



Pace plc Technology Briefing

3DTV - The technology behind the service

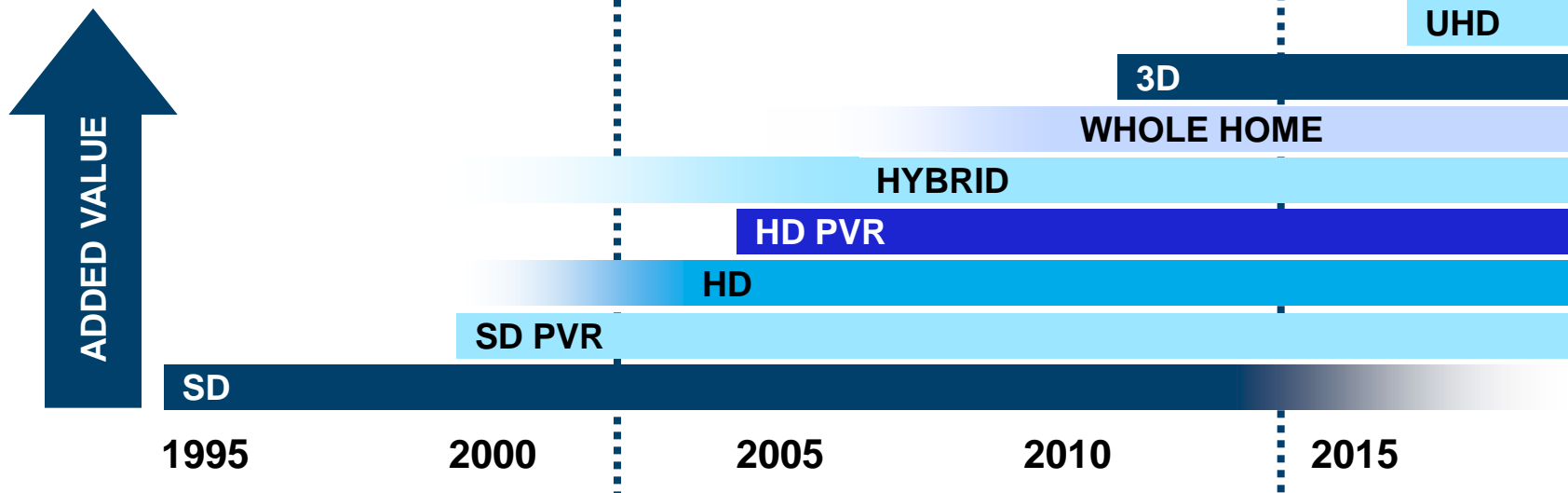
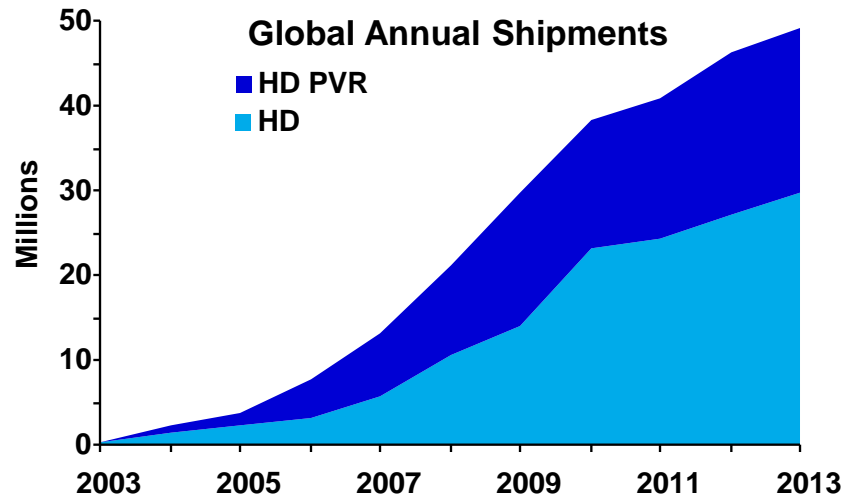


Dr. Paul Entwistle – Head of Investor Relations & Chief Technologist
Tuesday, 30th March 2010

- Product Evolution
- Perceiving 3D
- Displays for the home
- Delivering 3D TV services
- Technology
 - Coding
 - Connecting
 - Other considerations
- Conclusions
 - Future Technology Briefings
 - Q&A
 - Feedback

Product Evolution

3DTV in context



Perceiving 3D

Today - It's a trick !



- Still on a journey...



1st Generation

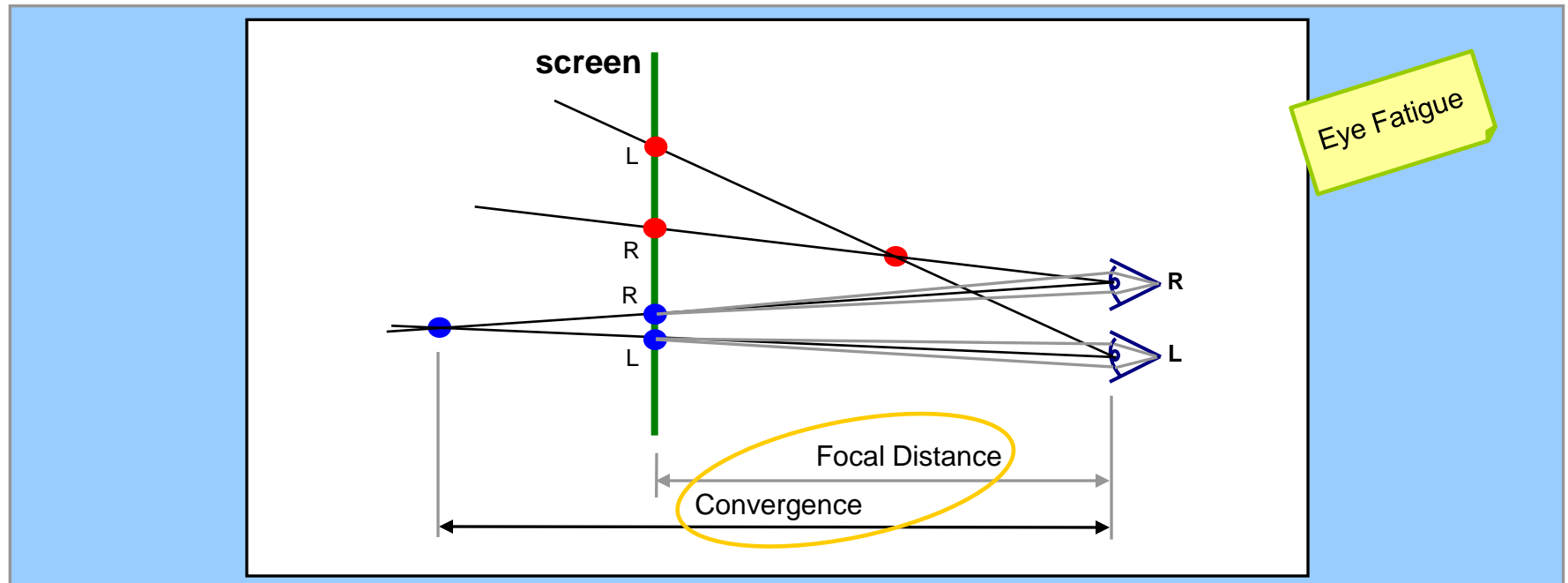
2nd Generation

3rd Generation



- Today: Single viewpoint plano-stereoscopic "3D"

- An illusion of depth caused by presenting differing images to each eye
- However, the view doesn't change if you move your head !



