



Developing BT Sport Ultra HD

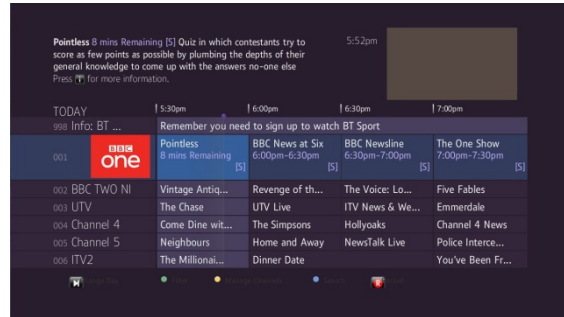
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BT TV Evolution



2006



2012



2012

All HD and h.264



BT TV Customer Equipment

youview



Zapper



PVR



UHD



Home Hub

Common STB Features

- Freeview SD and HD channels
- Over 50 IP Premium channels
- Public Broadcasters' Catch-up TV players
 - BBC iPlayer, ITV Player, All 4, ...
- BT TV Video on Demand in SD & HD
 - Other VoD services
- HTML-5 Red Button

Zapper

- Small footprint HD STB (no HDD)

PVR

- HD 500 GB PVR STB

UHD

- UHD 1TB PVR STB

Home Hub 5

- Wi-Fi



Rights Created Opportunity For New Services

The screenshot shows the BT Sport website interface. At the top, there is a navigation bar with tabs for Home, Football, MotoGP, Rugby Union, UFC, More Sport, Videos, Betting, TV Guide, and Watch live. Below this is a secondary navigation bar with links for Football, Videos, Champions League, Europa League, FA Cup, Transfer News, Results, Fixtures, and Tables. The main content area features a large article titled "BT Sport wins all live UK TV rights to Champions League and Europa League". The article text states: "BT Sport announce the acquisition of exclusive live rights to all 350 matches a season for three years from 2015/16. Both finals to be free on BT Sport, as well as top matches from earlier rounds." Below the text are social media sharing icons for Facebook, Twitter, YouTube, Email, Print, and a question mark. To the right of the article is an advertisement for ACCA PLUS CASH BONUS + INSURANCE from williamhill.com, with a "JOIN US" button. Below the advertisement is a "Football News" section with three news items, each with a small thumbnail image: "Louis van Gaal disappointed in Mike Dean's decision to send off Juan Mata", "Alan Pardew criticises Christian Benteke over penalty", and "England games will be offered for video tests - FA chief". At the bottom left of the article area is a large image of a football player in a red Bayern Munich kit celebrating, with a play button icon overlaid on it.

BT Sport will be the new UK home of UEFA Champions League and UEFA Europa League football, following a tender process in which BT won the exclusive live broadcast rights to all 350 matches from both tournaments. The rights run for three seasons from 2015/16.

This is the first time a single UK broadcaster has won the exclusive live rights to all matches from both tournaments. The hundreds of additional top tier matches will boost BT Sport and make it the natural home for football fans who wish to see the very best European sides pitted against each other.

BT has shaken up the UK TV market with BT Sport and it today pledged to make its new matches far more accessible and affordable for fans who wish to enjoy all the action. It also announced it will show a selection of these new matches for free on BT Sport, even to homes that have not signed up to the channels.

The finals of each tournament will be showcased in this fashion along with a selection of top matches from earlier rounds. Fans will also be delighted to know that each participating British team will feature for free at least once each season.

BT Sport already boasts a very strong line-up of live sport coverage from Fridays to Sundays and the new mid-week games will ensure the channels are even stronger, with fantastic live football being broadcast regularly throughout the week.

<http://sport.bt.com/>



4K Viewing on BT TV

4K viewing on BT TV

Amazing sharpness and four times the detail of HD

Netflix 4K

Experience popular TV programmes and films in Ultra HD on Netflix*. Instantly stream Netflix originals such as House of Cards, Marvel's Jessica Jones and Better Call Saul in stunning UHD. With the premium subscription, you also get access to Netflix on up to 4 screens (devices) at a time.

BT Sport Ultra HD

Welcome to the UK's first Ultra HD or 4k TV channel. Bringing you the UEFA Champions League, Barclays Premier League, UEFA Europa League and the FA Cup as you've never seen them before.

