



Made in Wales

November 2017





COUPE DES CLUBS CHAMPIONS
EUROPÉENS

BT

On Saturday 3rd June 2017 Wales hosted the UEFA Champions League Final. Spain's Real Madrid beat Italy's Juventus at the Millennium Stadium in Cardiff. It was the final match of the 2016–17 UEFA Champions League.

Several of our teams came together with partners to plan and deliver this end to end communication experience. So that a global audience of over 220 million people could watch and engage with the event how and where they wanted.

This is a story of teamwork.

Great teamwork.

BT is a very large organisation. We have over 106,000 people based in 62 countries worldwide. And I'm very proud that almost 4,500 colleagues live here in Wales.

It would be easy to believe that this scale and reach comes with immeasurable power and advantage. But in reality, in today's highly competitive and volatile market, all organisations compete at the same level. It's the speed at which an organisation can adapt to ever changing customer demands and how well they meet those requirements that sets them apart.

Large organisations generally have many processes, systems and policies to manage and govern the business and operations. To manage these effectively, and be agile enough to move quickly, requires meticulous planning, communication and teamwork at every level. All this means our people are right at the heart of our business.

We are all about communication services – phone, broadband, mobile, internet and TV. The telecommunications industry requires people with very different skill sets and capabilities. But you often don't see their work and their achievements because it's buried underground, hidden away in big buildings or carried in the airwaves and invisible to the eye.

In today's world the communication network touches everyone in society. And we are responsible and accountable to our customers, our shareholders and our people through the work we do.

Being a brand that has a heritage of over 170 years our failures, when they happen, quickly get played out in the media but our successes are often taken for granted.

On June 3rd 2017, we celebrated one of our biggest successes at BT. We made digital innovation history in Wales through the broadcast of the UEFA Champions League final in Cardiff.

Thank you BT colleagues for making this happen in Wales and thank you Wales for hosting an event that broke the mould in many ways!



Alwen Williams

Director - BT Cymru Wales

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Wales is a proud nation.

We love a good game of football or rugby.

It was a great day for Cardiff to host the UEFA Champions League Final.

All public, private and third sector organisations involved worked long hours for many weeks to make it a spectacular event as global eyes were on Wales.

It was a great success for Cardiff and for Wales.

Football is a game where working together wins the day. As any good coach knows, good teamwork beats one or two star players.

The same goes in large organisations. You need to pull together to deliver your strategy and come through for your customers, shareholders and your people. But that's easier said than done sometimes.

UEFA Champions League Final was watched by 220 million people worldwide. That makes it the biggest single TV event in the world this year. Bigger than the Superbowl!

We have some very talented and committed people working in our company. And we have very innovative and clever industry partners – big ones and little ones!

A number of teams, from both inside and outside our company, worked together to make the UEFA Champions League final successful.

We wanted to share our experience of the kind of collaboration required to deliver this kind of key event.

So we are making the invisible visible.

And sharing the story of all the different players. Working together.

For Wales.



Jon Reynolds

Regional Business Director

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1. BT Sport

“With a little help from our friends...”

From the 2018/19 season BT Sport will enhance its social media coverage to reach new audiences.

This will include making clips, weekly highlights, UEFA’s magazine show, and both finals available for free on social media.

BT Sport conducted a world first on June 3rd by broadcasting, live, the UEFA Champions League Final using High Dynamic Range (HDR) technology in Ultra-High Definition (UHD) with Dolby Atmos® sound at a private screening in London. The match was also available for the first time ever in Virtual Reality to fans. The milestones are part of a series of innovations led by the broadcaster in conjunction with partners across the televisual and technology sectors.

The UEFA Champions League final on BT Sport used the latest broadcast technology, giving viewers the best pictures and the best sound experience available, with the game available for the first time in 4K UHD on YouTube and 4K UHD with Dolby Atmos sound on BT TV.



Jamie Hindhaugh
Chief Operating Officer, BT Sport

“Innovation and collaboration with our technology partners is core to the way BT Sport works. Additionally the support of valued partners such as Dolby, UEFA, the Premier League and more, provide the scope for us to expand technology for the benefit of fans. Our editorial aspiration since we launched is to be at ‘The Heart of Sport’, bringing our audiences closer to the action.”



Additionally, BT Sport deployed a number of innovations and new services with its partners:

HDR: High Dynamic Range

VR: Virtual Reality

Free

HDR increases picture quality by preserving details in the darkest and brightest areas of a picture. This allows for more natural, true-to-life colours that are closer to how we see them in real life. BT Sport developed some of the first ever live workflows for the demonstration of the live coverage of the weekend's final.