Perceiving 3D

Today - It's a trick !



- Brain uses more than just stereoscopic image processing

- Perspective
- Depth of field
- Object knowledge
- Relative size



- What its not – “real” 3D !

- Volumetric displays
- Object wave : holographic
 - >10years



“...OK, one last time. These are *small*... but the ones out there are *far away*”

Displays for the Home

Active shutter glasses



- Today's predominant technology
 - TV pictures are synchronised with the LC shutters on the glasses
- Requires:
 - Fast frame rate displays (+100Hz) to reduce flicker
 - Good brightness
- Benefits:
 - "Full HD" spatial and temporal resolution (of the display)
- Drawbacks:
 - Each viewer requires an "expensive" pair of glasses



Plasma

- Panasonic, LG, Samsung ...

Concurrent update, but long phosphor...

LCD

- Sony, Samsung ...

Line sequential update... when to switch

DLP (micro-mirror)

- (Rear projected TV) eg. Mitsubishi,

Very fast switching time

(Projectors*) eg. Mitsubishi, (*tend to be less than full-HD)

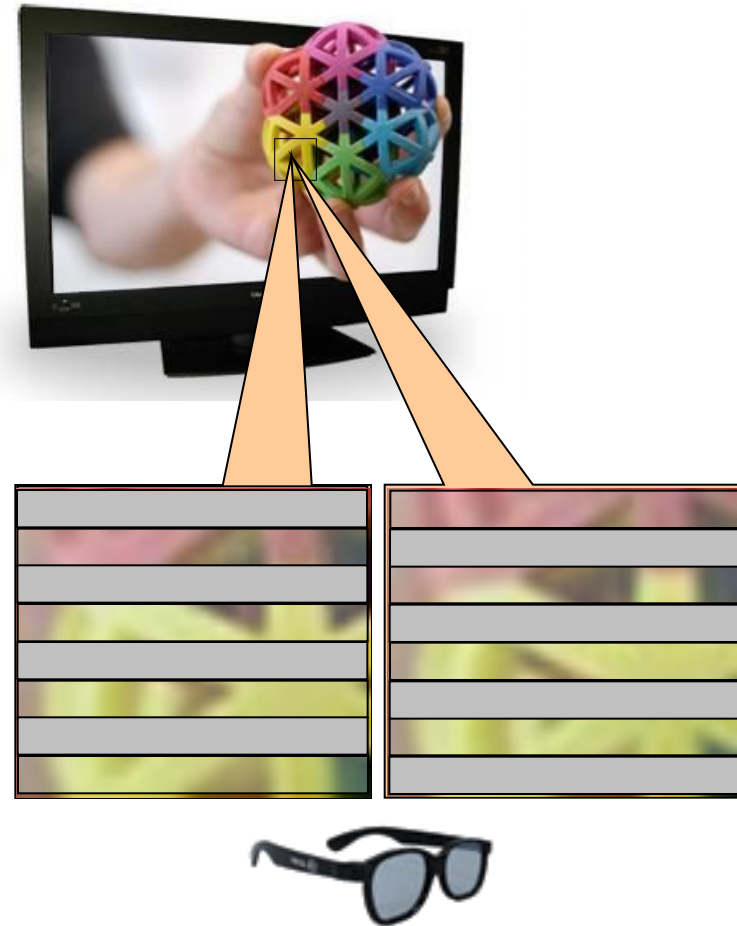
LED...
Backlit not OLED

Displays “for the Home”

Passive (polarised) glasses



- Passive (polarised) glasses
 - Complementary polarising technology built into the display
 - Both left and right eye images presented simultaneously
- Technique:
 - Micro cross polarisers typically line alternate
 - Xpol® is a registered trademark of Arisawa Manufacturing
- Benefits:
 - Low cost glasses
 - Professional use : Pubs & Clubs
- Drawbacks:
 - Half spatial resolution



<http://www.3dmovielist.com/3dhdtvs.html>

- Passive (polarised) glasses

- Cinema

- eg. RealD system, single digital projector, 144Hz switching (72Hz per eye)
 - Switched circular polarized filter on projector
 - Special screen (silvered/reflective - not just white)

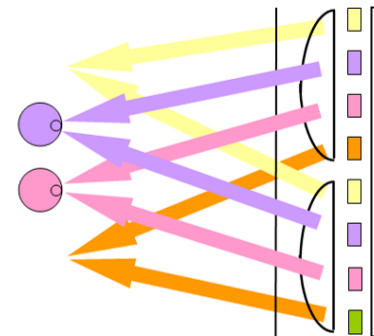
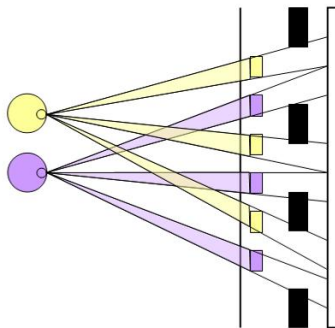