[See TV Packages >](#)

[Upgrade your BT TV >](#)

*Ultra HD availability subject to your Netflix subscription plan, Internet service, device capabilities, and content availability. www.netflix.com/TermsOfUse

NETFLIX



Performance: ★★★★★
Design: ★★★★★
Features: ★★★★★
Overall: ★★★★★

Marvel's Jessica Jones © 2015 MARVEL & ABC Studios

BT Sport Ultra HD

- Approx. 1 live Ultra HD event per week



First Live UHD Event: FA Community 2nd August 2015



https://twitter.com/Broadcast_TECH/status/627842864119160832



<https://twitter.com/qwincowper/status/627801328450973696>

Arsenal 1 – Chelsea 0

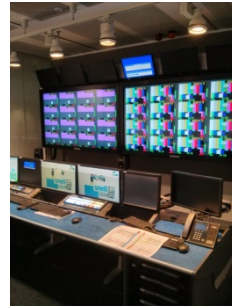
BT Sport – Camera to TV



Multicast



Baseband



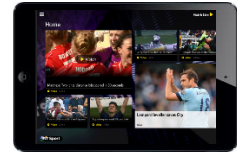
Baseband



Baseband



Unicast
Multicast



BT TV
youview

Stadium

- Camera
- Commentate
- Produce
- Edit
- Highlights

Studio

- Camera
- Produce
- Edit
- Program
- Archive

Play-out

- Acquisition
- Compliance
- Advertising
- Scheduling
- Automation

Switching

- Recording
- Archiving
- Hand-off

Distribution

- Satellite
- Cable
- OTT
- Broadband
- NGA
- MSAN

Production and Acquisition at Stadium Outside Broadcast



Outside Broadcast Unit



First purpose built Ultra HD 4K OB unit in Europe - Built by Timeline TV in conjunction with BT Sport

- Sony 4300 2/3 inch UHD 4K cameras
- Fujinon UHD 80:1 box & 22:1 ENG lenses
- Sony UHD 4K PWS-4400 server
- Snell Kahuna UHD 4K vision mixer and Sirius router
- Axon signal processing & Cerebrum control system
- EVS XT3 UHD 4K servers
- Grass Valley Kaleido-Modular-X multi-viewers

BT Links vehicle – Connects OB Unit to BT Network



Link capabilities

- 2 x UHD In, 2 x UHD Out
- Quad 3G-SDI over fibre

UHD Encoding

- 4 x Ericsson

Monitoring

- Tektronix WVR8300 monitoring and analysis
- Phabrix RX monitoring and control
- Miranda Multi-viewer
- Native UHD display

Studio, MCR, Playout and SMC



Sport Management Centre Upgrade

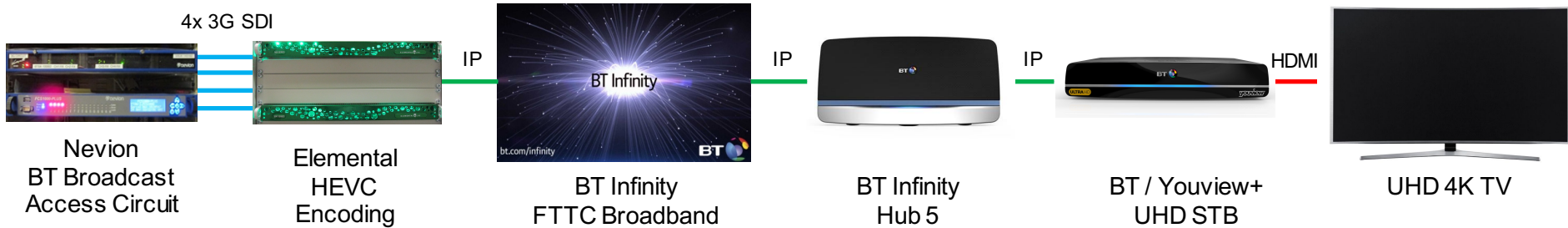
- UHD Contribution
- UHD Distribution monitoring

New Studio Facilities

- New UHD playout chain
- Sony server technology
- Two UHD ready edit suites
- Master Control Room (MCR) uplift
- UHD channel monitoring



IPTV Channel Distribution for UHD



Channel transported from Playout to Headend

BT Broadcast Access Circuit supporting 4x 3G SDI

Headend encodes and protects channel

Elemental Live UHD HEVC encoders

Harmonic Scramblers with Marlin Content Protection

Cisco Retransmission servers provide Stream Protection

Ineoquest video and stream monitoring

BT Infinity FTTC Broadband and Hub transports channel

Separate multicast VLAN with TV aware monitoring

BT Youview+ STB decodes channel

HDMI 2.0 interface to UHD TV

BT UHD Linear Stream Format

Resolution	UHD	3840 x 2160
Frame Rate		50 Frames per second progressive
Video encoding		HEVC 10 bit
Audio	As HD	Stereo and 5.1
IP bit-rate		Approx. 30 Mbps
IP Transport	As HD	RTP Multicast of MPEG2-TS
Stream protection	As HD	DVB Application level retransmission
Content protection	As HD	Marlin MS3

BT UHD STB



Common features with HD STB

- Youview user interface and BT TV Player
- Remote control
- Multicast linear IP channels
- Packaging, user guide and STB fully BT branded
- External power supply
- STB Power/ standby and control buttons
- Dual DVB-T2 tuner

