

The State of 3D in the Home – April 2010

**A Presentation by Insight Media for the 3D @ Home
Consortium**

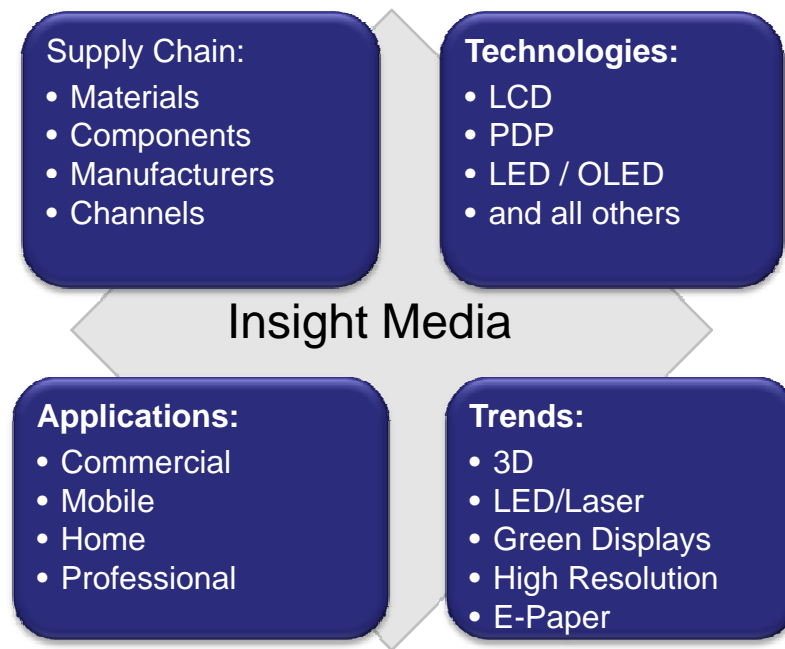
- Chris Chinnock
- Founder & President, Insight Media
- Board Member, 3D @ Home Consortium
- 20 year display veteran
- Common industry speaker and advisor



- Intro to Insight Media
- Is 3D Real?
- 3D Basics
- Frame Compatible (Broadcast) Distribution
- 3D Playback
- 3D Glasses
- 3D Electronics
- 3DTV & Projectors

Introduction to Insight Media

- Insight Media is a Market Research, Publishing and Consulting Firm focusing on the Display Industry



Our Services

Reports

Client
Services

Newsletters

Conferences

Consulting

- 3D is major focus for Insight Media
 - 10 Analysts covering 3D – Lens to Living room
 - Content creation
 - Mastering, encoding and distribution
 - Cameras, phones, PCs, TVs, projectors
 - Consumer and Professional applications
 - News, report, consulting and conferences around 3D
 - Co-founder and service provider to 3D @ Home Consortium
 - Five 3D reports so far
 - TV (2008)
 - Gaming (2009)
 - 3DTV Forecast (2010)
 - AS-3D for Professional Applications (2009)
 - 3D Technology & Markets (2007)
 - 2D-to-3D Real Time Video Conversion (Coming)
- **Insight Media has the best 3D team in the industry**

Is 3D Real?

- 3D on theaters is a hit
 - Avatar has set a high bar for quality 3D
- Announced Theatrical Releases¹
 - For 2010 – 56 planned titles
 - For 2011 – 33 planned titles
 - For 2012 – 14 planned titles
- 50-60% of Hollywood's income is from non-theatrical sources like DVD and Blu-ray
 - Blu-ray releases²
 - For 2010 – 15-25 (includes converted 2D movies); increasing from there
- **Studios are highly motivated to bring 3D to homes**

¹Source: 3D at Home Consortium

²Source: Insight Media 3DTV Report

- Any PC with a decent graphics card can support 3D gaming
 - Supported by nVidia and AMD
 - First crop of 3D laptops and monitors available
 - Over 400 PC games can be run in 3D
- Sony will do firmware upgrade of PS3 this summer to support 3D
 - Expect Microsoft to follow
 - Requires new 3D game and 3DTV
- 3D games³
 - For 2010 – 15-25 native 3D, increasing from there
- **The gaming, PC and console industries are motivated to see more 3D**

