3D Overview – IEEE Denver Communications Society December 2, 2010

HARRIS

ONE

Chris Lennon
CTO Group Lead

ONE Company. ONE Direction. The Future.

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Overview

What We'll Cover:

- What is 3D?
- 3D Cinema – setting the stage for 3DTV
- Rapid rollout
- Displays
- Cameras
- Distribution Formats
  - Frame-compatible
  - 2D + Difference
- Things to Ponder
- 3DTV Standards Activities
- Harris and 3DTV

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What is 3D?

A 3-D (three-dimensional) photograph, movie or TV picture that provides the illusion of depth perception.

This technique is often referred to as stereoscopic, giving two different views as used by our left and right eyes do.

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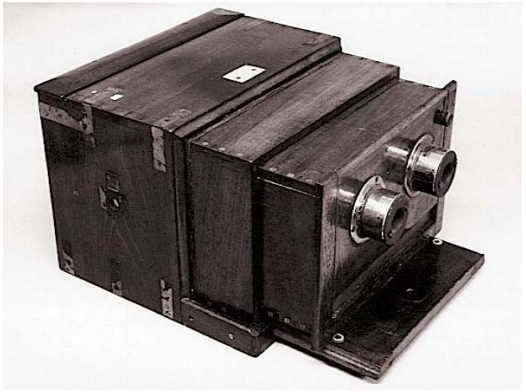
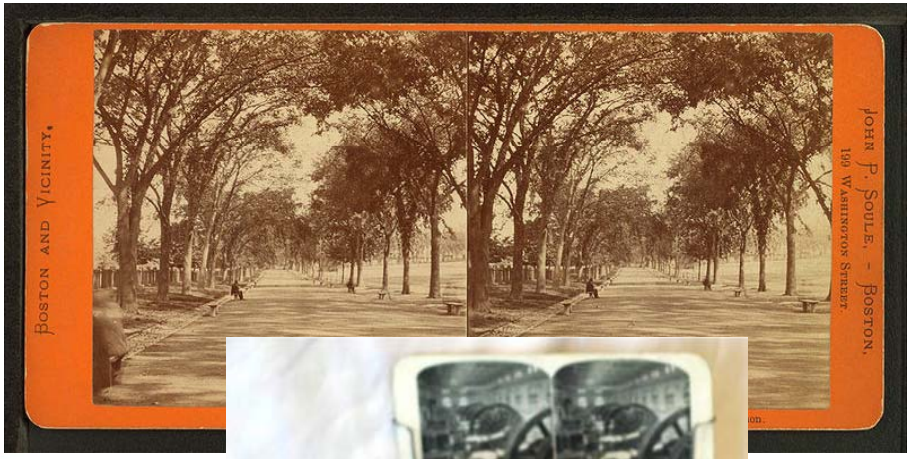
What is 3D Hype about?

3-D certainly isn't new. Stereo cameras have been around for over a century





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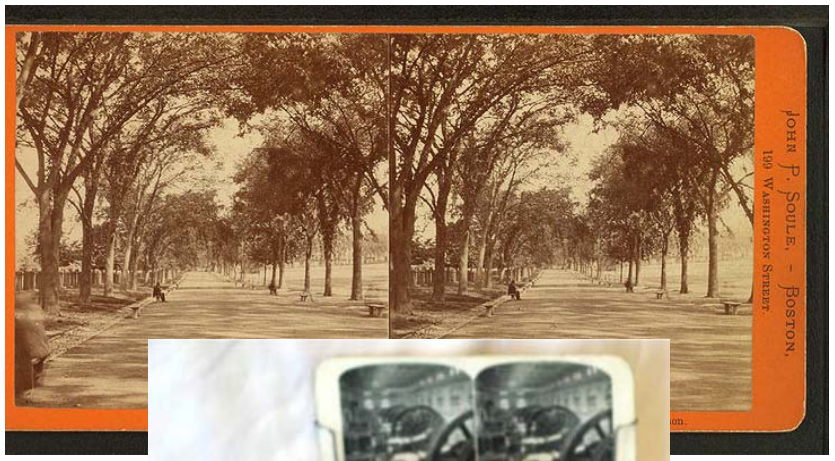

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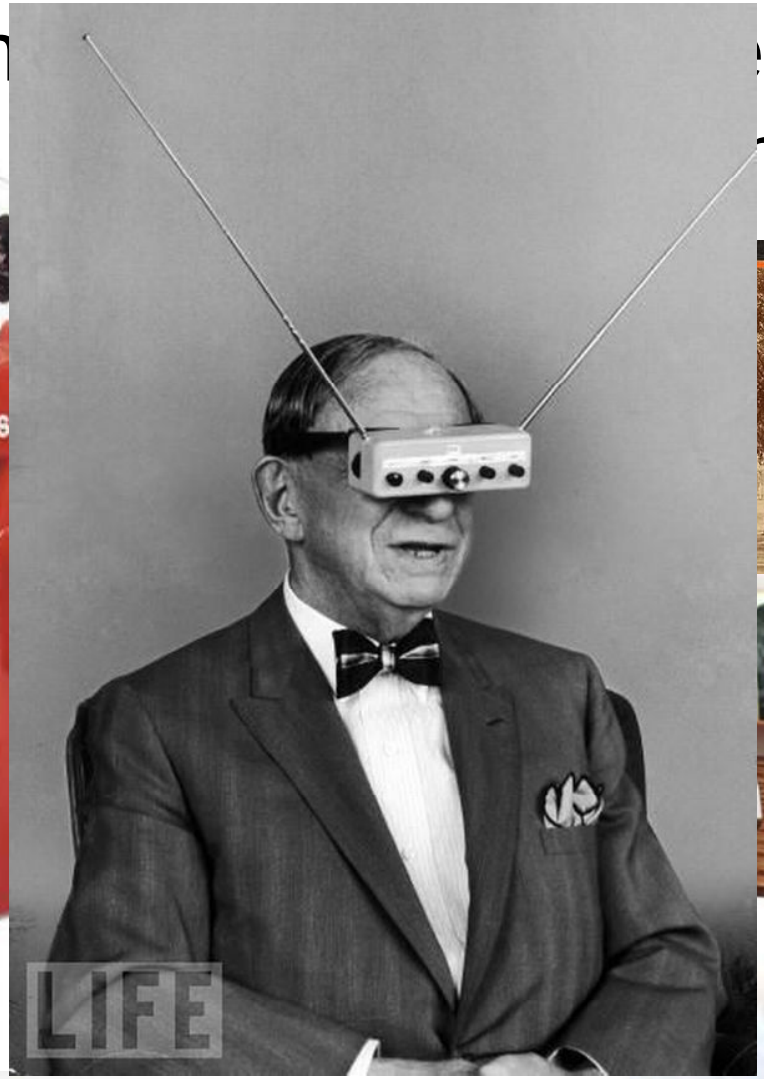

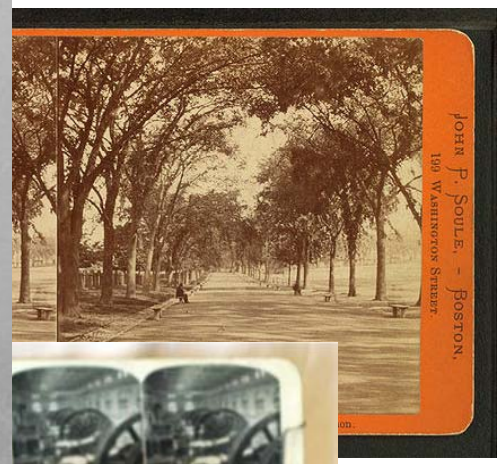

3D Games & Web 3D

- Games & PCs
  - 425 3D games released
  - Major monitor manufacturers offer 3D
  - 1M 3D PCs by mid 2011
  - Glasses which allow you to adjust convergence yourself (decrease discomfort)