3 x 24 fps

- Auto-stereoscopic

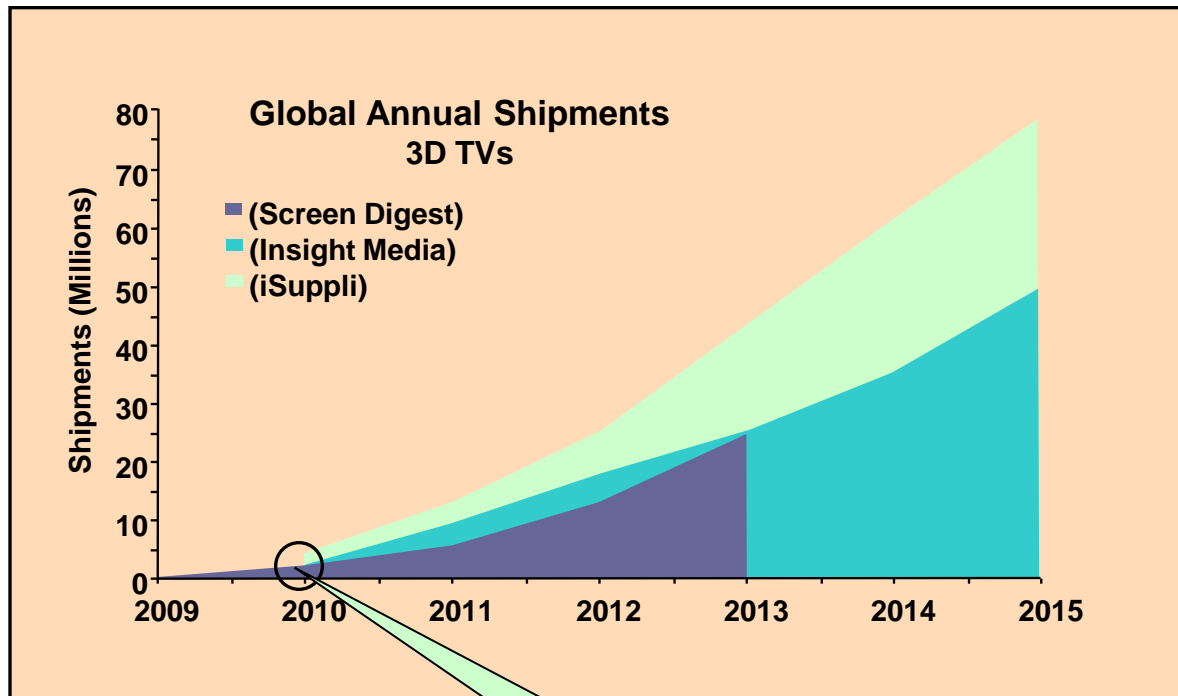
- Lenticular / parallax barrier

- Viewing angle and distance limitations
 - Digital Signage
 - Lenticular, interesting for Multi View Point Stereoscopic imaging



TV Shipments

Market



3D TV ASPs (iSuppli)

- 2010 - £1200
- 2015 - £550

CE

- Market push
- “Normal” feature

Sony 2-2.5 M
Samsung 2 M
Panasonic 1 M
LG 400K
...

3DTV Services

Content



BSkyB
April 2010 launch : Pubs & Clubs
Later 2010 : Domestic



DirecTV
June 2010 launch
• 24/7 PPV
• 24/7 OnDemand
• Sampler channel



Canal+ Spain
April 2010 launch

Canal+ France
Christmas 2010 launch



Comcast
April 2010 "Masters" in 3D



PayTV driving and investing in innovative services

And many, many more ...

3DTV

Profiles, Levels, Phases & Generations...



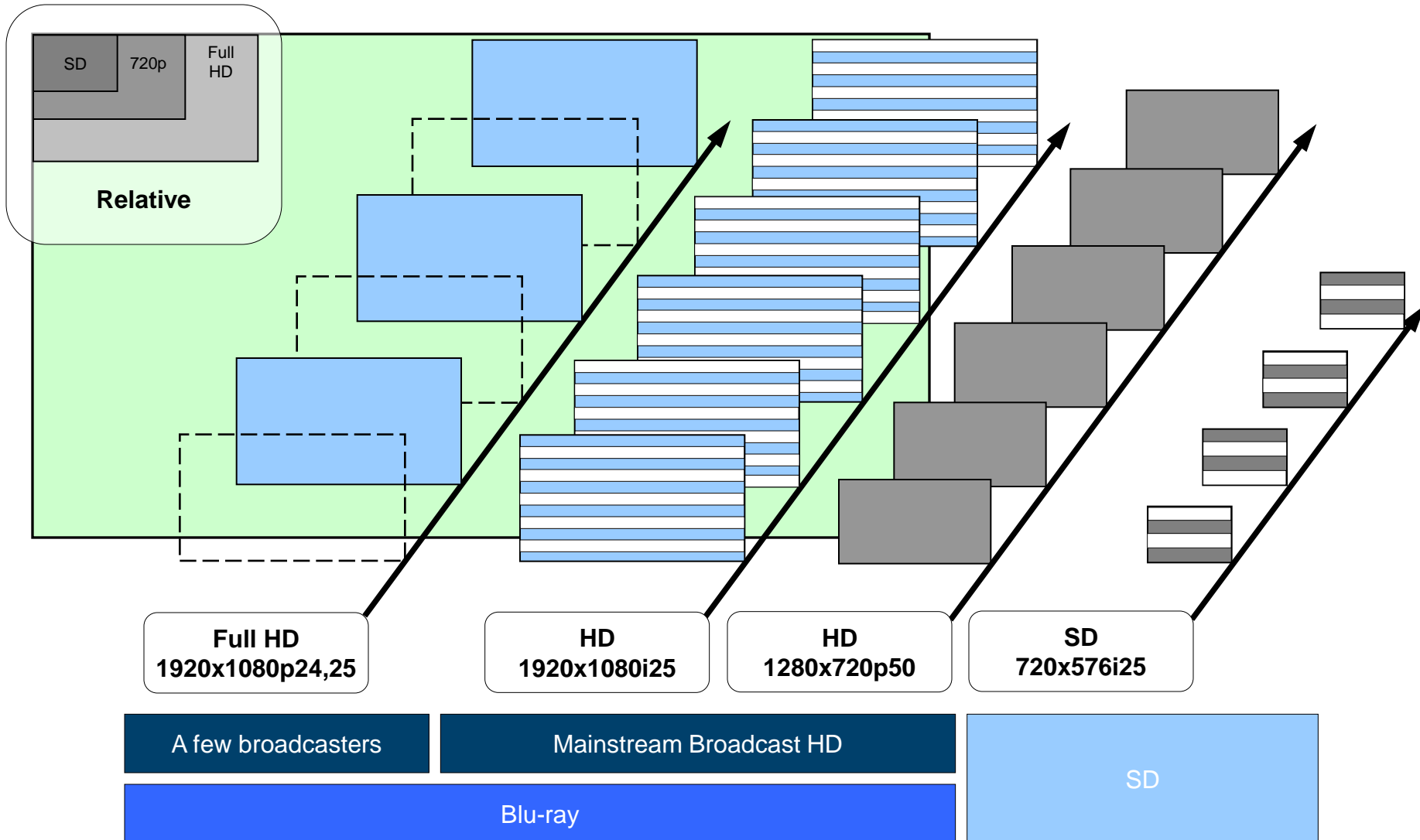
- ITU (International Telecommunications Union) partitioning of 3D:

Compatibility	TV	STB	Service	1 st Generation Plano-stereoscopic	2 nd Generation Multi view	3 rd Generation Object wave
Level 0 Conventional Display Compatible	Old	Old	3D	Eg. Anaglyph		
Level 1 Conventional (HD) Frame Compatible	3D	HD	3D	Eg. Side-by-side		
Level 2 3DinHD & Frame Compatible	3D	New	3DinHD	Eg.		
	3D	HD	3D	Side-by-side + SVC		
Level 3 Conventional HD Service Compatible	3D	New	3DinHD	Eg.	Eg. 2D HD + MVC	
	HD	HD	2DinHD	2D HD + MVC		