- Samsung + Technicolor + DreamWorks – Starts in April
 - Produce 3D Blu-ray discs
 - Monsters vs. Aliens and Toy Story exclusives
 - Technicolor setting up cable 3D channel in UK
- ESPN - Starts in June 2010
 - 85 events planned in first year (starting with 2010 FIFA World Cup in June)
 - 24/7 3D sports broadcasting
 - Negotiating with production & distribution partners now
- DirecTV + Panasonic - Starts June 2010
 - Pay per view channel, occasional 3D channel and video on demand channel
 - Movies, sports and entertainment
- Discovery + IMAX + Sony - Launch in 2011
 - Entertainment, sports and nature content

- Live events¹
 - For 2010 – >35 events by pay per view
- Video on Demand channels¹
 - For 2010 – >15
- Internet channels¹
 - For 2010 – 12-15
- Cable/Satellite channels¹
 - For 2010 – 8-12
- Terrestrial broadcast channels¹
 - For 2010 – 1-2
- User generated 3D videos
 - Over 8,000 on YouTube now!
- **Programming and Distribution is coming on a worldwide basis**

- HDTV revolution is maturing
 - Price reductions are severe
 - Innovations are incremental
- 3D adds new vigor and reason to buy a TV
 - May slow price declines
 - Leverages technology advances already in the pipeline
 - Price premiums will be modest to start, declining fairly rapidly
- **Every major TV maker will offer 1 to 14 3DTV models in 2010**

3D Basics

- 3D means different things to different people
 - We will talk about stereoscopic 3D
 - Not rendered 3D
 - Not volumetric 3D
 - Not holographic 3D
- Stereoscopic 3D comes in two major types:
 - Glasses-based = stereoscopic 3D (S-3D)
 - Glassesless = autostereoscopic 3D (AS-3D)

- Human eye/brain combination integrates multiple 2D and 3D cues to perceive depth
- 2D depth cues can create the illusion of 3D on a 2D monitor
- S-3D cues (derived from the slightly different views from each eye) add more realism
 - In reality, 3D cues are important out to ~50 feet only
- S-3D and AS-3D display systems seek to replicate the ways the eyes see 3D

- Eyestrain and even nausea has many factors
 - Fast moving scene (happens with 2D too)
 - Misalignment of the left/right images
 - Poor depth parameters and scene cuts
 - Excessive negative parallax (objects in front of the screen)
- KEY POINT
 - **Most ill effects are caused by choices made in content capture and production – not in the distribution or display of the 3D content**

Frame Compatible (Broadcast) Distribution

- For 3D transmission, Cable/Satellite operators
 - Want to use existing set top boxes
 - Want to use existing 2D infrastructure and compression methods
 - Want to use exiting in-home cabling
 - Want to have new 3DTVs create required 3D signal
- The solution: frame compatible 3D signal packaging
 - Possible with firmware update
 - There will be some implementation issues
 - Higher bandwidth solutions may come later

Left Eye



L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L

Filtering

Packing

Top/Bottom

Right Eye



R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
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L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
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R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R



Preferred for 720 or 1080p content

Left Eye



L	L	L	L	L	L	L	L	L	L
L	L	L	L	L	L	L	L	L	L
L	L	L	L	L	L	L	L	L	L
L	L	L	L	L	L	L	L	L	L
L	L	L	L	L	L	L	L	L	L
L	L	L	L	L	L	L	L	L	L
L	L	L	L	L	L	L	L	L	L
L	L	L	L	L	L	L	L	L	L

Right Eye



R	R	R	R	R	R	R	R	R	R
R	R	R	R	R	R	R	R	R	R
R	R	R	R	R	R	R	R	R	R
R	R	R	R	R	R	R	R	R	R
R	R	R	R	R	R	R	R	R	R
R	R	R	R	R	R	R	R	R	R
R	R	R	R	R	R	R	R	R	R
R	R	R	R	R	R	R	R	R	R