- Web
  - Adobe Flash 3D
  - YouTube3D
  - Google Earth
  - Next3D
  - Live full-res 1080p 3D streaming shown at CES
  - Some anaglyph, but heading largely toward side-by-side

3D Cinema

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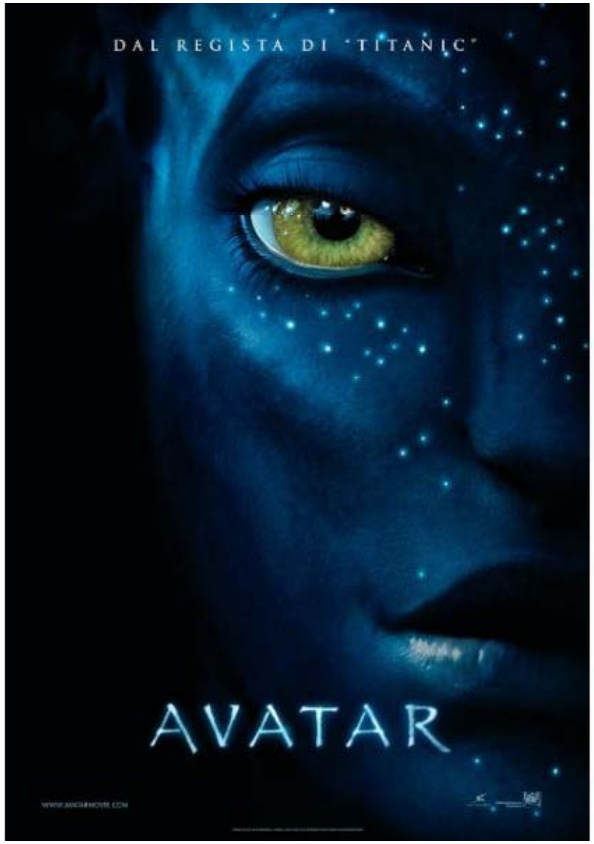
3D Cinema

- 35 3D films in 2009, 28M viewers
- Many tout 15% incremental cost, averages 2.4x revenue
- Animated features
  - Created in 3D space anyway
  - Simply render second eye view on computer
  - All Dreamworks, almost all Disney, and many independent going 3D



- Live action
  - James Cameron showed everyone how to do it very well with Avatar
- Next genres: Horror and high profile releases

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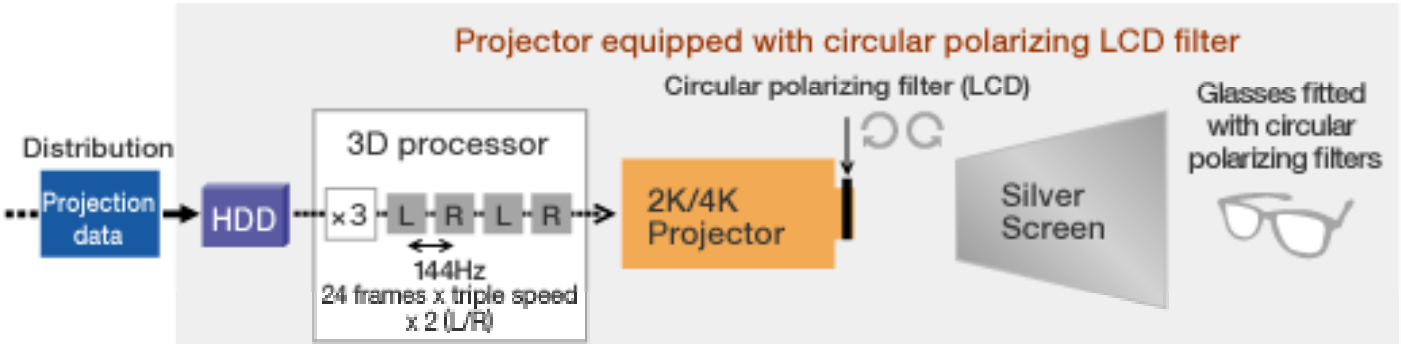
3D Cinema - RealD™

- LCD circular polarizing filter placed in front of the cinema projector lens.
- Two streams of image data, left and right, are circularly polarized - clockwise and anticlockwise - to generate pictures for the left and right eyes, respectively.
- These are alternated at high speed for projection on a silver screen, watched by an audience wearing glasses fitted with circular polarizing filters. The alternating images reflected from the screen are thus seen by left and right eyes alternately, allowing the viewer to enjoy a 3D experience.



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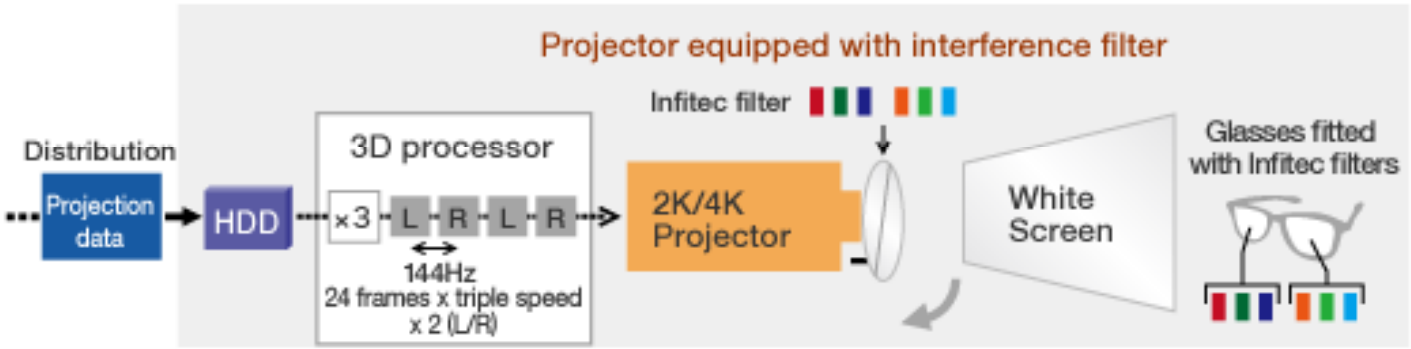
3D Cinema – Dolby® 3D

- Each of the three primary colors - red, green and blue - is split into 2 different wavelengths, one for the left eye and one for the right eye.
- For projection, an interference filter (Infitec) is rotated at high speed, displaying RGB for left and right eyes alternately, while the viewer wears Infitec filter glasses for this "wavelength multiplex visualization system."



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3D Television

- What is 3DTV?
  - More accurately, “stereoscopic television”
  - Two pictures presented to viewer (one for each eye)
  - Brain combines two views and interprets it as a 3D view

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3DTV is happening now!

Why is it “for real” this time?

- Digital is the difference
- True HD quality (or close to it)
- Nausea, discomfort issues addressed
- Production “lessons learned”
- ROI is clear
- Industry needs a follow-on to HD (media, consumer, and professional equipment companies)
- Rapid embrace by consumers

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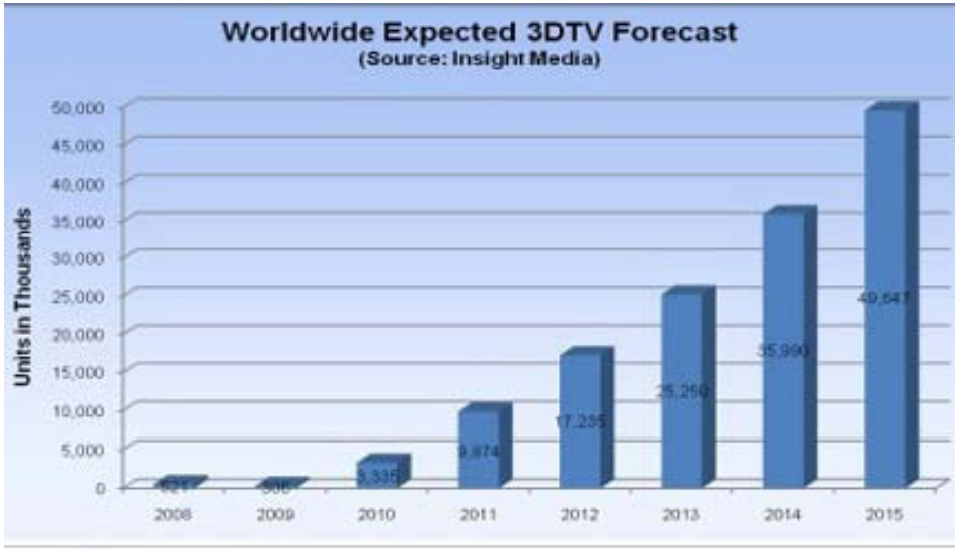
3DTV is happening now!