- SVC – Scalable Video Coding – a picture enhancement layer
- MVC – Multiview Video Coding – another view

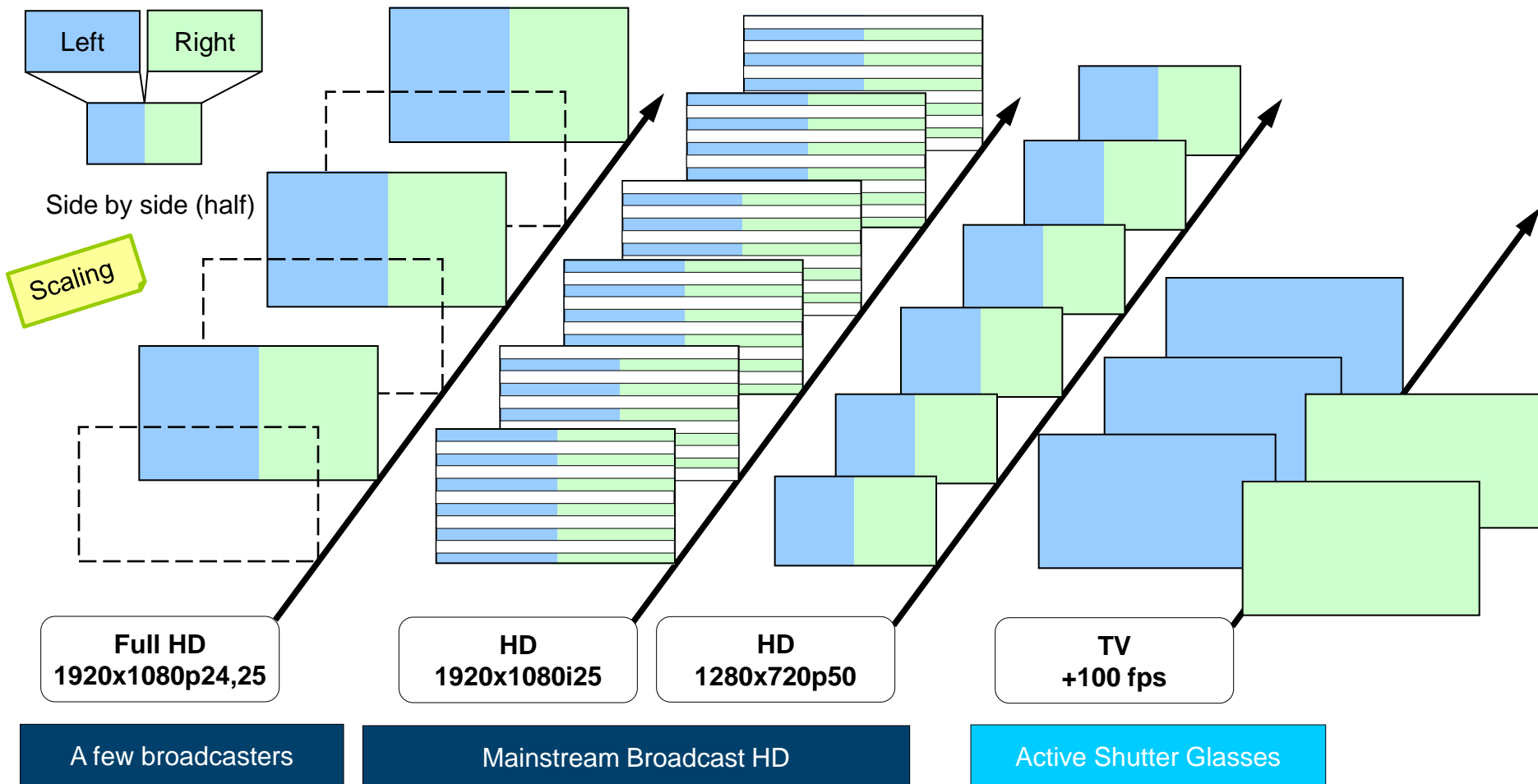
Video Resolution

SD, HD, HD Ready 1080p, Full HD ...