BT Sport gave away free VR Google Cardboard headsets to football fans ahead of the game. For the first time ever the UEFA Champions League final was available through a number of 360° streams via YouTube and also in a new BT Sport Virtual Reality App. This allowed viewers to choose between a 360° produced programme with commentary and graphics, or select their own camera viewpoint. And it was all for free.

BT Sport once again made this season's UEFA Champions League and UEFA Europa League finals available for free to as many people as possible. The matches could be watched on YouTube, our website, BT Sport channels and the App. This showed our commitment to make televised sport more accessible to fans.

1. BT Sport

The clash between European giants Real Madrid and Juventus on Saturday, 3 June, from Cardiff's National Stadium of Wales, was the latest step in BT Sport's collaboration with partners including:

Arena: Worked with us on two world firsts in preparation for this weekend. Using their state of the art IP UHD truck OBX, simultaneously broadcasting in UHD and HD over an IP backbone, plus live coverage of the Premier League and the FA Cup in Dolby Atmos.

Axon: BT Sport streamlined our 4K production setup using their Synapse signal processing technology.

Media & Broadcast: The National Stadium of Wales, host to this football clash, joined our Media and Broadcast's terabit next-generation fibre-based TV Outside Broadcast network. This specialist network links football grounds across the UK to BT Tower and transports HD video uncompressed from venues to production hubs.

Our Sport Engineers & Innovation team: They developed our technology strategy to be at the heart of sport. And in doing so, created the industry-facing vision for collaboration.

Our Technology Service & Operations (TSO) team: They worked with BT Sport to get the game on YouTube for free, and the BT Sport App and website too. They also worked with YouTube to deliver Virtual Reality (VR) and 4K streams of the game. And they worked with partners to create a new VR App, and kept our network running while we streamed UHD back to the BT Sport studios in London from Cardiff.

Deltatre: With their Diva technology, people could use our digital player to replay key events, choose multiple camera angles and access statistics – like passes and distance covered. Perfect for pundits.

Dolby: A proof of concept live broadcast in professional quality-based HDR and Dolby Atmos was transmitted into Dolby's Soho screening room with technology supplied by Ateme and Broadcom.

While in Cardiff, Dolby supported us with proof of concept demos of live VR Sport with Dolby Atmos audio. For a sports broadcast like the Champions League final, Atmos audio recreates the event atmosphere by bringing the all-encompassing soundtrack of a football stadium into your living room from every direction.

Ericsson: They played out BT Sport in both UHD and HD. And they helped us broadcast the final simultaneously to YouTube and Dolby – all in 4K HD.

EVS Broadcast Equipment: They installed servers onsite in Cardiff to host our UHD camera feeds. The result? Nail-biting slow motion replays. And using their C-Cast platform, we were able to show multi-angle replays on our App, too.

LiveLike: They built the platform for our VR App. It let fans choose between different 360 camera angles or a live 'director's cut', automatically moving around the stadium. In the past, they've helped us with VR broadcasts like the Arsenal vs Chelsea match in September 2016.

From an Outside Broadcast perspective, the team delivered a network to carry High Definition (HD) and Dolby Atmos enabling Ultra High Definition (UHD) TV feeds back to the BT Sport studios in London from Cardiff.





MOOV: They've developed a range of software and apps to support us with VR, like 4K VR graphics and its MOOV360 Commentator App, which lets you plug into VR without a headset.

Nokia: UEFA conducted a 12 camera VR shoot – the biggest ever for a live VR stream according to Nokia – using Nokia's OZO Live and OZO+ live VR broadcasting solution.

RT Software: Their augmented reality (AR) technology allows viewers to see an intricate night-time 3D map of the cities hosting games on UEFA match-nights, spread across the BT Sport studio.

Snell Advanced Media: They deployed switchers by Kahuna and Kula across Cardiff, Stratford and Soho. We used their Livetouch technology, too. It helped us put fans right in the action with VR.

Sony: Filming in live HD can be a logistical nightmare – we had a lot of different teams and technology to co-ordinate. So we used Sony's SR Live service to keep our workflows running

smoothly. And we used their technology too, from widely-used HDC-4300 cameras to more specialist equipment.

Telegenic: We had four of their trucks in Cardiff covering four feeds including HD, 4K and HDR. This was following on from the successful delivery of more than 130 live simultaneous broadcast HD/4K productions for BT Sport this season.

Timeline: They provided an broadcast truck UHD 1 and staff to produce the sub-mix element for BT Sport. Timeline supplied BT Sport with UHD cameras, lenses, EVS equipment and edit facilities.