Filtering

Packing

Side by Side

L	L	L	L	L	L	L	L	R	R	R	R	R	R	R	R	R
L	L	L	L	L	L	L	L	R	R	R	R	R	R	R	R	R
L	L	L	L	L	L	L	L	R	R	R	R	R	R	R	R	R
L	L	L	L	L	L	L	L	R	R	R	R	R	R	R	R	R
L	L	L	L	L	L	L	L	R	R	R	R	R	R	R	R	R
L	L	L	L	L	L	L	L	R	R	R	R	R	R	R	R	R
L	L	L	L	L	L	L	L	R	R	R	R	R	R	R	R	R
L	L	L	L	L	L	L	L	R	R	R	R	R	R	R	R	R



Preferred for 1080i content

Left Eye



Filtering

L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
L	L	L	L	L	L	L	L	L	L	L	L	L	L	L

Packing

L	L	L	L	L	L	L	L	R	R	R	R	R	R	R	R	R	R
L	L	L	L	L	L	L	L	R	R	R	R	R	R	R	R	R	R
L	L	L	L	L	L	L	L	R	R	R	R	R	R	R	R	R	R
L	L	L	L	L	L	L	L	R	R	R	R	R	R	R	R	R	R
L	L	L	L	L	L	L	L	R	R	R	R	R	R	R	R	R	R
L	L	L	L	L	L	L	L	R	R	R	R	R	R	R	R	R	R
L	L	L	L	L	L	L	L	R	R	R	R	R	R	R	R	R	R
L	L	L	L	L	L	L	L	R	R	R	R	R	R	R	R	R	R

Side by Side



Right Eye



R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

- Checkerboard and additional proprietary filtering techniques can be used too (Sensio, Real D, etc.)
 - Add special enhancement layer or metadata – ignored is decoder not present
- These can then be packed as side-by-side or top/bottom

- 3D Broadcast over satellite and cable can be done now using side-by-side or top/bottom packing
 - Trade-off is lower resolution per eye
 - Proprietary filtering can improve image quality
 - Next generation set top boxes will improve image quality

3D Playback

- Blu-ray 3D spec issued
 - 3D discs encoded with MPEG4-MVC (Multiview Video Coding)
 - Players will decode to create two streams
 - 1080p/24 per eye for movies
 - 720p/60/50 per eye for games and other sources
 - Data streams need to be packed for output
 - Spec calls for 1080p/24 or 720p/60/50 per eye in a “frame packed” configuration (double height frame or double length frame)
 - Compatible with HDMI 1.4 or firmware enhanced 1.3
 - Backward compatible
 - 3D content will show 2D image on 2DTV; 3D on 3DTV
 - 2D content will show 2D image on 2DTV or 3DTV