3D (1st gen) Broadcast

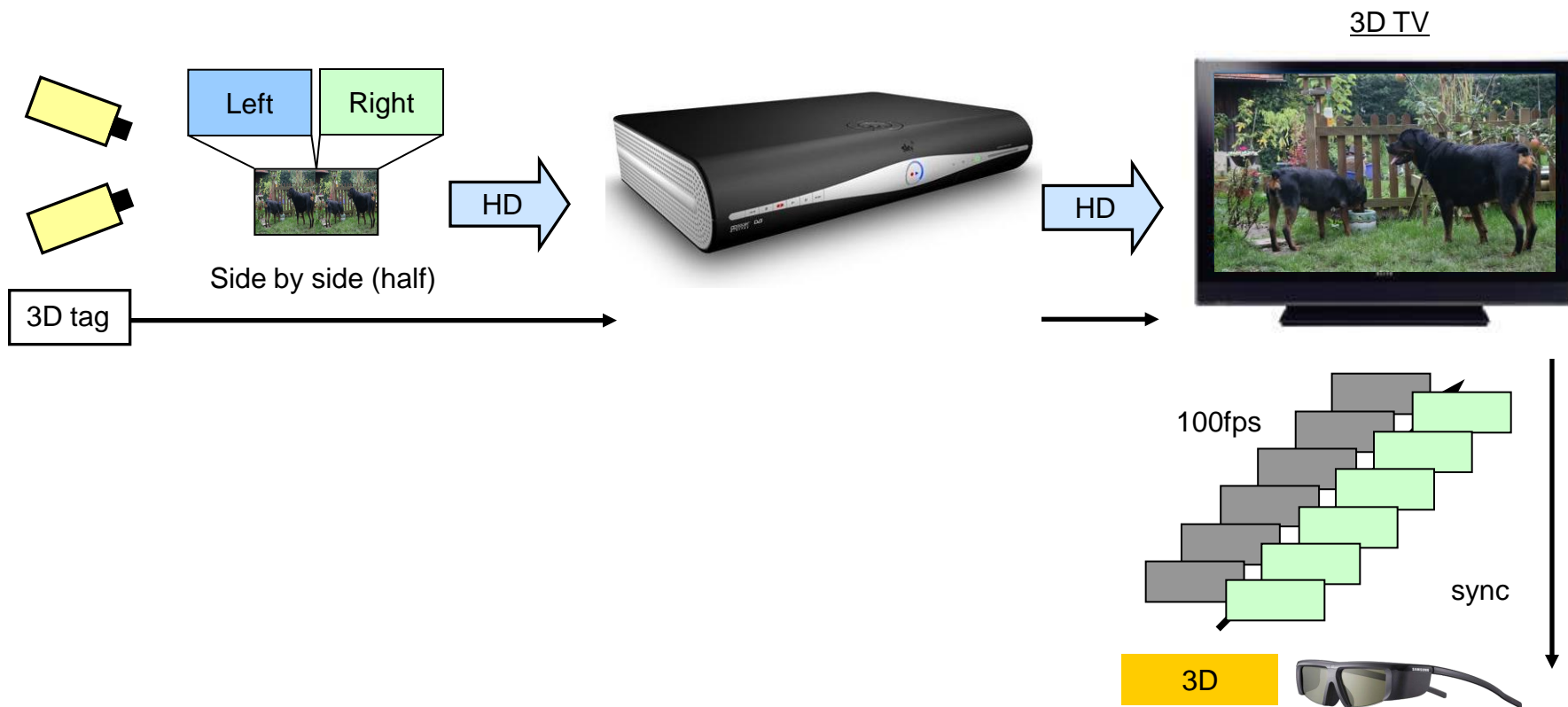
Level 1: Frame Compatible Mode



- Compatible with today's deployed HD STBs

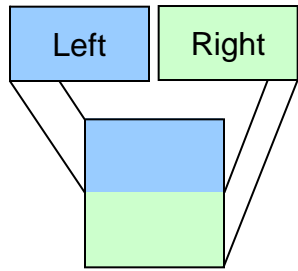
3D (1st gen) Broadcast

Level 1: Frame Compatible Mode

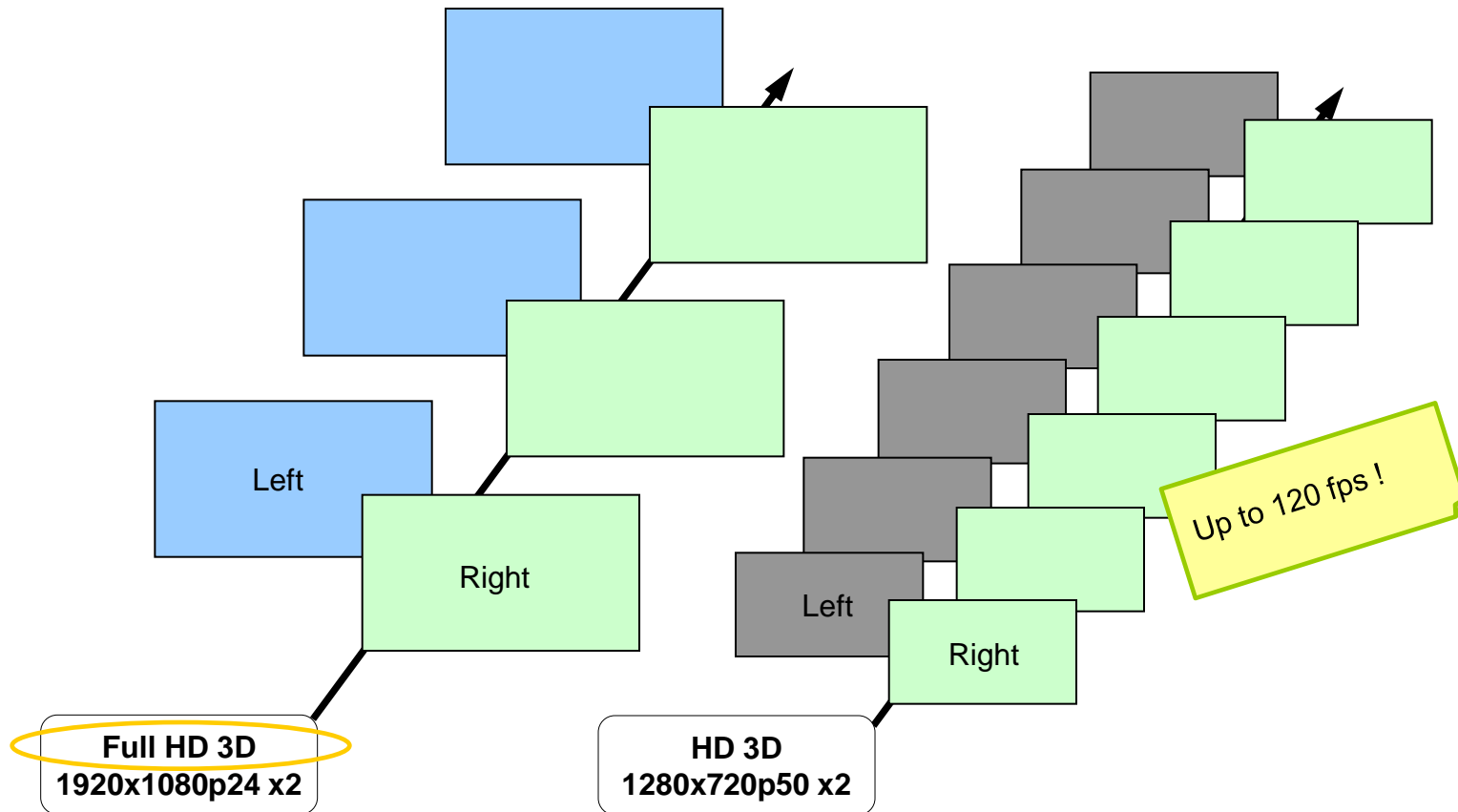


3D-in-HD (1st gen) Blu-ray

Level 3: HD Service Compatible Mode



Frame packing
&
Frame sequential

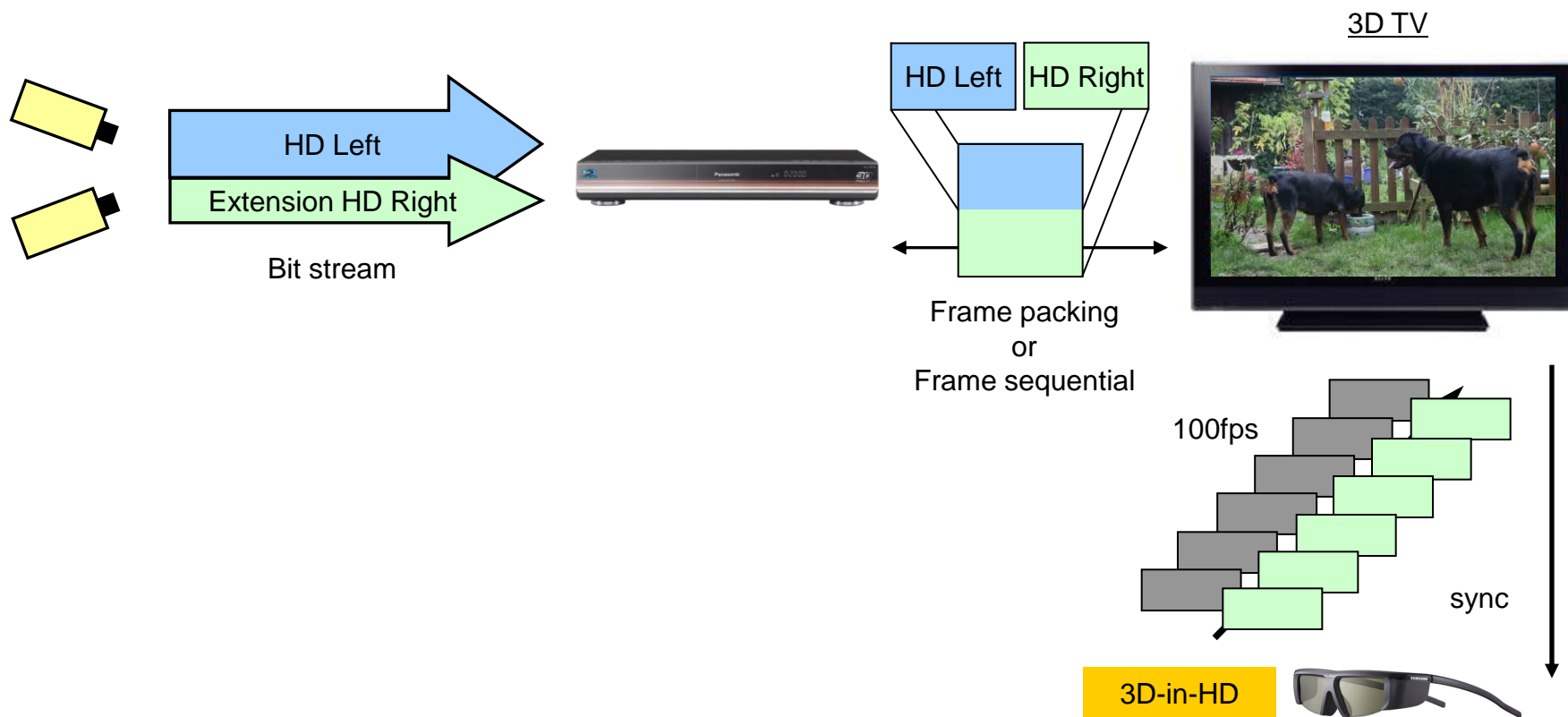


- Single disc for both legacy Blu-ray players and new Blu-ray 3D players
- 2 channel approach (left eye / right eye)
- Using a new extension to H.264, MVC (Multi view video coding) for a stereo view