- Quick CE Facts
  - 25% expect to buy a 3DTV within 3 years
  - 20% say they never will (2003: 33% said never for HDTV)
  - 10% of TVs 37” and up sold in 2010 have been 3D
  - By 2013, ¼ of all TVs will be 3DTVs



(Credit: Insight Media)

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3DTV Deployments

- Who's Deploying 3DTV?
  - BSkyB
    - Will work on existing STBs (Sky+HD boxes)
    - Movies, entertainment, sports
    - Focus on pubs & clubs initially, now homes

  - DirecTV
    - 3 channels (two linear, one VOD)
      - Working with AEG/AEG Digital Media, CBS, Fox Sports/FSN, Golden Boy Promotions, HDNet, MTV, NBC Universal and Turner Broadcasting System
      - Initially single PPV channel – movies, documentaries, etc.
      - Launched in June
      - Software update on existing MPEG-4 STBs
      - 2010 MLB All-Star Game on Fox Sports
      - Exclusive sponsor: Panasonic

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3DTV Deployments

- Who's Deploying 3DTV?
  - Comcast & Cox Cable
    - The Masters

  - Verizon
    - FiOS
      - WealthTV
      - On-demand movie channel launched mid-November
        - $2 premium over HD movies

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3DTV Domestic Update

- Who's Deploying 3DTV?
  - ESPN
    - 25 World Cup games
    - Minimum 85 sporting events all in 2010 (June 11 on)
    - College basketball, college football, BCS National Championship game in January 2011
    - Exclusive sponsor: Sony

3DTV in the US

CBS

- Final Four of NCAA Basketball Tournament
- US Open Tennis
- PGA Championship

Fox

- Airing sports beginning in a few months

Turner

- NBA Basketball, animation, other content

PBS

- Showing interest

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3DTV in the US

NBC

- Farther behind, but think 2012 Olympics at a minimum

ABC

- Focusing on ESPN3D, but could translate to broadcast network

Discovery

- 3DNet launching early 2011

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3DTV in the US

"Universe" Premier

- Shown late July on DirecTV

Oregon vs California college football game

- Shown mid-November on Verizon FiOS

3DTV in the US

CABLEVISION

Cablevision – first live stereoscopic broadcast to the home, powered by Harris equipment

3DTV Worldwide

France		Canal+ Orange
Portugal		Zon Multimedia
Germany		Sky Deutschland
Spain		Canal+ Spain Hispasat TV3

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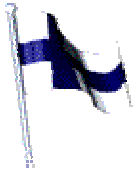
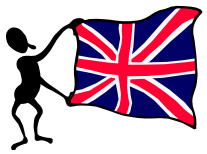
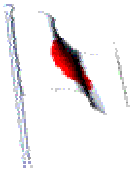
3DTV Worldwide

Poland		Cyfra+ Dialog
Finland		Welho
Italy		Sky Italia

3DTV Worldwide

UK		BSkyB BBC ITV Virgin
Brazil		TV Globo NET Servicios
Japan		Sky Perfect WOWOW J:com BS-11
Korea		CJ HelloVision TU Media Skylife OTA Trials

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3DTV Worldwide

What about the world's smallest country?

Vatican to launch HD/3D Channel

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Even Royalty is getting in on the act…

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Another “Guy”…December 4th…

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Recent Developments

ESPN Study

- Ads:
  - People remember 3D ads better
  - Purchase intent went from 49% for 2D to 83% for 3D
  - Ad “liking” went from 67% to 83%

- Programming:
  - Enjoyment – went from 65% to 70%
  - Involvement – went from 67% to 70%
  - Presence – went from 42% to 69%

- Glasses:
  - Little difference active vs passive, but latter considered “more comfortable and less distracting”

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Consumer Product Launches

- Samsung and Toshiba – live 2D-3D conversion on the TV
  - All Samsung 3D sets have this.
  - Analagous to upconversion of SD to HD, but worse
  - Still, very impressive technologically
  - Experience dependent on content – some looks great, some not.

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Consumer Product Launches

- Internet VOD 3D

Consumer Product Launches

- ViewSonic 3DV5 pocket camcorder…$180
  - 720p
  - Two 5 megapixel recorders
  - Includes autostereo display (parallax barrier)
  - Can buy their 3D photo frame, too! Also $180

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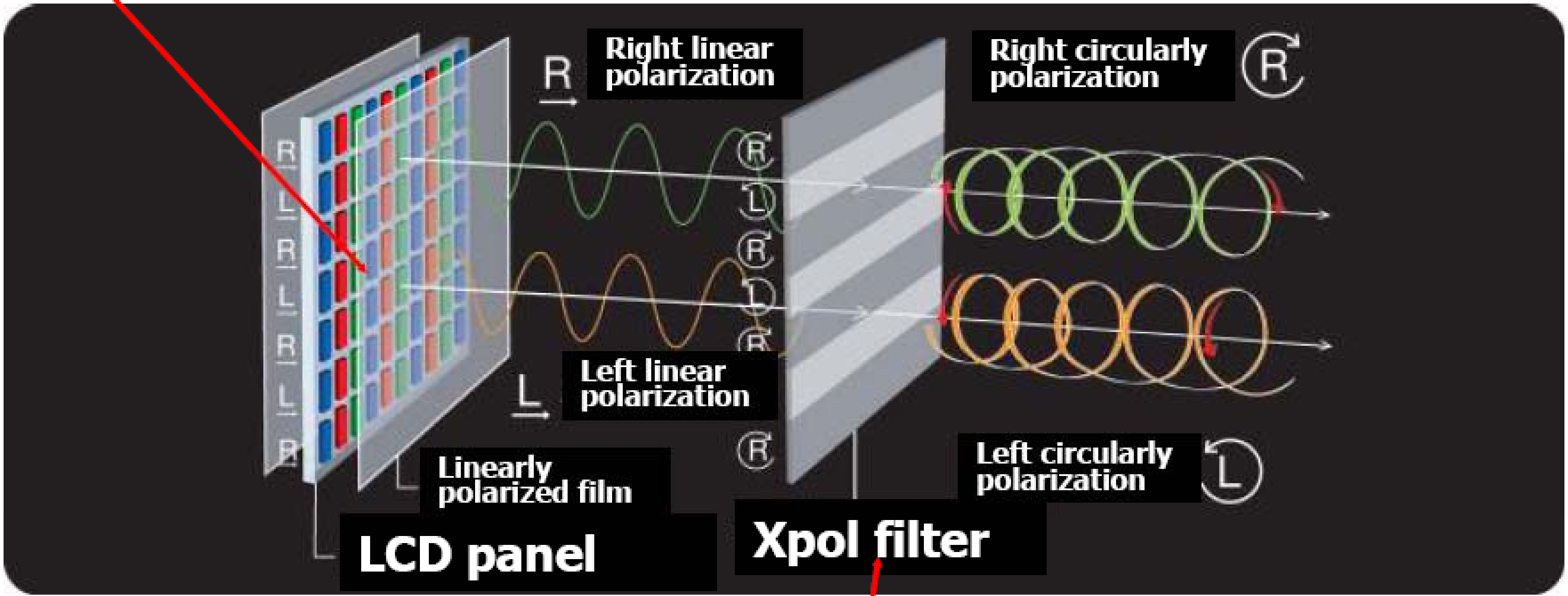
How Does 3DTV Work?- Xpol

