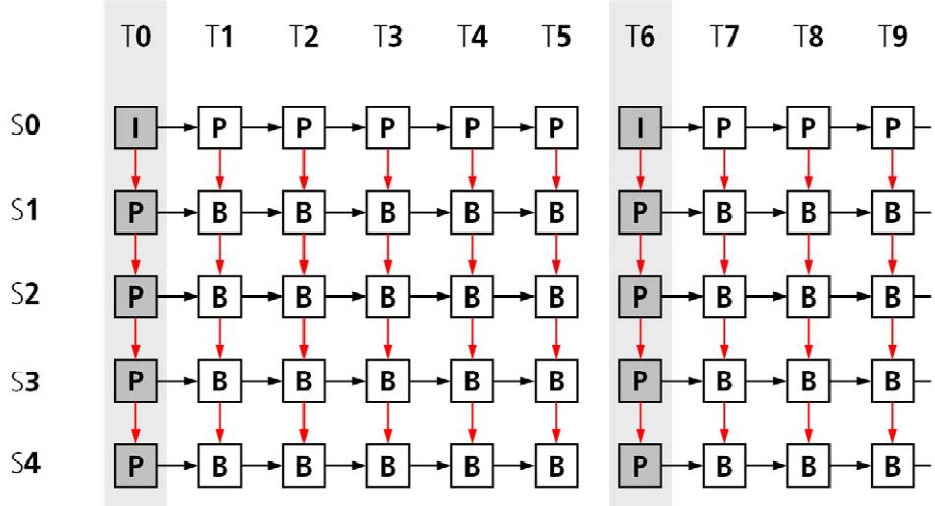
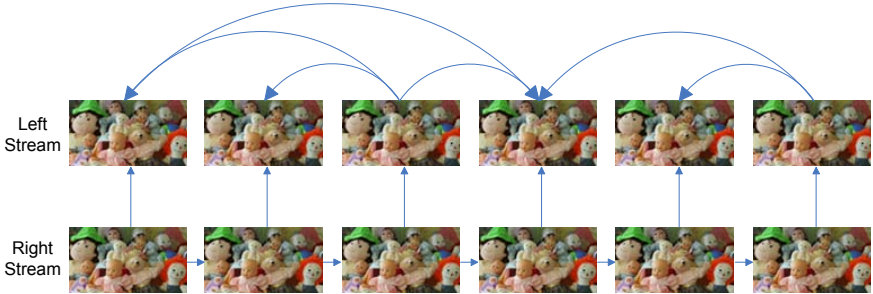
- 2D Compatible
- Characteristics
 - Stereo (multi-view) images need to be rendered from a depth map
 - Creating depth map is a difficult task !
 - Occlusions and reveals are a weakness
- Specified by MPEG as MPEG-C
 - Codec independent

Simulcast



- 2D Compatible
- Characteristics
 - Twice the bitrate and twice the storage
 - Codec independent
 - D-Cinema solution (pair of JPEG 2000 streams)
 - Two times the infrastructure
 - Needs new consumer devices (extra decoder)

AVC Inter-related (MVC) Streams



AVC Inter-related (MVC) Streams

- 2D compatible
- Characteristics
 - AVC core compression; MPEG-2 supports but not used
 - MVC (Multi-View Codec) describes this method with many views
 - Efficiency gain of 20% has been shown (over simulcast)
 - If first stream needs 10 Mb/s, second stream needs 6 Mb/s
 - Two 10 Mbps streams nets at 16 Mbps
 - Ten 10 Mbps streams nets at 64 Mbps
 - New infrastructure
 - Requires new consumer devices

2D + Difference

- 2D Compatible
- Characteristics
 - Modified MPEG-2 tables
 - Differencing is content dependant
 - Additional bitrate overhead range from 30% to 80%
 - There are numerous ways to build similarly compatible streams
 - Needs new consumer devices