- Expected to deliver “3D-in-HD” ~150-180% capacity of HD (rather than 200%)

Broadcast beyond Blu-ray?
1920x1080p50L50R ?

3D-in-HD (1st gen) Blu-ray

Level 3: HD Service Compatible Mode

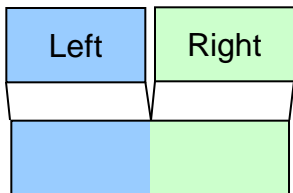
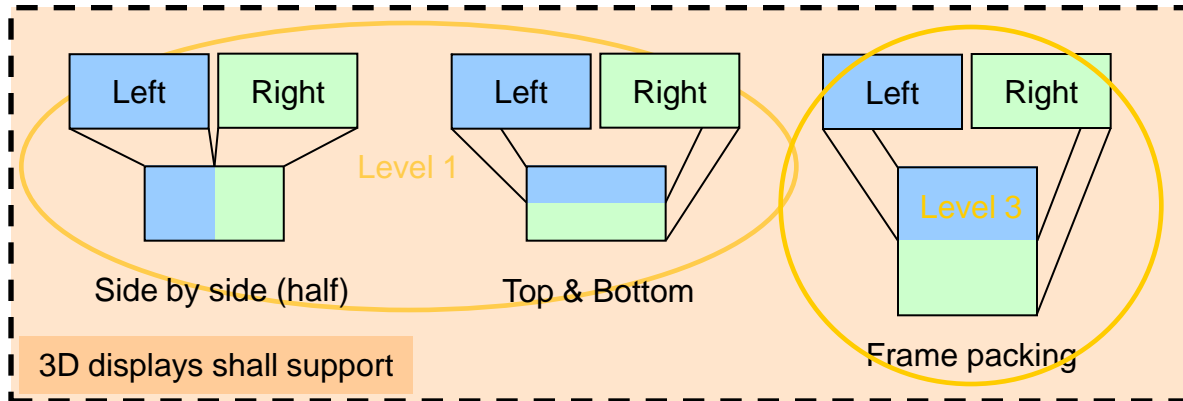


- HDMI: 3D extensions and 1.4**

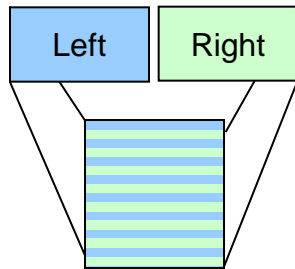
- Level 1: 3D Broadcast needs to signal the hybrid picture format
- Level 3: 3D-in-HD Blu-ray has higher picture information rates

Managed Product - software update

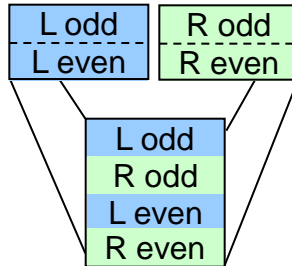
New silicon



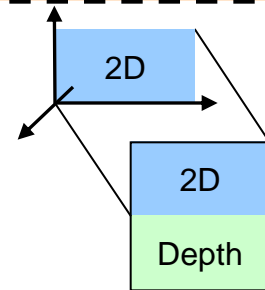
Side by side (full)