Image displayed alternatively
(Odd: for right eye, Even: for left eye)



Xpol filter converts linear to circularly

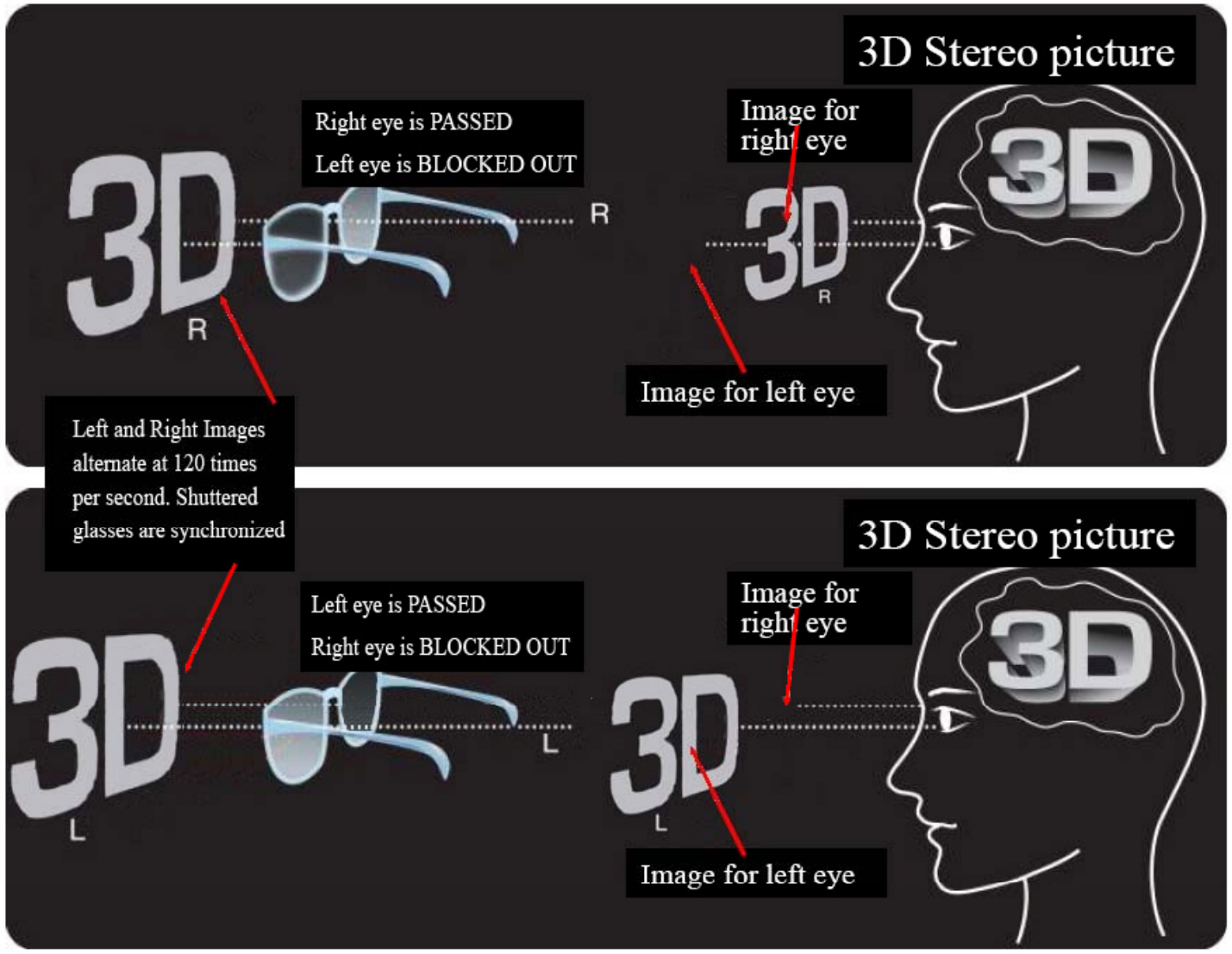
3D Update

- When used on TVs, viewed with polarized glasses
  - RealD
  - Very inexpensive (~$1)
  - Fashionable
- Works fine in large environments with ambient light (think bars, restaurants)
- Not 2D compatible
- Half-resolution (can be improved)
- TV sets more expensive (technology, licensing)

How Does 3DTV Work?- Shutter

Left and Right images are displayed sequentially. IR synchronized glasses pass only the right image to the right eye and left image to the left eye.

No loss in resolution!!!!!



How Does 3DTV Work?- Shutter

- Frame-Sequential (temporal compression)
  - Full resolution
  - Frame rates of 120Hz or more (up to 480Hz currently)
  - TV sets inexpensive (maybe a few hundred more)
  - Active shutter glasses
    - Expensive, but dropping rapidly
    - Need to be recharged
    - A little less fashionable
  - Not 2D compatible
  - Works best in a dark environment
  - Picture tends to look darker (each eye is blocked more than ½ the time)
  - Used for gaming, available on laptops

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- Cameras
  - Two lenses side by side – traditional approach
    - Panasonic - $21K twin lens professional camcorder now available, and has been followed by a consumer one.

- Cameras
  - Two lenses with mirror (beam splitting) – when there isn't enough room for a side by side rig

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- Cameras
  - Single lens camera (Sony)!

- Sports Production
  - Far fewer cameras needed for 3D vs 2D
  - Far fewer cuts needed to cover (single camera on single play is common)
  - Greatly increased router size needed
  - Today: separate production teams
  - Tomorrow: hybrid approach – share resources

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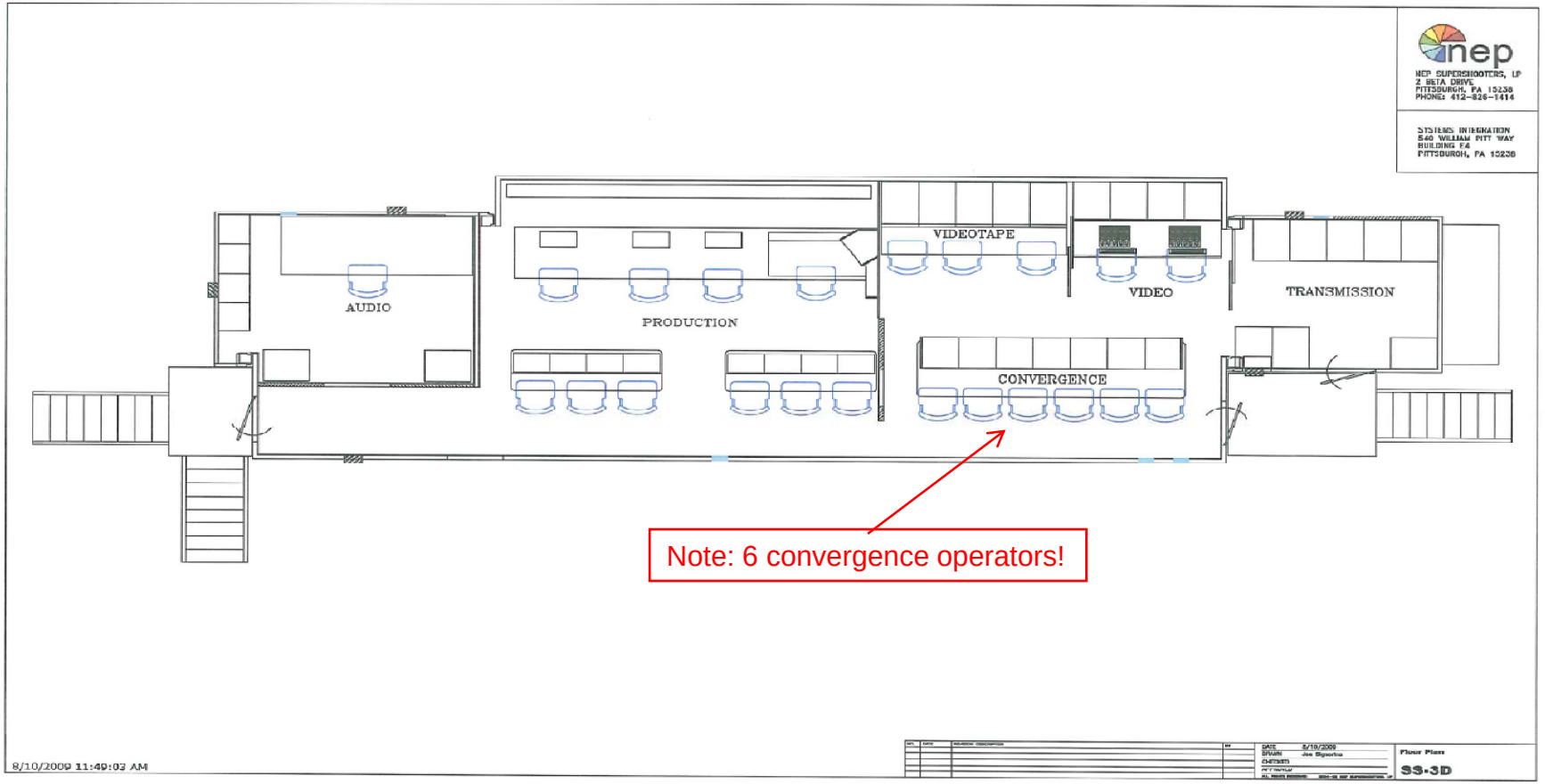
Remote 3DTV Production