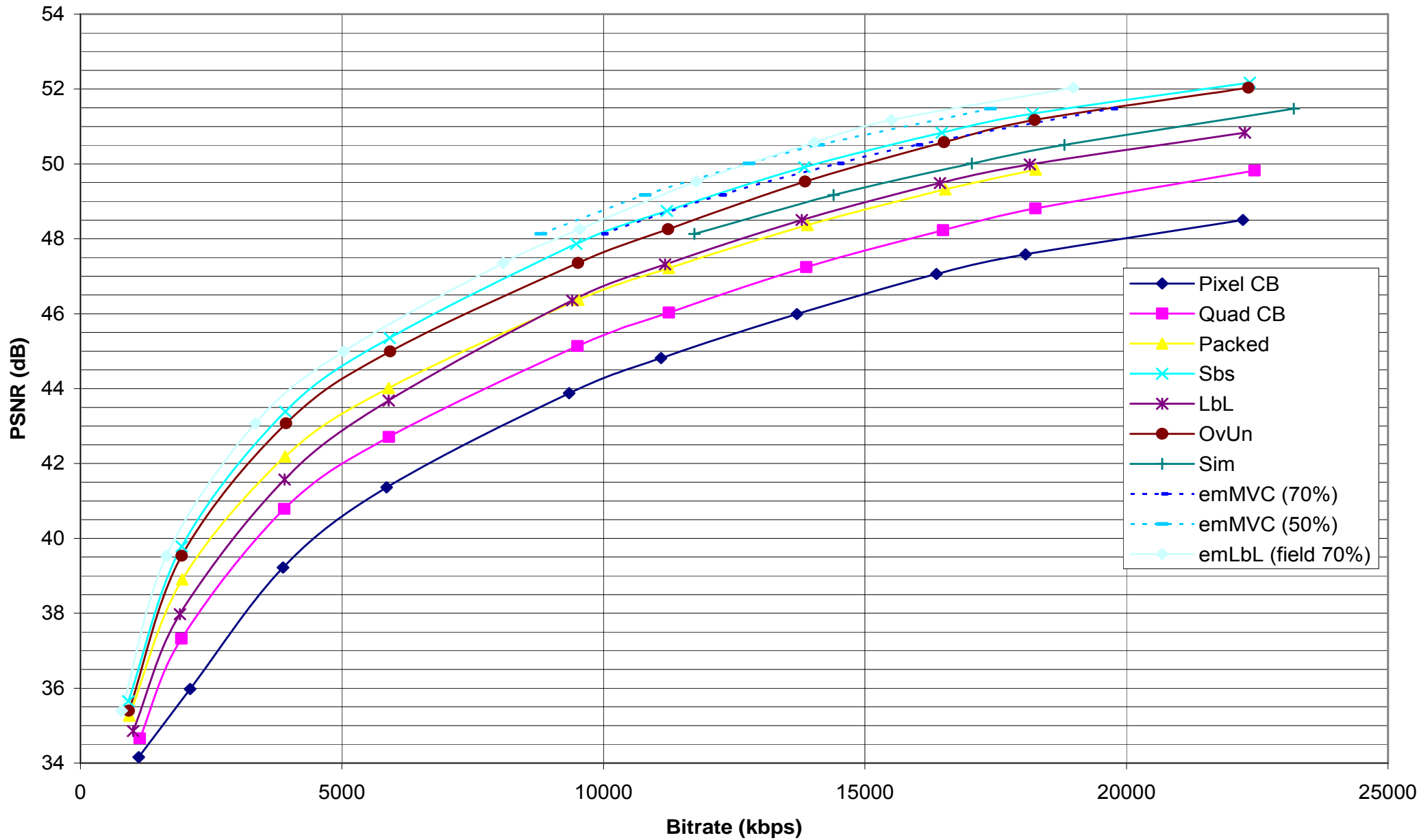
Common Characteristics of 2D compatible

- All methods require new consumer devices for 3D
 - 2D is available
- All require increased relative bandwidth
 - Ranges from 60% to 100% extra channel capacity
- Offers full resolution once deployed
- Recoding at the local station or MSO is problematic
 - New broadcast infrastructure is required
- Some need new standards or are limited to specific standards