Line alternative

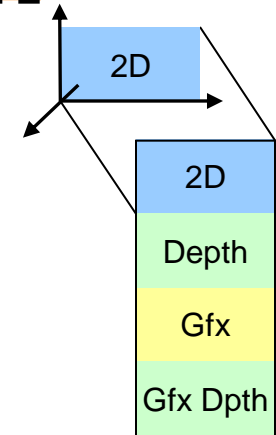


Field alternative



2D + Depth

Games



2D + Depth + Gfx + Gfx.dpth

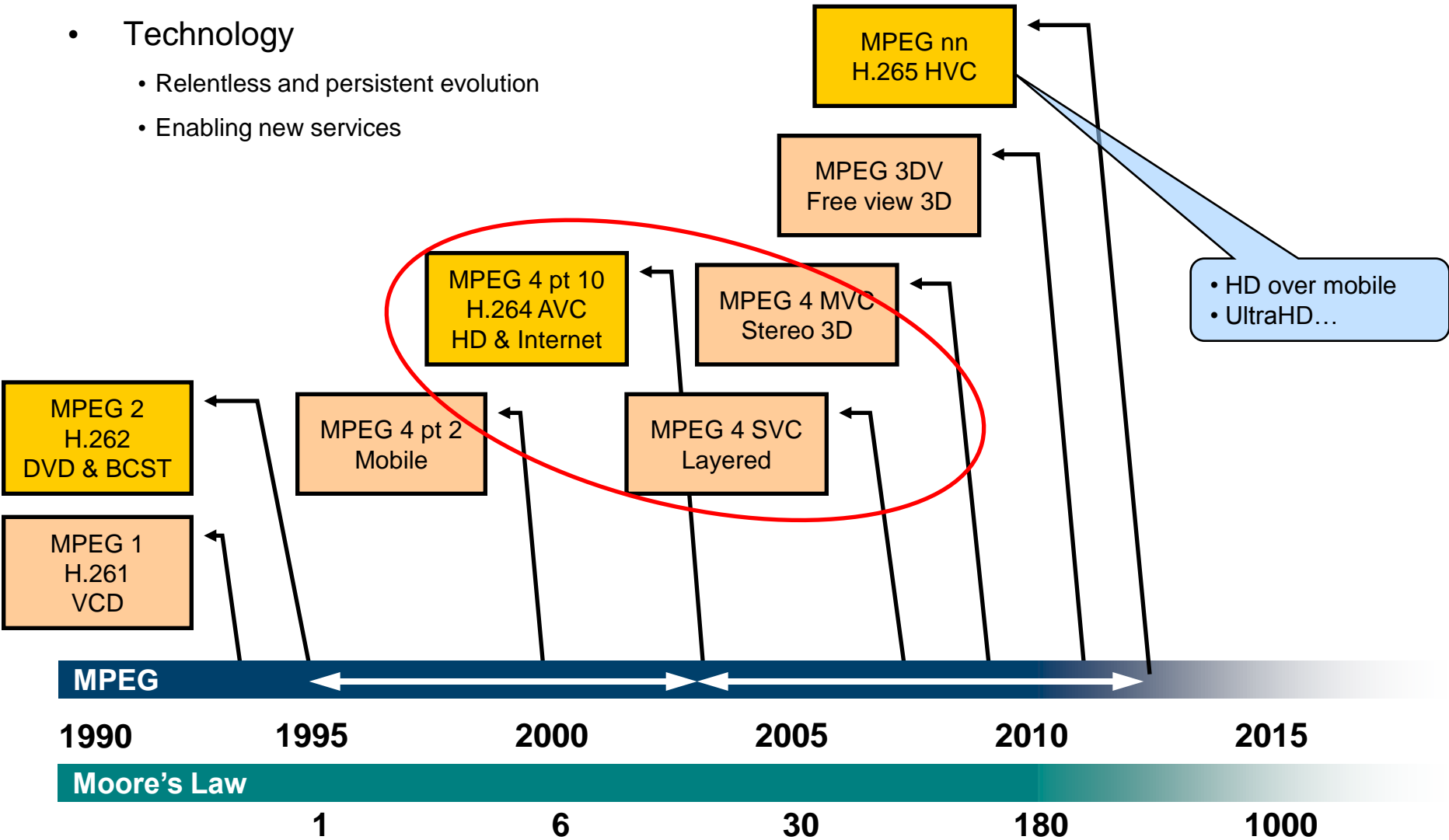
Technology

History of video coding



- Technology

- Relentless and persistent evolution
- Enabling new services

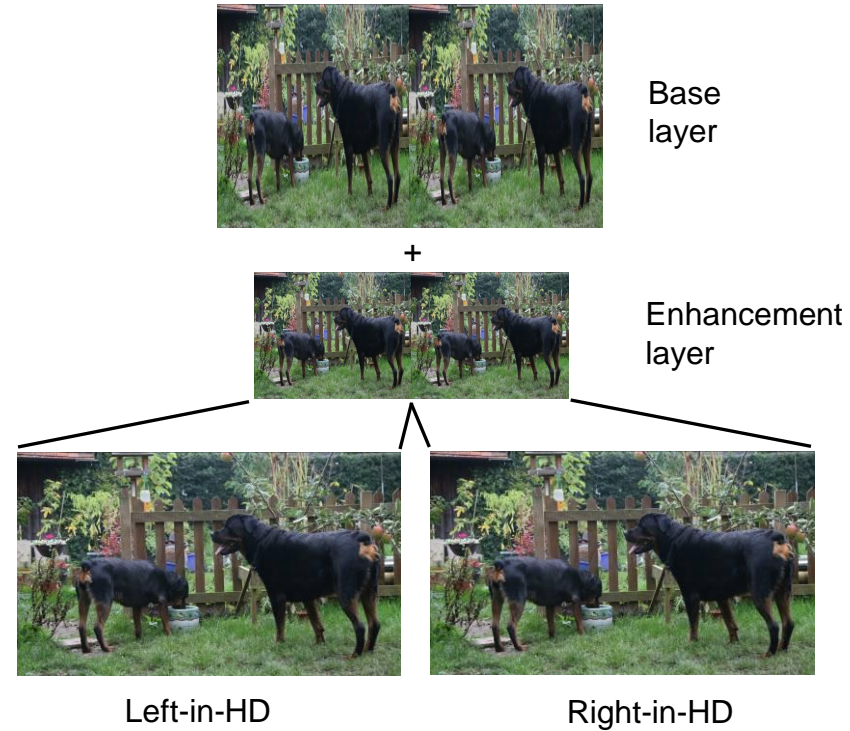


3D (1st gen)

Level 2: 3D-in-HD Frame-compatible mode



- Launch 3D over HD...
 - Easy introduction of 3D, but its not HD resolution
- “3D-in-HD” service compatible upgrade
 - New STB for those that want their “3D-in-HD”
- SVC (Scalable Video Coding)
 - An extension to AVC (H.264)
 - “Base-layer” is regular HD, carrying Frame-compatible 3D
 - “Enhancement Layer”
 - Ignored by regular HD STB
 - New “3D-in-HD” STB
 - Augments “Base-layer” to produce HD resolution 3D
 - Outputs Frame-packed or Frame-sequential “3D-in-HD”



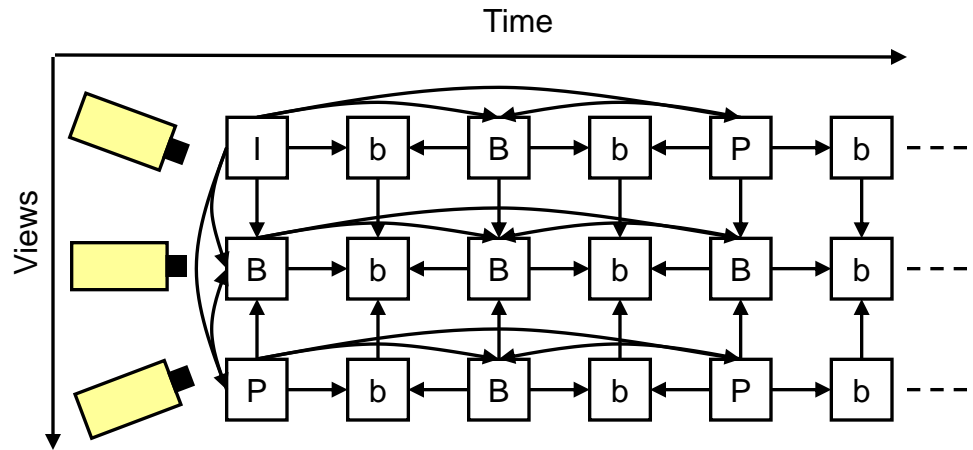
3D (2nd gen)