3D Update

- Formats, formats, and more formats…
  - Winners and losers already becoming apparent (to some degree)

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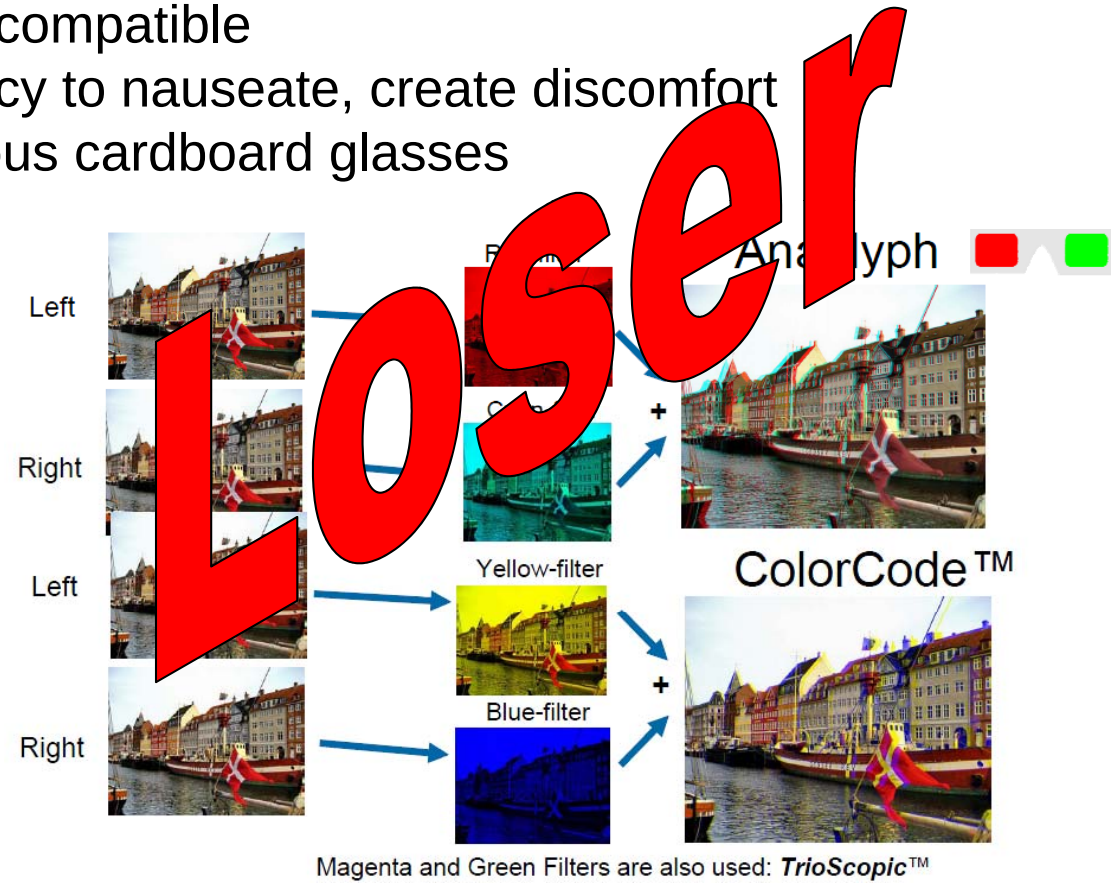
- Anaglyph & ColorCode
  - Use different colors for L & R
  - Inferior quality
  - Not 2D compatible
  - Tendancy to nauseate, create discomfort
  - Ridiculous cardboard glasses



Magenta and Green Filters are also used: ***TrioScopic***™

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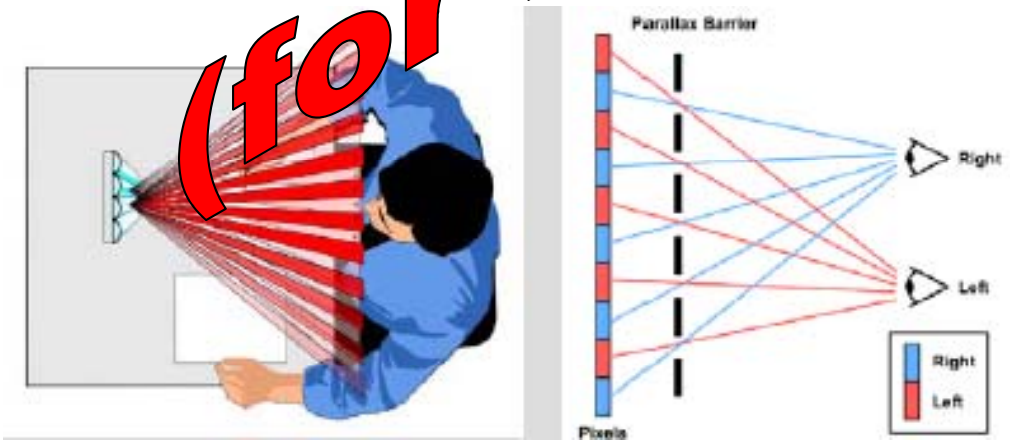
- Glasses-free (autostereoscopic)
  - Mobile phones – looks fine on a small screen, smaller bandwidth impact
  - Digital signage (people are not going to put on glasses to see 3D when shopping)
  - Home use - perhaps 10 years away – Philips (early proponent) stopped pushing this publicly
  - Issues: bandwidth, quality, head placement, etc.