Blu-Ray Double Frame

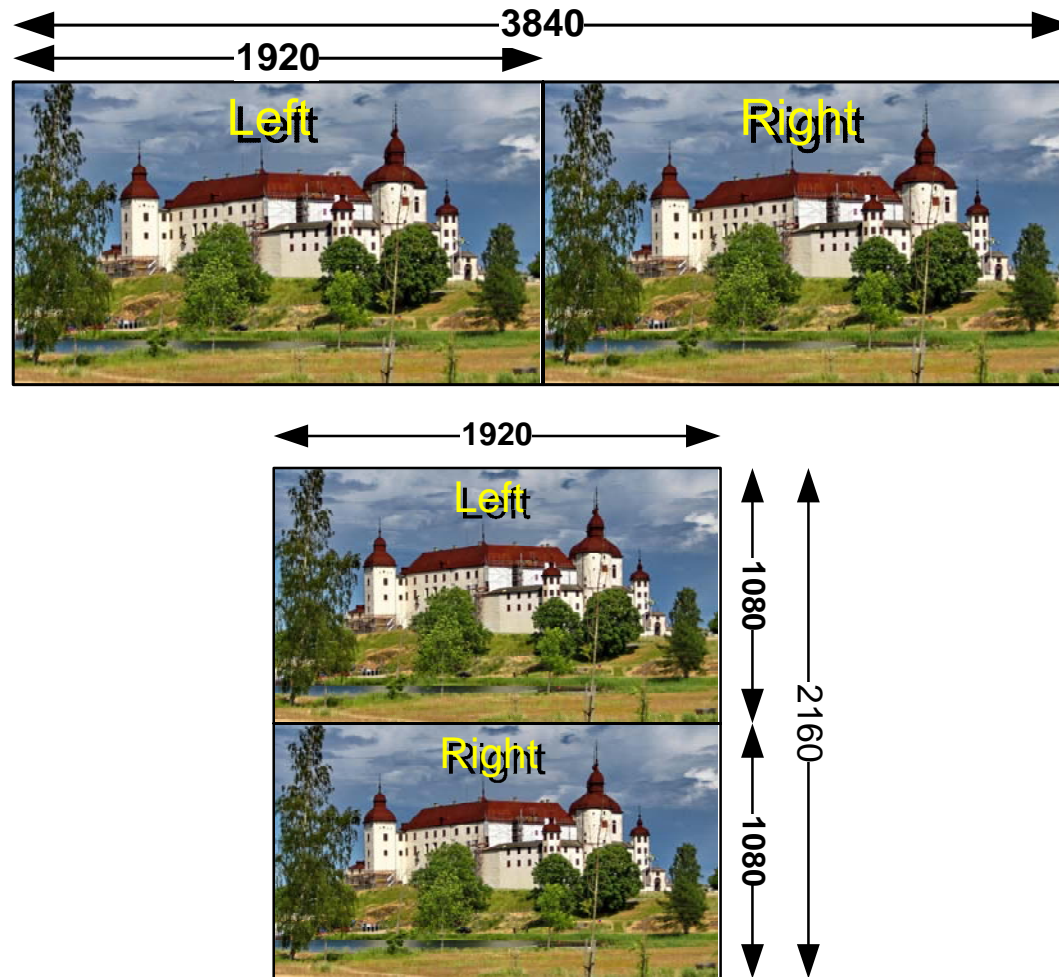


Image: CableLabs

- HDMI 1.4A spec issued
 - Details 3D signaling support (among other things)
 - Mandatory formats:
 - 1080p/24Hz
 - 720p/50 or 60Hz
 - Top/Bottom @ 60Hz
 - Side by Side @ 60Hz
 - Optional 3D formats possible too
- HDMI 1.3 transceivers can support 3D signaling if they allow firmware upgrade
 - Enables many set top boxes, Blu-ray players, AV receivers to support 3D
- **Handshaking problems can be expected**

- Software-based 3D playback can be implemented on PCs, consoles or Blu-ray players
 - Can decode and output to a variety of formats
- Demos and announcements shown at CES:
 - Corel will have a Blu-ray playback solution in Summer 2010
 - CyberLink' PowerDVD Ultra supports 3D playback on Blu-ray using Intel, AMD or Nvidia hardware. Includes TDVision 2D+Delta and Sensio decoding.
 - ArcSoft will offer TotalMedia Theater 3 for Blu-ray using Nvidia hardware

- New 3D Blu-ray players are coming
 - HDMI 1.4 allows output to 3DTVs
 - Offers highest quality image
- PC and Internet 3D playback coming too
 - Can mix hardware and software decoding and formatting for TVs
- Game console will soon support 3D playback (via firmware upgrade)
 - Will need new games, however

3D Glasses

LCD Shutter Glasses Timing

Write Left Eye



Hold Left Eye



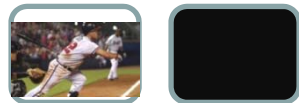
Write Right Eye



Hold Right Eye



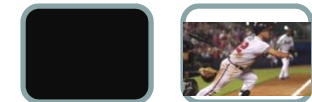
Both Shutters Closed



Left Shutter Open



Both Shutters Closed



Right Shutter Open

3D Light On Time is Low – 15-20%: Much dimmer than 2D Operation

- Sync signals tell the liquid crystal shutters in the glasses to pass or block light to each eye: Multiple protocols exist

IR Transmitter



Proprietary Protocols

- Panasonic, Sony, RealD, Samsung, etc.

Shutter glasses



RF Transmitter



BlueTooth and ZigBee Protocols

- Vizio, others?