Fans were able to choose between different 360 camera viewing angles.

2. Media & Broadcast

Our Media & Broadcast team didn't just help broadcast the match to a worldwide audience of 220 million. They also used our Outside Broadcast network to spark a series of technology firsts for BT Sport.

In the lead up for this event, the National Stadium of Wales joined Media & Broadcast's terabit next-generation fibre-based TV Outside Broadcast network.

This specialist contribution network links Football grounds across the UK to BT Tower, carrying High Definition (HD) video uncompressed from venues to production hubs. As well as carrying the standard broadcast to BT Sport customers throughout the UK, our network also made it possible for BT Sport to broadcast the match live using High Dynamic Range (HDR) technology in Ultra-High Definition (UHD) with Dolby Atmos sound to a private screening in London. The network also provided the connectivity to the Internet Gateway at BT Tower to allow BT Sport to deliver the match in Virtual Reality (VR) to fans for the first time ever.

As well as supporting the host broadcaster, BT Sport, we also delivered over 10 gigabits of connectivity to International broadcasters for their unilateral feeds. And provided temporary communication services to more than 50 International Broadcasters, making it possible for them to take live commentary from the Stadium around the globe.

Media & Broadcast were also part of the BT team that provided a 'pop-up' 4 storey office next to the National Stadium for UEFA, with network connectivity for 200 of their Operations and Accreditation people. With mission critical work to be done, our cross-departmental mobilisation meant that UEFA could move in to the event location and seamlessly connect with their corporate services in Switzerland.



Mark Wilson-Dunn

Vice President, BT Media & Broadcast

"This was a fantastic example of Media & Broadcast working with the wider BT team to deliver outstanding service to a wide range of stakeholders. We are really proud to have supported bringing this experience to such a Global audience."

Mark Wilson-Dunn



3. Technology, Service & Operations

We have an internal Technology, Service & Operations team (TSO). They keep our networks, platforms and systems running smoothly.

More people watched the UEFA Champions League final this year on BT Sport across digital and TV platforms than last year, when over 6m viewers watched the final.

The UEFA Champions League final was one of the most demanding events delivered across our network in throughput terms. We believe that the future of TV and Video delivery will be over IP networks.

TSO work closely with each of our customer-facing lines of business to create new products and ensure that existing services evolve to meet the needs of our customers.

Always looking towards the future, TSO manage most of BT's research and development and are responsible for our worldwide portfolio of more than 4,500 patents and related applications. TSO is also responsible for managing the group's energy consumption and putting strategies in place to cut the group's carbon footprint. Through their efforts, we've reduced energy usage for six consecutive years.

This year TSO upgraded BT's core IP network to handle record volumes of data traffic in the UK.

6.5 million people watched BT Sport's coverage of the 2017 UEFA Champions League Final across digital and TV platforms in the UK. Made up of 4.4m on TV and 2.1m across digital platforms – this includes BT Sport YouTube channel, the BT Sport App and website. At the UEFA Champion's League Final, live TV was distributed to BT's set top boxes over the BT core IP network using "multicast": a bandwidth-conserving technology that reduces traffic by delivering a single feed into the network that is replicated to provide each city and town with its own feed, which is copied again to all the street cabinets and in turn copied to all the broadband lines watching the match.

PCs and tablets access our live content using the same system we have to distribute the on-demand content around the country - by accessing copies