Multi view point – beyond stereoscopic



- MVC (Multiview Video Coding)

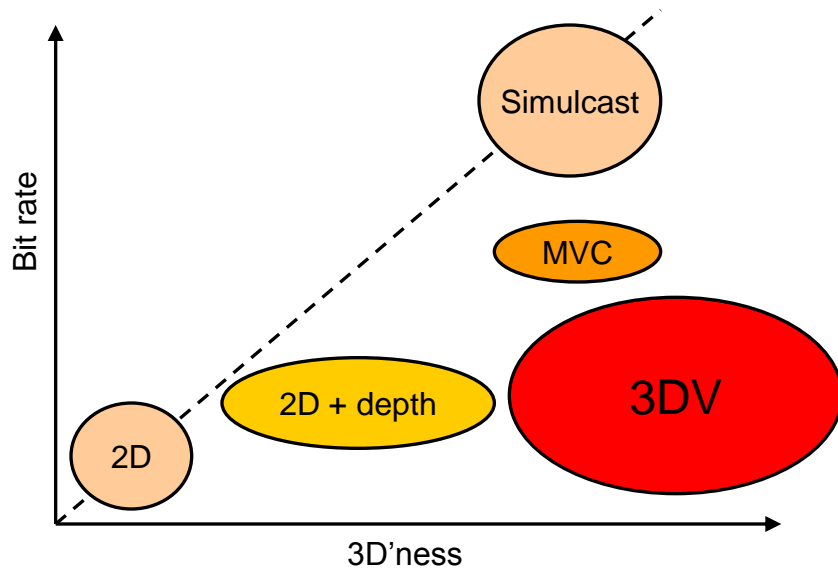
- An extension to AVC (H.264)
- Stereo form used by Blu-ray
- **Direct coding** of multiple (camera) views
 - Adds “Interview” coding
- But bandwidth proportional to number of views encoded
- Coding assumptions not optimal



Interview prediction and hierarchical B pictures

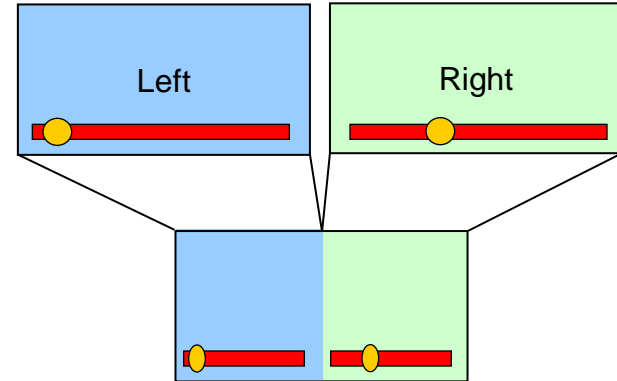
- MPEG 3DV (Free view point)

- Any view (interpolated, synthesized viewpoint)
- Target standard complete 2011
 - 2D + depth
 - 2D + depth + occlusion
 - ...



- Graphics

- (User Interface, EPG, Interactive Services, Subtitling...)
- Rendering a right/left from a “3D” description
 - (OpenGL & 3D graphics accelerated chipsets)
- Level 1 (legacy) – Frame Compatible
 - Rendering two appropriately scaled & positioned graphics



- Signalling & Standardisation

- Standardizing the messaging, metadata ... needed to deliver and identify 3D programming
- DVB : Phase 1: FrameCompatible, Phase 2: ...
- DTG, SMPTE, MPEG, ITU, EBU, ...
 - Codecs, signalling, metadata, interfaces, market specific profiling, subtitling / closed-captioning, ...

- **Compelling Service**
 - New technology delivers a compelling 3D-like experience
 - Consumer proposition simple to explain and clear “to see”
- **Displays**

3D capable display becoming increasingly available and “affordable”

Active shutter could become a “normal” feature of primary displays
- **Broadcasters**
 - Can leverage existing HD infrastructure to deliver 3D today (level 1)
 - However, some may need HD service compatibility (due to bandwidth limitations) (level 3)
- **Quality**
 - Blu-ray currently sets highest specification: it will do “3D-in-HD”
 - Broadcasters : could choose a service compatible “3D-in-HD” STB upgrade (level 2)
- **STB**
 - “Managed edge of network device” software upgradeable to add 3D signalling
 - “3D-in-HD” will need new codec and upgraded connectivity STBs
 - “HD service compatibility” will need new codec STBs
 - “3D UI” will need higher-performance (graphics) STBs

And that was just 1st Generation 3D

!!!

Technology Briefings

Format – 30min presentation + 20min Q&A

London, late-afternoon

Dr. Paul Entwistle

Head of Investor Relations & Chief Technologist

- **OTT & Hybrid** tba
- **Whole Home** tba

The image shows three overlapping presentation slides from Pace, each detailing a different technological evolution. The top slide, 'Evolution - 3D', features a timeline from 2000 to 2020 with a '3D' bar starting around 2010. It lists 'A step change in visual presentation' including stereoscopic 3D, 3D graphical overlays, FullHD stereoscopic 3D, scalable delivery (MVC), new codec H.265/HVC2, Multiview Point 3D, and Object wave (Holographic). It also shows 'Sky 3D' and 'Blu-ray 3D HDMI' logos. The middle slide, 'Evolution - Hybrid and OTT', has a timeline with a 'HYBRID' bar from 2010 to 2020. It describes 'The delivery of interactive services using broadband' with bullet points for graphically rich information, video (promotions, trailers, catch-up, on-demand), social networking services, communications, and games. It includes a 'Requires a persistent and on-going evolution of the STB' section. The bottom slide, 'Evolution - Whole Home', has a timeline with a 'WHOLE HOME' bar from 2010 to 2020. It details 'The distribution of TV services within the home' including second room 'slave' STBs, multichannel HDTV storage and streaming (HCS), smart pre-emptive recording, content discovery and navigation, and any device. It features a diagram of a central HDTV connected to multiple slave STBs, with 'eg. CableTV' as an input. It also lists requirements for STB evolution like content security, processing performance, home network (LAN: MoCA, G.Hn, Wifi), media transcoding, storage and archiving, and inter-operability (DLNA). The 'home CONTENT SHARING' logo is at the bottom.

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