Shutter glasses



White Light (Lamp or LEDs in projector)



DLPLink Protocol

- Many DLP projector makers

Shutter glasses



- The vast majority of 3D solutions will use active shutter glasses
 - Passive used in public and post production
- 3D brightness of shutter glasses is greatly reduced (15-20% of 2D)
 - Passive is 40-45% of 2D brightness
- There is little compatibility between suppliers now
 - Universal glasses coming
 - Standards in process
- Active glasses cost (\$100-\$150) is a hurdle and opportunity
 - Should come down quickly with volume and new entrants
- Desire of consumers to use the glasses remains an unknown

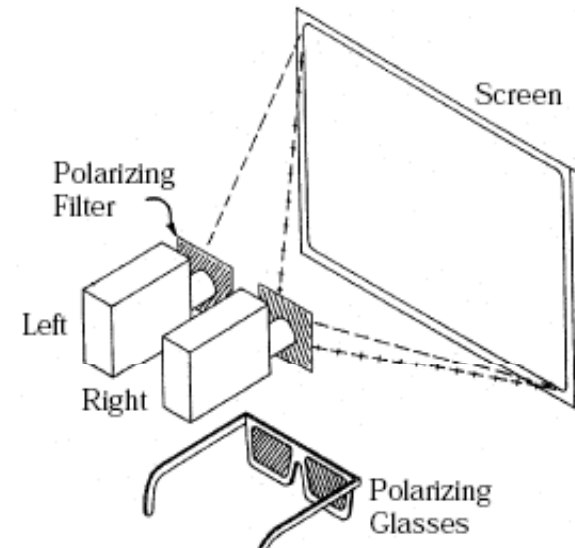
3D Electronics

- Recognize and unpack 3D signal
- Decode proprietary encoding schemes
- Transcode to native 3DTV format
- Scaling & frame rate conversion
- Signals for shutter glasses sync
- Signals for backlight control
- Real time 2D-to-3D conversion
- Motion compensation/Motion estimation

- Algorithms convert 2D to 3D in real time
 - Dozens of companies & universities working this
 - New Insight Media report on this soon
- Quality not great, but improving every year
 - Benefit
 - Allows legacy content and personal videos and pictures to be displayed in 3D
 - Supported by Samsung, Sony, Toshiba, others
 - Concern
 - Fair quality level may create impressions this is the best the technology can offer
 - Not supported by Panasonic today

3DTVs and Projectors

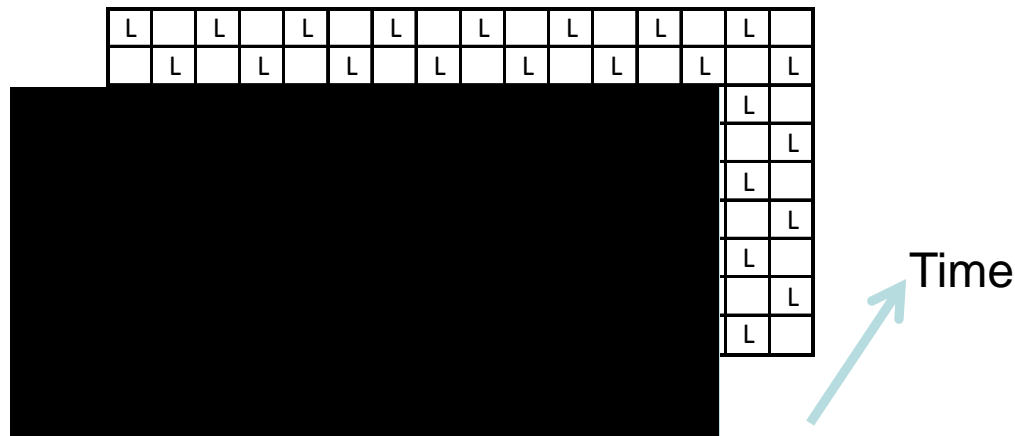
- Two projectors are used for L/R images and carefully aligned
- Filters placed in front of each projector
 - Polarized (linear or circular)
 - Narrowband spectral (Infitec)
 - User wears passive glasses
- Commercialized projection for cinema by Barco, Christie, IMAX and NEC
- Limited opportunity for CEDIA
 - Brighter than a single projector solution
 - More flexibility to do cinemascope on blended projection system
 - More expensive and complex set up