Loser (for now)



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3D Distribution – side by side

- Side-by-side
  - Compresses horizontal resolution, which we have more of.
  - Works well on lower bitrates
  - Enhancement layer option to improve resolution

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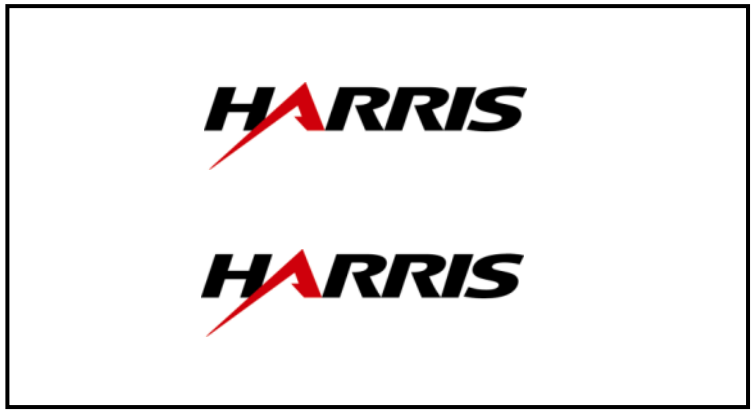
3D Distribution – Over-Under

- Over-Under (also called Top-Bottom)
  - Reduces vertical resolution (which you have less of) – problem for graphics, captions, subtitles
  - Doesn't work well for 1080i



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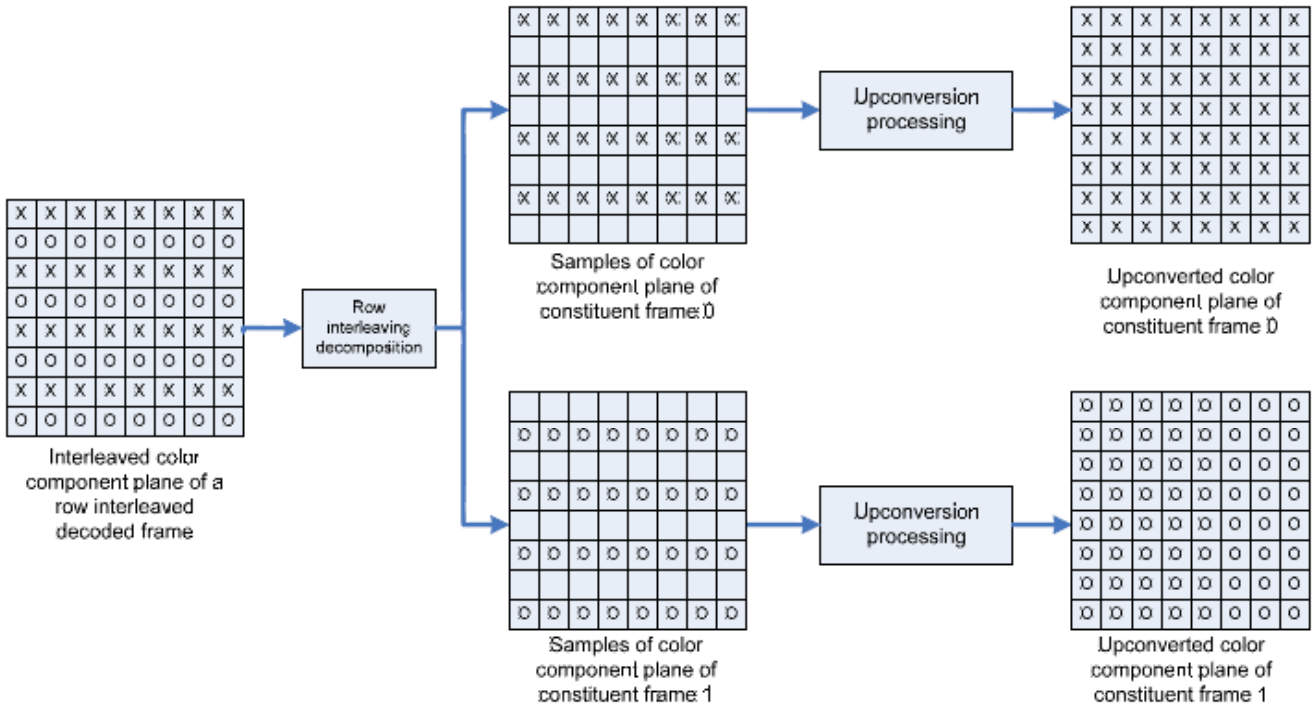
3D Distribution – Interleaved

- Line-Interleaved (a.k.a. row interleaved)
  - Loss of vertical resolution
  - Compression artifact issues



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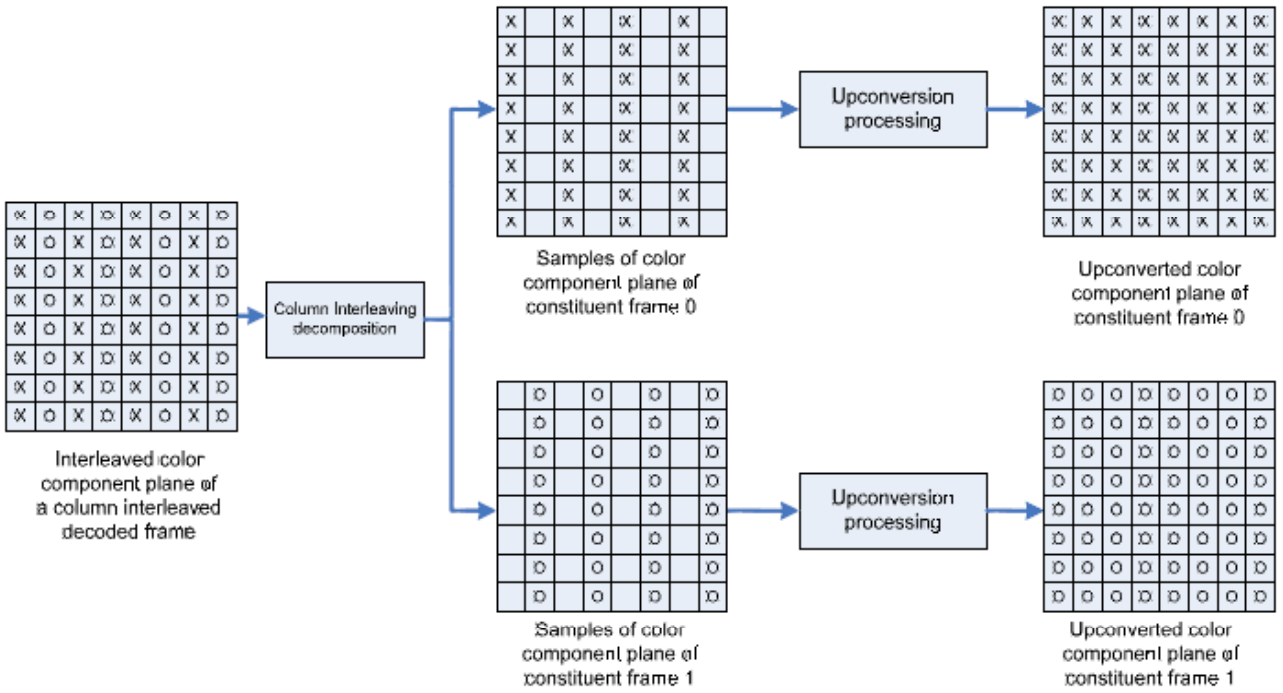
3D Distribution – Interleaved

- Column-Interleaved
  - Loss of horizontal resolution
  - Compression artifact issues