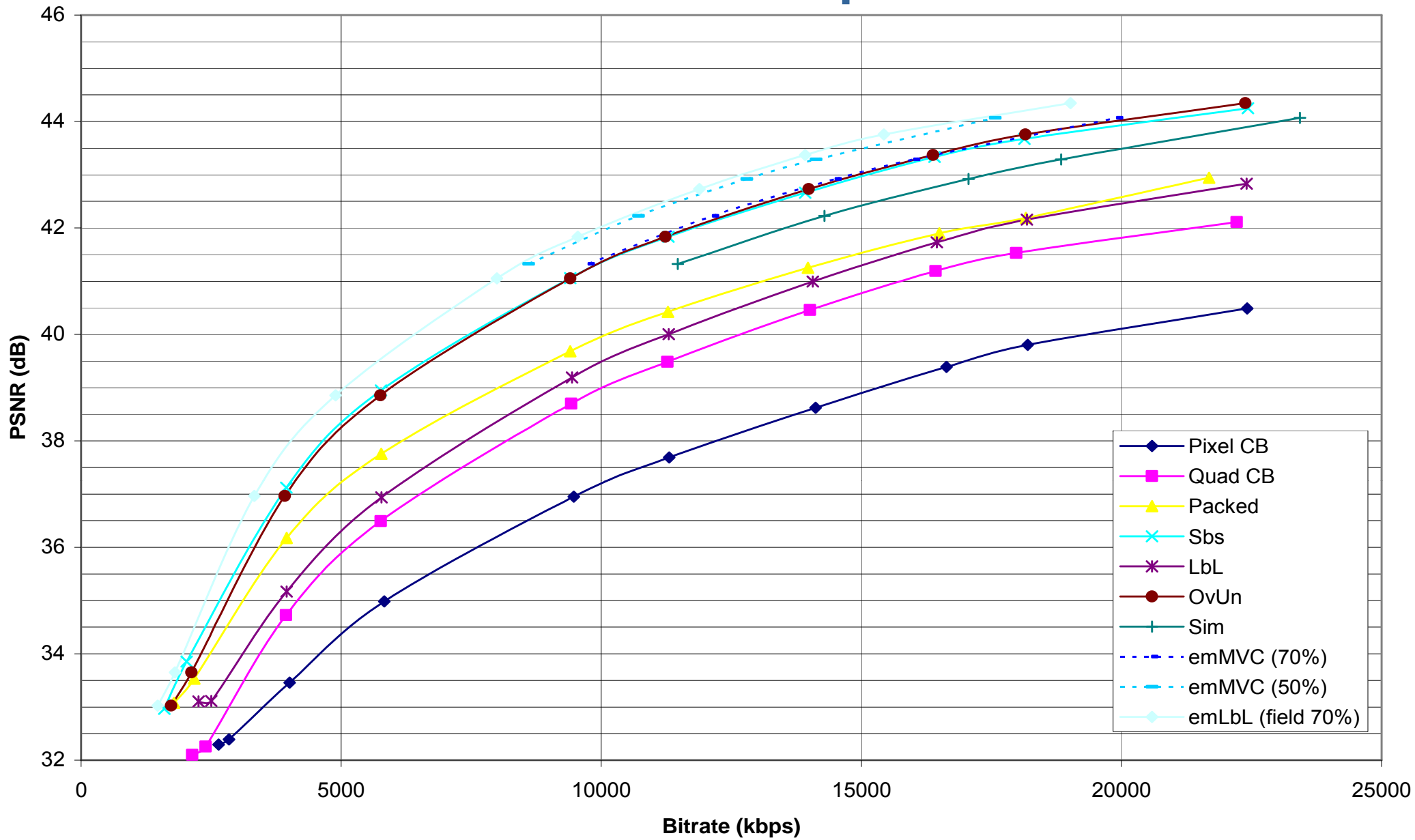
Performance Comparisons

- What are the limitations from the carriers?
 - Bitrate?
 - Codecs?
- Other competing services?
 - HD or SD?
 - Mobile Services?
- How much 3D will you broadcast?
 - Several channels 24 hours per day?
 - One show per week?
- What are you willing to replace for 3D?