- Most DLP-based solutions use active shutter glasses
 - XGA, WXGA, 720p solutions now in single chip
 - 1080p and higher resolutions in 3-chip
 - Does not require special (polarization preserving) screen
 - Uses DLPLink sync protocol (no additional transmitter)
- Market just starting
 - Some crossover from pro 3D projectors; new HT designs coming
 - Suppliers include Lightspeed Design, Digital Projection, projectiondesign, BenQ, Optoma, etc.
 - Opportunity to educate, install and upsell
 - Opportunity to sell active glasses with good margin

- LG has launched a dual-engine, single chassis 3D projector
 - Model CF3D (~\$10K)
 - Uses 6 Sony SXRD 1080p panels
 - Allows use of passive polarized glasses
 - Requires polarization preserving screen
- Future 3D projectors expected from 3LCD
 - Likely to be shutter glasses based
- DLP-based projectors with Infitec technology could reach home theaters too
 - Leverages cinema technology
 - Features two narrow-band RGB filter sets for each eye (passive glasses)
- DLP with polarization switch will come to home theaters
 - Leverage cinema technology
 - Switches polarization at projector so special screen needed with passive polarized glasses

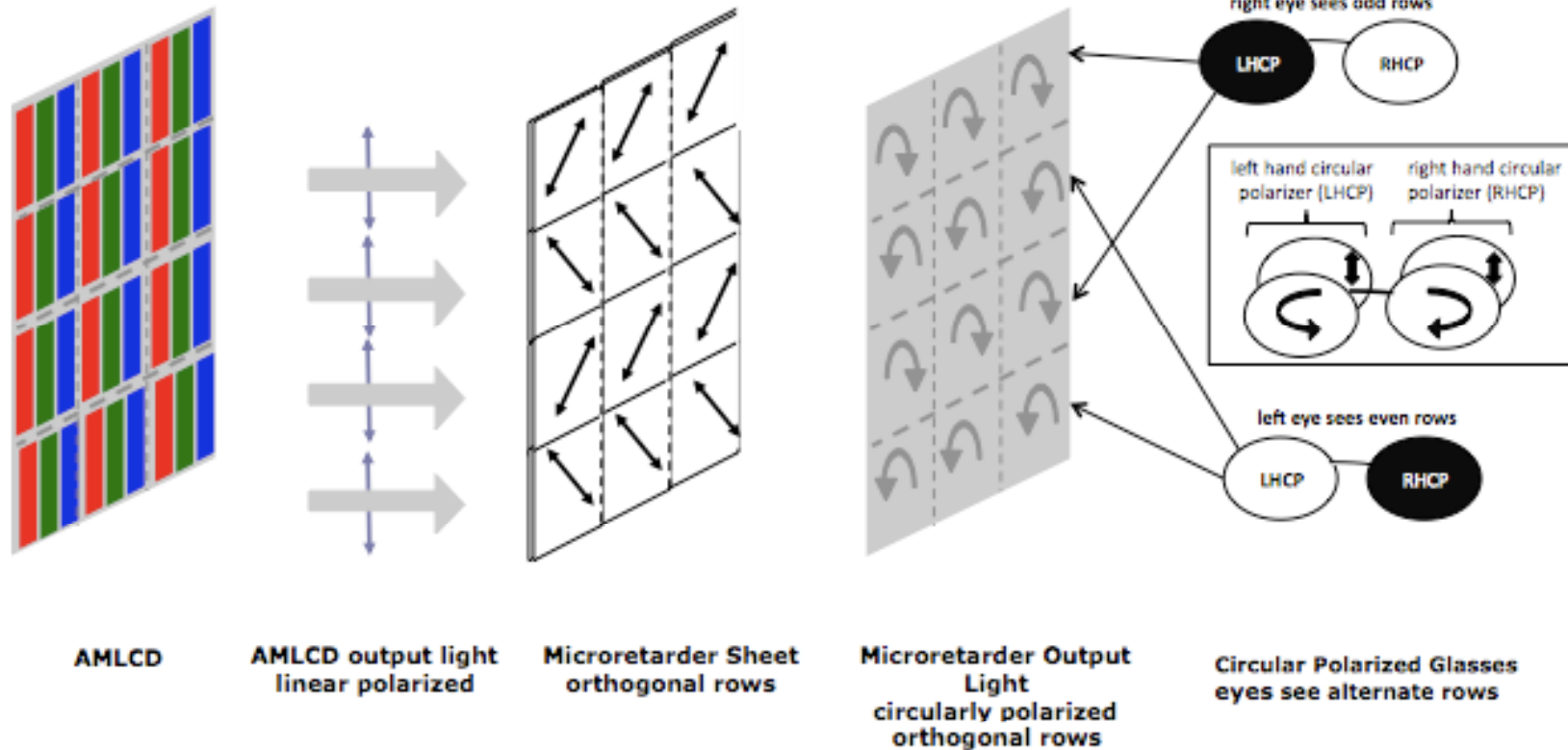
- Mitsubishi last supplier
 - All DLP TVs are 3D ready
 - User wears active shutter glasses
- DLP TVs require a checkerboard signal in a time sequential format (120Hz per field)