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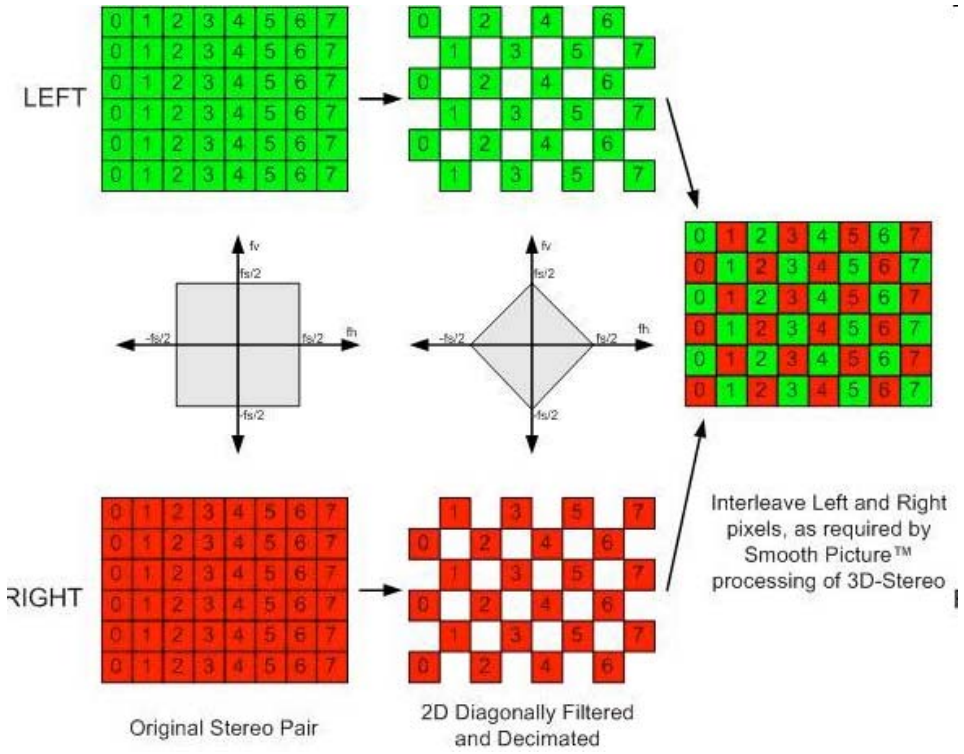
3D Distribution – Checkerboard

- Checkerboard
  - Halves both horiz/vert resolution
  - Difficult to compress, scaling problems, etc.



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3D Distribution – 2D + Difference

- 2D + Difference/Delta/Depth/Metadata
  - Basis of MPEG H.264/AVC MVC
  - TDVision
  - Full-resolution left eye
  - Right eye view constructed using metadata
  - Only format that's inherently 2D compatible (old displays simply ignore the 3D metadata)
  - Roughly 1.35x regular HD bandwidth
  - Good picture in 7 Mbps

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Distribution and Display Formats

- Which format is the winner?
  - For distribution to consumers (non Blu-ray):
    - Today: frame compatible
    - As ROI becomes evident, perhaps 2D+Delta/MVC, or other full-resolution per eye
  - For display:
    - Today: frame sequential with shutter glasses (dominant at CES)
    - As prices drop, maybe frame compatible with polarized glasses

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Things to Ponder

- Best-suited content?
- Production costs
- Graphics/subtitles/caption considerations
- Distribution bandwidth versus quality
- What about ad-supported channels?

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Ad-Supported Channels

- First 3DTV channels not ad-supported
- Issue will be faced sooner than you think
- Will we see 3D ads soon?
  - Some out there
  - Harris working on educating Adv/Agy community
- Can you charge a premium for 3D ads?
- Meanwhile…take 2D content and float it a little in front of screen plane.
- Automated 2D-3D conversions not the whole answer

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3D Standards Activities

- SMPTE Activities
  - Dealing with 3D Home Master
    - Common professional format for both live and recorded content.
  - Three active ad hoc groups:
    - Image Format
    - Graphics & Subtitling
    - Metadata
  - Documents now appearing for ballot!

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Other SMPTE 3D Activities

- Frame Compatible (10E-3DFC): define methods and establish signaling
- Disparity Maps (10E): WS under review for standardization of these
- 2x SMPTE 292 (1.5G SDI)
- Multi-link 3G (32NF-20): mapping 2 or 4 links (for 6 and 12G) – multi-part SMPTE 425
- 3D Contribution Links: MPEG-2 codec agnostic links over ASI or IP
- MXF 3D Work (31FS)

3D Standards Activities

- ATSC Activities
  - New group (PT-1) formed
  - Looking at technology, business cases, broadcaster needs.
  - Interest in Korean trials (MPEG-2 left eye, MPEG-4 right eye)

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3D Standards Activities

- SCTE Activities
  - Active working group
  - Working closely with CableLabs and MPEG
  - Unique challenges in cable environment (eg. STB)
  - Constituents moving forward
  - Published report in June

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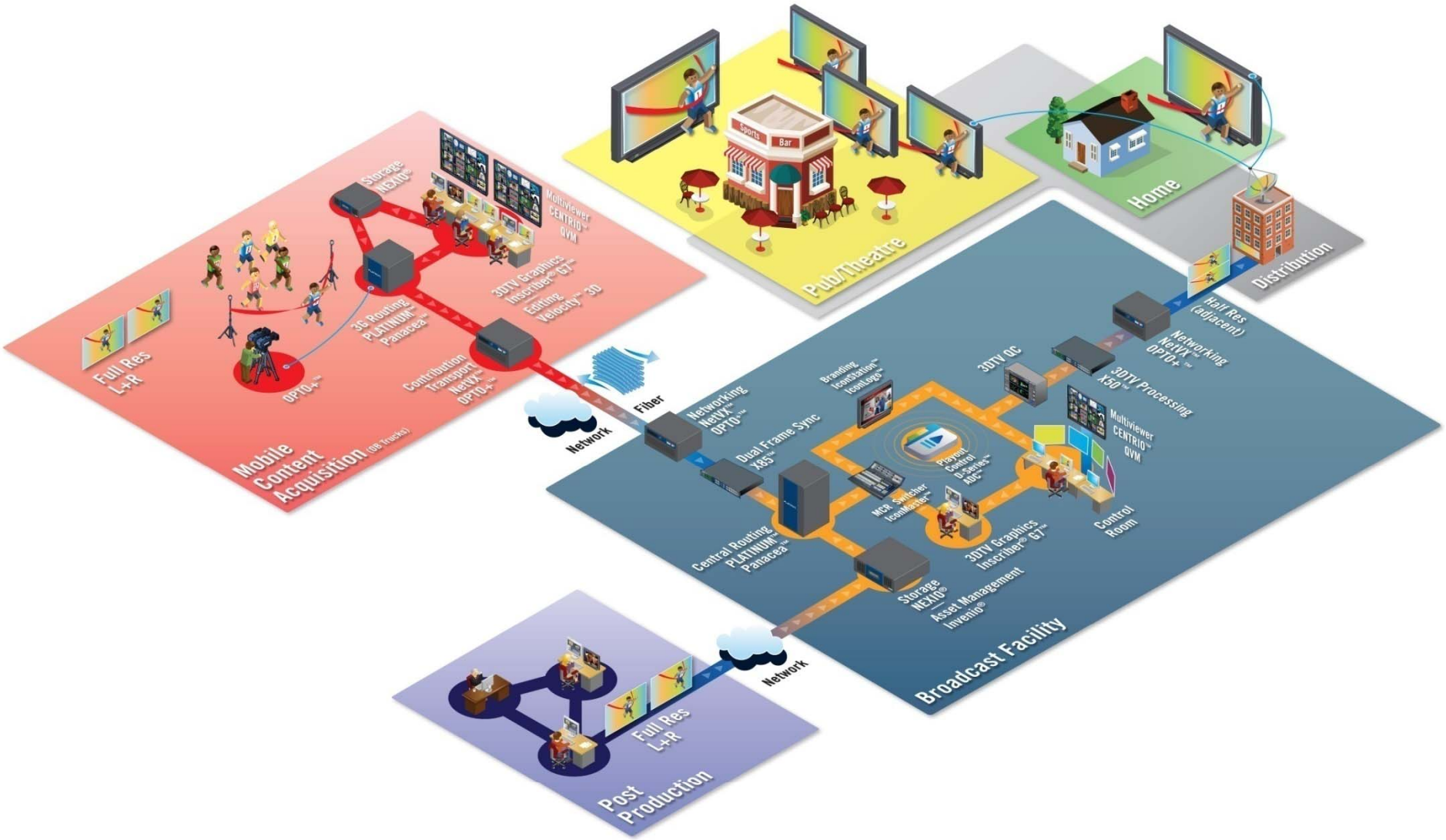
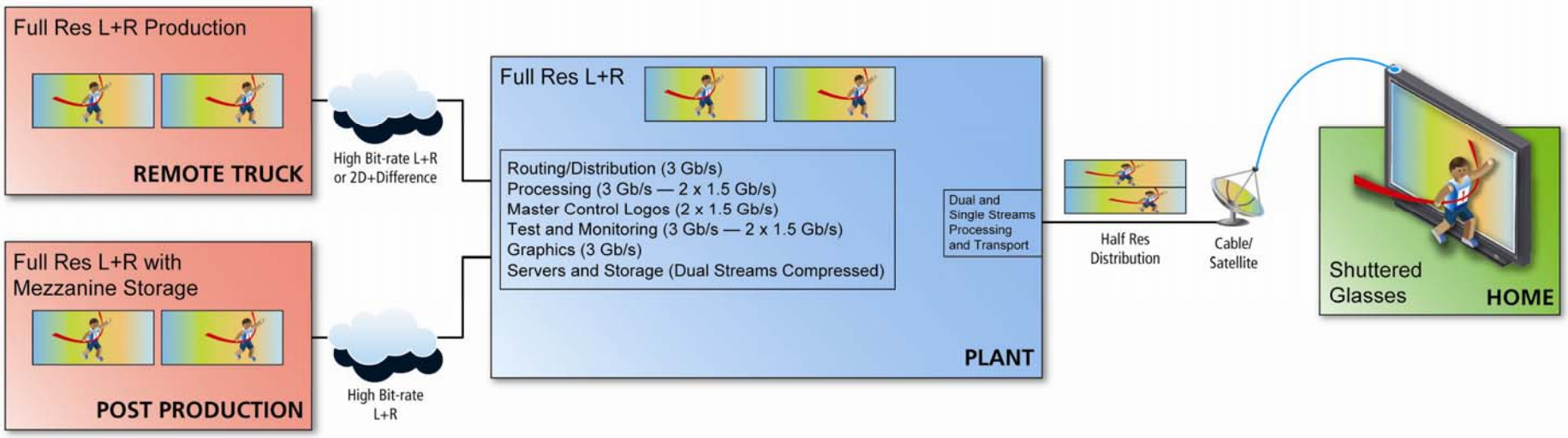
3DTV – Workflow