Howard Watson
CEO Technology, Service and Operations, BT

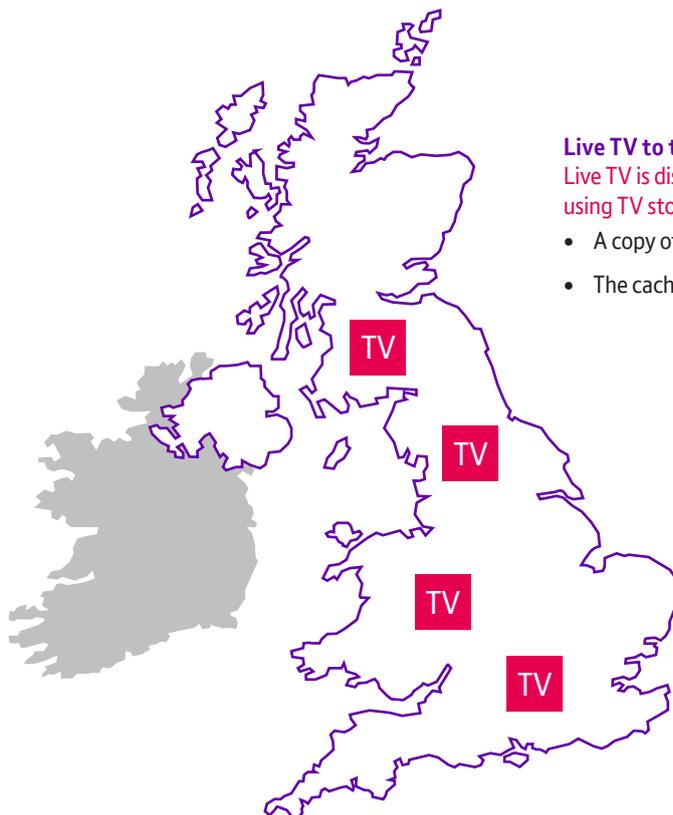
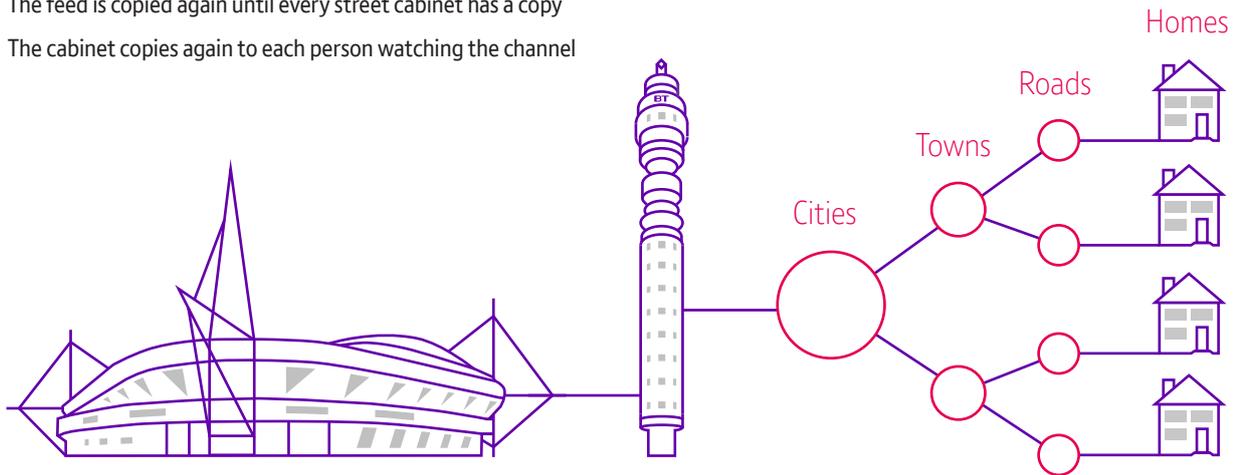
of TV content stored in local 'caches', essentially racks of computers holding the most popular video content in locations around the country ready to serve to our customers.

This was our first use of 360 degree video / virtual reality. This viewing medium presents an increasing challenge due to its higher bandwidth demands. We expect to be doing much more of this in TV and will plan and build our network accordingly. It was also our first use of 4K/UltraHD distribution with our social media partners Google and YouTube. It was a great demonstration of our ability to plan and deliver capacity to meet forecast demand and delight our customers with a better quality participant experience. This event was a blueprint for the future delivery of high quality content to our customers.

Live TV to a BT Set Top Box

Live TV is distributed using “Multicast” technology:

- A single TV feed is fed into the network in London
- A single copy is sent on to each major city
- Each city copies a single feed to each suburb and town
- The feed is copied again until every street cabinet has a copy
- The cabinet copies again to each person watching the channel



Live TV to tablets, phones and PC's

Live TV is distributed in the same way as on-demand TV, using TV stores known as 'caches' located around the UK.

- A copy of the TV feed is sent to each cache
- The cache copies the feed on to each tablet, phone, PC watching the feed

4. Security

With operations in over 180 countries supporting some of the world's largest companies, nation states and critical national infrastructures, we have a unique perspective on cyber crime. From our 15 global security operations centres (SOC), our 2,500 security professionals are constantly watching, learning, predicting and responding to the latest threats to protect our customers and BT.

In the 24 hours leading up to the final on 3rd of June 2017, our security resources were active in detecting and taking action on cyber security threats, protecting the live broadcast and preventing illegal streaming of the events.

New security threats appear every day. Malware is growing at an unprecedented rate. Having visibility of these threats in time to do something about them is a constant battle.

Threat intelligence is key to understanding the growing attack surface but crucially, if it is to be effective, it must be both actionable and acted upon. Having the right people in place with the expertise for a real-time response is vital.