- Not supported by Blu-ray or broadcasters
- Mitsubishi will offer an external converter box to transcode these signals for playback on the DLP TV

Micro-pol (or X-pol) LCD

- Micro-polarizer sheet is laminated to standard LCD panel
 - Creates interlaced rows with alternating circular or linear polarization



- 3D signal interlaces L/R images @60Hz

L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L

- Passive polarized glasses separate images
- LG, JVC and Hyundai main proponents – mostly for professional and commercial applications
 - LG selling 3,000 sets to BSkyB for 3D in pubs
 - JVC focused on post production monitors
 - More expensive than shutter glass solutions
 - Main benefit of low cost passive glasses
 - Main detriment is ½ resolution per eye
 - Micro-pol needs to move inside panel long term for cost competitiveness

- LCD
 - Samsung (40", 46", 55", 60", 65")
 - LG (47", 55", 60", 72")
 - Vizio (47", 55", 72")
 - Sharp (60")
 - Toshiba (42", 47", 52", 55", 65")
 - Sony (40", 46", 52", 55", 60")
 - TCL (46") (demo)
 - Hisense (55") (demo)
- PDP
 - Panasonic (50", 54", 58", 65")
 - Samsung (58", 63")
 - LG (60") (demo)
- OLED
 - Samsung (31") (demo)
 - Sony (24") (demo)
- DLP
 - Mitsubishi (60", 65", 73", 82")

- Lots of screen sizes and models from top brands
- 3DTVs will be top-of-the-line models
- Pricing will seek to have same or higher pricing as last year's top models
- Price premium vs. equivalent 2D versions could be several hundred dollars
 - Current announced pricing is ~20% over equivalent 2D TV price
- Samsung, Panasonic roll out in March, LG in April, Sony in June, Vizio, Sharp, Toshiba in Q3

¹Source: Insight Media 3DTV Report

- You need a new 3DTV to see the best forms of 3D
 - Anaglyph (colored glasses) approach works on all TVs, but much lower quality and not being promoted)
 - 60Hz, 120Hz even some 240Hz TVs are not 3D compatible and they can't be upgraded
- 3DTVs are also high quality 2DTVs
 - Consumers will buy based on 2D quality, 3D quality and advanced features
- Lots of 3DTVs coming to market
 - Huge support from retails, TV makers, content creators and distributors
- 3D Home theater market starting now too
- 3D “premium” will be modest
 - Cost of 3D most with consumer in the cost of the glasses and access to content

- FREE
 - www.displaydaily.com
- Subscribe (<http://www.insightmedia.info/monthlyreports.php>)
 - Large Display Report (100 pages/month)
 - Mobile Display Report (50 pages/month)
- Join
 - 3D @ Home Consortium (www.3dathome.org)
- Buy
 - 3DTV Forecast, 2D to 3D Conversion, Autostereoscopic 3D, 3D Gaming reports (<http://www.insightmedia.info/yearlyreports.php>)
- Attend (<http://www.insightmedia.info/conferences/3dcomm.php>)
 - 3D Comm (June 9-11 in conjunction with InfoComm, Las Vegas)
 - 21 3D Seminars
 - Alioscopy Pavilion
 - 4 3D Theaters
 - 3D Exhibitors

Thank You

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