3D Signal Flow

- 3 Gb/s is preferred to keep signals together
  - Two 1.5 Gb/s packed to make 3 Gb/s
  - expect a mix of two 1.5 Gb/s and 3 Gb/s for a while
  - Difficult to guarantee the sync-up of two 1.5 Gb/s feeds



Harris Differences

- Many other vendors are offering 3DTV point products
- We look at entire “glass to glass” ecosystem
- We are not new to this
  - Government 3D work for many years
  - One of the first to take this seriously
    - SMPTE 3DTF founding member “way back” in 2008

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Harris 3DTV Products

Routing (Platinum/Panacea)

- 3G of course
- Marriage of dual channels in control system

X50-X85

- Dual/Single Link
- HDMI for 3D and supering for 2D viewing
- 3D Timing/Sync/Proc functions – can frame sync two 1.5Gbps streams

Servers (Nexio)

- slaved ingest and playout for left and right channels

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Harris 3DTV Products

Master Control & Branding (IconMaster)

– Slaved MC operations using two units with single control panel for left and right channels
– 3D logo insertion

Automation

– Can control two streams

Networking/Encoding (NetVX)

– Demoing dual channel using X85s for dual sync up

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Harris 3DTV Products

Monitoring (Multiviewer)

– 2D and 3D monitoring

Editing (Velocity)

– Working on changes to the editor to support left and right channel editing, initially from dual link captured material

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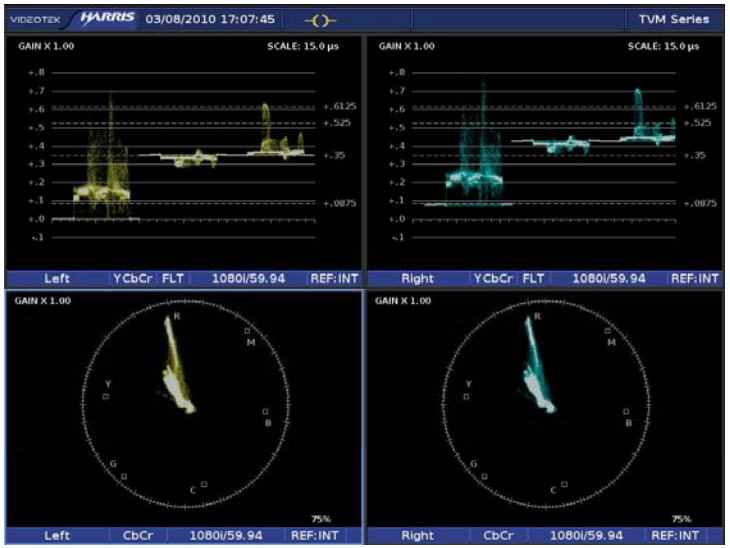
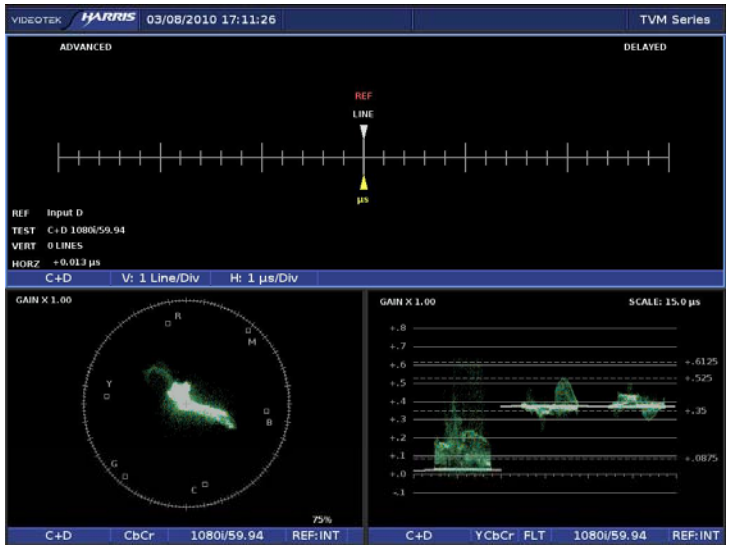
Harris 3DTV Products

Test & Measurement



Left Eye/Right Eye Luminance/Chrominance Measurement



Overlay with Position Measurement, Luminance/Chrominance Measurement

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Harris 3DTV Products

Graphics (Inscriber G7-3D)

– Working with Nvidia card now, private customer demos underway in Toronto

– Leverages all the functionality of the currently shipping Gscribe 7.0 software.

– Realtime 2D and 3D graphics in 3D stereo

– Output dual link 1.5G L+R HD SDI

Harris 3DTV Products

Graphics (Inscriber G7-3D)

– Also single link side-by side and top-bottom and field sequential

– Dynamically adjust Z depth and focal depth in real time

– Preview stereo 3D directly on the design canvas

– Supports pre-rendered 3D content Playback (stereo AVIs, MOVs etc)

Product Deliverability

- All products we are discussing are available today!

- Film-Patterned Retarder (FPR) Passive Displays
  - Easier to make
  - Less expensive
  - LG and others

- Autostereoscopic Displays
  - MVC enables packaging of multiple views
  - Technical hurdles remain

- Live Holography
  - Japan set goal of 2022 World Cup

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- **Our Rivals are so far behind…**

- Never mind…

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Conclusions

- 3DTV is moving forward at an unprecedented pace
- Predictions are difficult and dangerous
- Harris is the only vendor offering end-to-end 3DTV solutions now, rather than simply a point product or two
- We offer top notch solutions for today's HD needs, which are also 3D-capable if you need it tomorrow

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Thank You

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