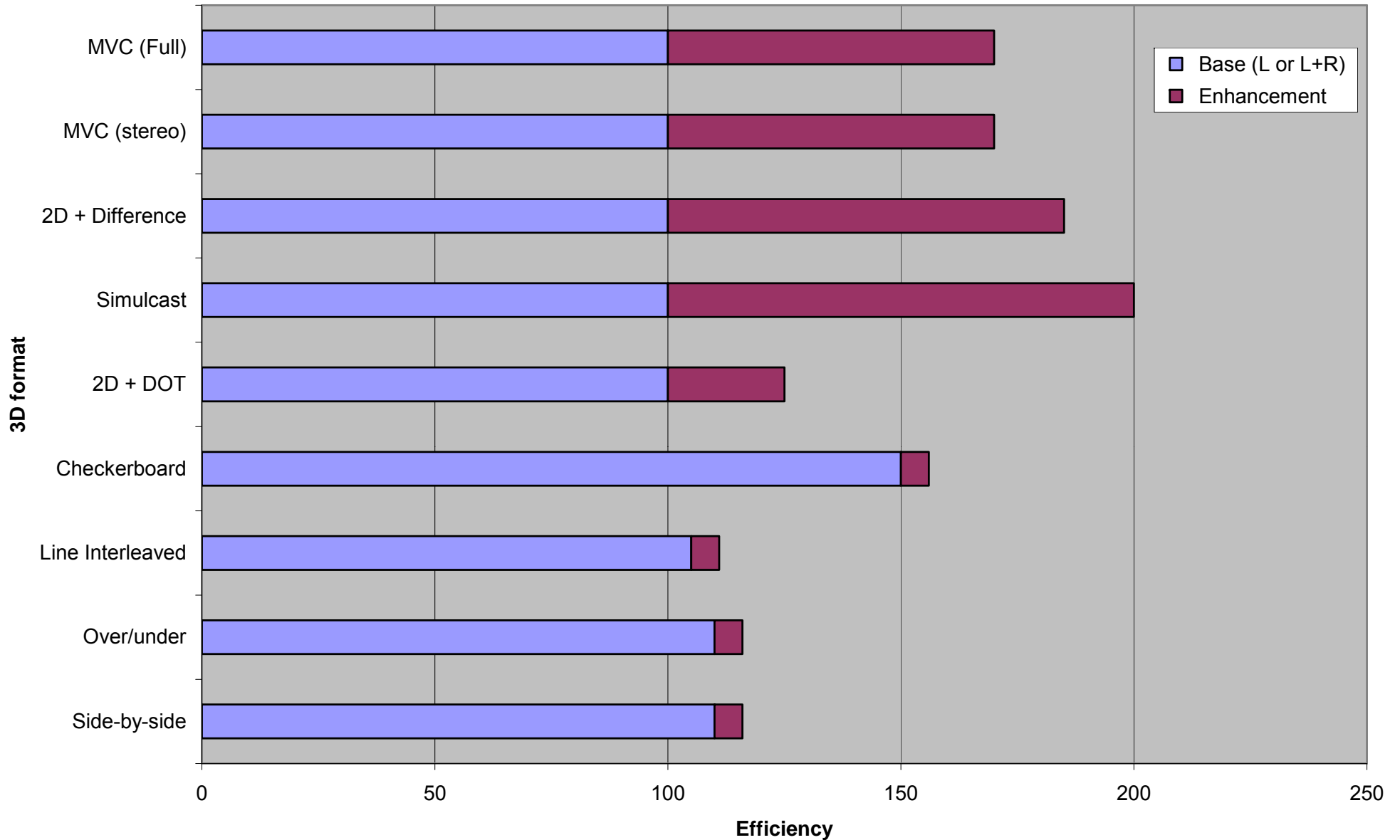
Rate Distortion Performance - Bolt



Rate Distortion Performance - Splash



Relative Efficiency



Technical Summary

- Frame compatible systems can be deployed now
 - Deployment costs are small
 - Fits in the current channels and infrastructure
 - Only the consumer needs to buy new equipment
 - Full resolution can be added later bundled with other features
- 2D compatible systems require buying new equipment
 - Content production weaknesses for some systems
 - Distribution bandwidth is almost twice the 2D bandwidth
 - Both the consumer and provider need to buy new equipment
 - Full resolution available when 3D is fully deployed

Summary

- The problem is not technical
 - Numerous technologies are available with various tradeoffs
 - Economics and user interface are larger issues
- Limited market for 3D goods
 - Home theater (living room)
 - Not kitchen or bedroom
- Economic realities
 - Not enough content to entice consumers to spend money
 - Cable and satellite providers also need to consider infrastructure changes including deploying set top boxes
 - Some vendors would like you to purchase all new equipment...

Parting thoughts...

- Will 3D be mandated by the government?
- Will 3D compete for other services?
- How much are you willing to invest in 3D?
- What will be the return on your investment?
- Does 2D compatibility really save bandwidth?
- Which is more important:
 - Full resolution and buying new equipment and infrastructure?
 - Affordable equipment and full resolution later?

Thank You

Walt Husak
Dolby Laboratories
3601 W. Alameda Ave.
Burbank, CA 91505
wjh@dolby.com