New UHD STB Features

- Broadcom SoC (7252) with multi-core ARM CPU
 - DRAM 2GB
 - Flash 4GB (eMMC)
 - Hard drive 1TB
- Support for UHD (4k) content via multicast and VoD
 - HEVC (H.265) 10 bit decode
- Dolby Digital Plus audio
- Front panel revised with UHD logo
- Extended TR-069 remote management
- Multi colour LED with updated lighting sequence
- External Interfaces
 - HDMI 2.0 including HDCP 2.2 copy protection
 - GigE port
 - Digital Audio SPDIF
 - RF loop-through for DTT aerial signal
 - Two USB (not currently used)



24cm



Technology Challenges

UHD Acquisition



4 x 1920 x 1080 p50

4 x 3G-SDI
Quad-Optical



Typically interconnected over baseband serial interfaces

- 1080 p50 requires ~3Gbps - 3G-SDI connections
 - SMPTE ST 424M
- 2160 p50 requires ~12Gbps - 12G-SDI connections
 - SMPTE ST 2082
- Limited equipment availability and cable lengths

Acquisition based on Quad 3G-SDI

- 2160p50 UHD images split into 4 1080p50 quadrants
 - Can be carried over existing 3G-SDI infrastructure
 - Switches, routers, distribution...

Need to compress for delivery from Stadium to Studio

- Limited availability of full frame contribution encoders
 - Need high bit-rate, low latency
 - Carried and compressed as four quadrants
- Connect over Opticon Quad Optical 3G-SDI
- Use Ericsson Full-HD Encoders H.264
 - Need to synchronise all quadrants, Top Left reference
 - Top Left also carries audio and ancillary data

Need robust delivery over wide area networks

- Diverse and separate routes for two streams
- Seamless Protection Switching
 - SMPTE ST 2022-7:2013

UHD Acquisition IP Evolution

Uncompressed transport of SDI over IP

- SMPTE-2022-6:2012
 - Chops stream into blocks with padding
 - Adds RTP headers
 - Adds IP headers
 - Adds Forward Error Correction
- UHD would require greater than 10 Gbps interfaces
 - 40G and 100G Ethernet interfaces expensive
 - Primary used in core networks

SDI format has analogue legacy e.g. blanking regions

- Vertical Ancillary Data
- Horizontal Ancillary Data
 - Audio is embedded into the ancillary space
 - SMPTE ST 299M
 - 3G allows up to 32 channels
 - Typically encoded in the AES3 format

SDI lost bandwidth

- 385 Mbps of “wasted space” in an HD signal
- 12G-SDI (UHD) nearly 3 Gbps of “wasted space”
 - One quadrant can carry all audio and data needs



Is SDI over IP the best way in an all IP world?

- No but SDI and SDI over IP are very interoperable

Lightweight compression

- 10 GE interfaces could be used with lightweight low latency compression:
 - Intopix TICO
 - Sony Low Latency Video Codec
 - SMPTE VC2 2042-1

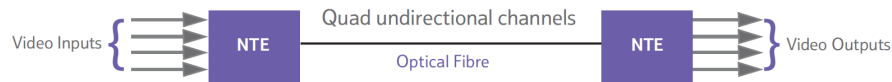
When do we move to a true All-IP Video world?

- Work in VSF, SMPTE and other fora

UHD Distribution

Connectivity from Playout to Headend

- Baseband for maximum quality
- BT Openreach Broadcast Access product
 - Maximum main link distance 35km
 - Supports Quad 3G SDI over single fibre
 - Two fibres for resilient operation



Distribution Headend

- Introduced HEVC 10bit Encoders
- All IP components same as HD distribution
 - Validated to operate at UHD bit-rates

End to End

- Need to ensure all components are truly 10bit
 - Production, Acquisition, Distribution, STB & TV
- Limited availability of test content and test tools



DVB IPTV

ETSI TS 102 034

UHD Viewing

BT Sport Ultra HD requires TV to support

- 3840 x 2160 p50
- HDMI 2.0
- HDCP 2.2

Not all early 4K TVs worked

- Most 2014 models work fine
- Not a problem for 2015 onwards



STB supports

DVB-T2

DVB-IPTV

DVB-MPEG



Summary



BT Sport Ultra HD launched on time

- Very positive feedback from customers

Launch required innovation in all areas from production to distribution

- Some areas were able to build upon Full-HD infrastructure

Launch would not have been possible without extensive testing

- Multiple test events to determine impact on production and outside broadcast
- Full end to end rehearsals of Playout, Acquisition, and Distribution to STBs

Production continues to evolve

- Moving from separate UHD and HD productions
 - To single Outside Broadcast unit delivering all UHD, HD and SD requirements

Acquisition will evolve

- To full frame encoding and in the longer term to All-IP

Distribution and STB will evolve

- To take advantage of the improvements in 10 bit HEVC encoding



BT's UHD journey has just begun