As one of the world's largest network operators we devote huge resources to protecting our own systems and those of our customers from possible attack. We employ hundreds of security specialists who regularly scan thousands of information sources – ranging from social media to specialist blogs and underground forums – for anything that could impact or interrupt our services and those of our customers. We also have strategic partnerships with intelligence gathering organisations around the world.



Mark Hughes
President, BT Security

Find out more about BT Security solutions [here](#)



Some success statistics from our security team:

- In the 24 hours before the final, we stopped 11 million DNS (Domain Name Service) queries for the top 3000 malware domains
- 3.5 million malicious emails in last month delivering malware and phishing
- Capture 100,000 unique malware samples every day, this is more than 1 per second
- Over 240 billion security alerts every month
- Over 50 high alerts on the DDoS (Distributed Denial of Service) platform every day
- Over 2000 cyber alerts every week from open source and dark web
- DDoS attacks of up to 650Gbps (billions of bits per second)
- Over 600 sites illegally streaming live football every week

5. EE

Live sport is the biggest driver of live mobile streaming for EE customers. Mobile networks must evolve to keep up.

“the BT Sport site and App peaked at around 22 Gb per second.”

The Champions League final, in June, drove the biggest live streaming peak ever on the EE network. It underlined the popularity of streaming live sport – always a big driver of data consumption – among our customers. Many of our customers like to watch live sport whilst they are outside of the home to fit in with their busy lives.

“On YouTube across the EE mobile network we saw peak demand at more than 40Gb per second during the final – that’s the equivalent of around 40,000 concurrent users streaming the match in HD over the mobile network.

In addition, the BT Sport site and App peaked at around 22 Gb per second.”



Matt Stagg

Head of Mobile Video and Content, EE



Building the new EE 'Supersite' in Cardiff

EE built a new 4G site on BT Stadium House in Cardiff. The supersite was the first to use BT's 10 Gigabit Ethernet solution. It tripled mobile capacity in the city centre for EE customers.

Lynne Toogood, programme director strategic programmes EE, managed the installation. "Once we identified the opportunity to put a new EE site on Stadium House, everyone came together brilliantly. From our BT Facilities to make sure we had access to the build when we needed, BT Wholesale to organise the legal paperwork for the site share and engage the rigging teams, BT TSO to provide the rigging teams to build the site and all the EE subcontractors required to deploy the equipment.

This was an incredible example of seemingly siloed teams dropping the barriers and becoming one team. We were united with the goal to build a complex site in record time. It made me proud to be part of such a great team!"

You can see the Cardiff mobile speed test [here](#)



6. PSBA

Public Sector Broadband Aggregation (PSBA) is a Wales-wide network which was launched in 2007 and is unique. It is a managed network which connects public sector organisations in Wales to a private secure Information and Communications Technology (ICT) Wide Area Network (WAN).

PSBA enables local health boards, local authorities, higher and further education, blue light emergency services and other public sector organisations in Wales to deliver effective and efficient services to Welsh citizens.

BT currently supplies and manages the PSBA network and related services for more than 100 public sector organisations through PSBA infrastructure across Wales.

When we heard that the UEFA Champions League final was coming to Cardiff, we realised that the scale of the event had the potential to disrupt critical network operations. We anticipated serious traffic congestion because of the large numbers of supporters and VIPs coming into central Cardiff.

We realised this could delay or even prevent support staff from being able to access buildings where PSBA core equipment is housed. We also considered the worst case scenario of some kind of major incident where areas of the City could be put under lockdown.

We assessed the risks, and took advice from a civil contingencies planning committee. We decided to move part of our network operations centre out of Cardiff for the duration of the Champions League event.

We had to find a suitable office location, and make sure that network and other facilities were available there. We also needed the support of some of our staff, who would need to commute and work in an alternate location for up to a week.

We ended up moving half our Service Desk team to Bridgend on 1st June. The other half continued to work from Cardiff.



l-r **Timothy Morris, Peter Wilson, Jeremy Thompson**
PSBA BT team members

There was seamless communications between the two teams. Our customers didn't notice any difference in the service. The event was a great success with no incidents reported.

The PSBA BT team received a letter of thanks from Ken Skates: Cabinet Secretary for Economy and Infrastructure.

The recognition was great for team motivation.

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PSBA BT team members on a Christmas jumper day in Cardiff, 2016



PSBA BT team members join staff at Cardiff & Vale University Health Board to help Santa give gifts to young patients, 2016



BT AGM in Cardiff, 2016

BT 

WELCOMES YOU
TO **CARDIFF**




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LEAGUE

FINAL
CARDIFF 2017



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