# BBC R&D at Commonwealth Games 2014
# End-to-End UHD over IP

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BBC R&D

# IP end to end

- Broadcast traditionally one way, limited return channels added, fine for tweeting your brains and simple multiscreen

- Evolution to IP world
  - Tailored content
  - IoT
  - UGC
  - Atomised content

- Step 1 . Move broadcast to IP

# BBC R&D showcase at Glasgow Science Centre

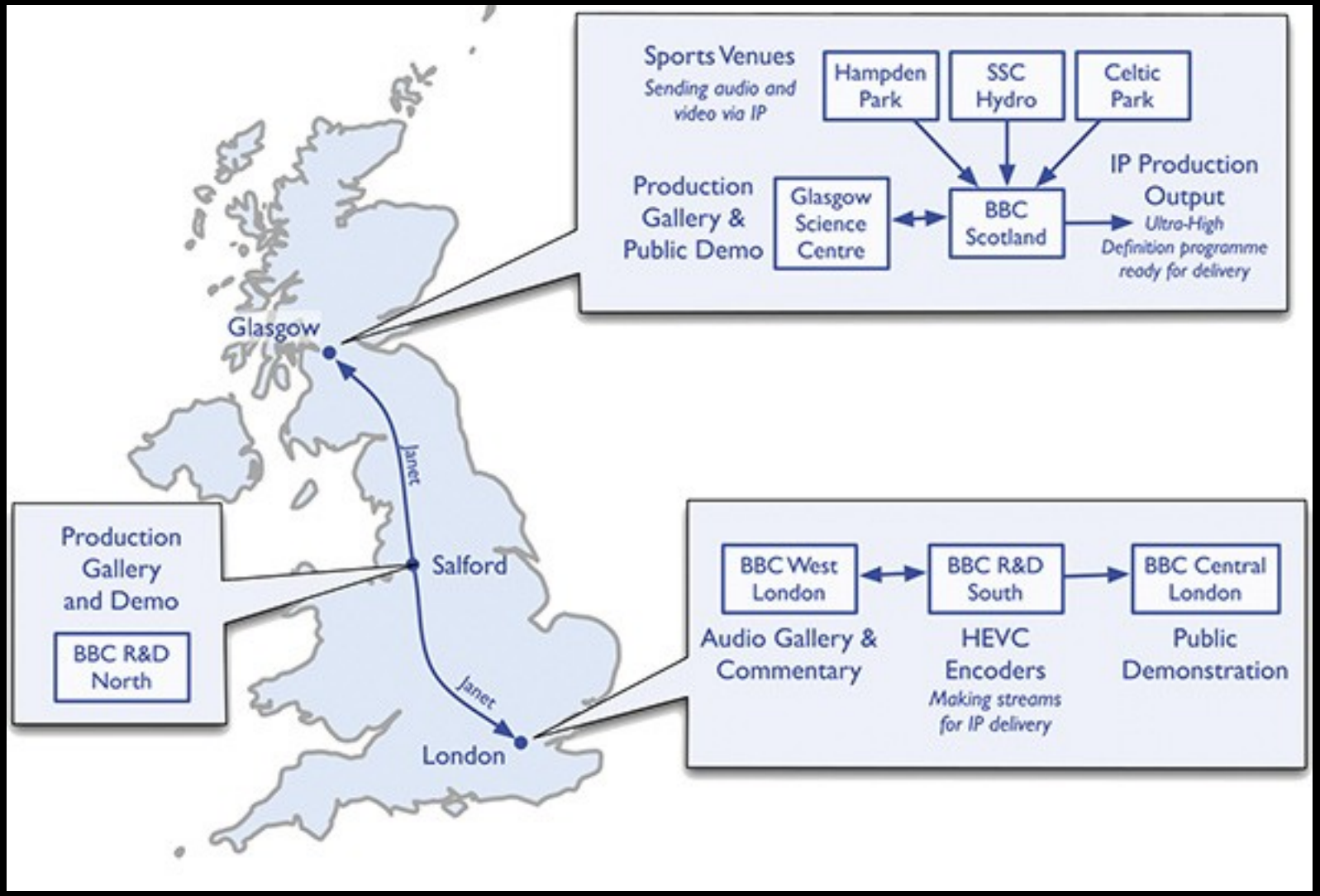

# Showcase aims

- Public demonstration of BBC R&D work
- Support BBC activity in Scotland and support the Games
- Cover some of the Games at UHD
  - What is different from HD sports production?
- Use IP (Internet Protocol) End-to-End:
  - Convert to IP at the cameras and microphones
  - Produce in IP domain – *IP Studio project*
    - IP already in common use for p2p links.  We do *
  - Demonstrate some of what IP has to offer:
    - multi-format working
    - distributed production operations
    - flexible control and monitoring
  - Deliver to the home over broadband networks (and legacy DTT)

# Firsts

- First all-IP multi-camera sports production
- First UHD coverage of Commonwealth Games
- First all-IP UHD end-to-end programme

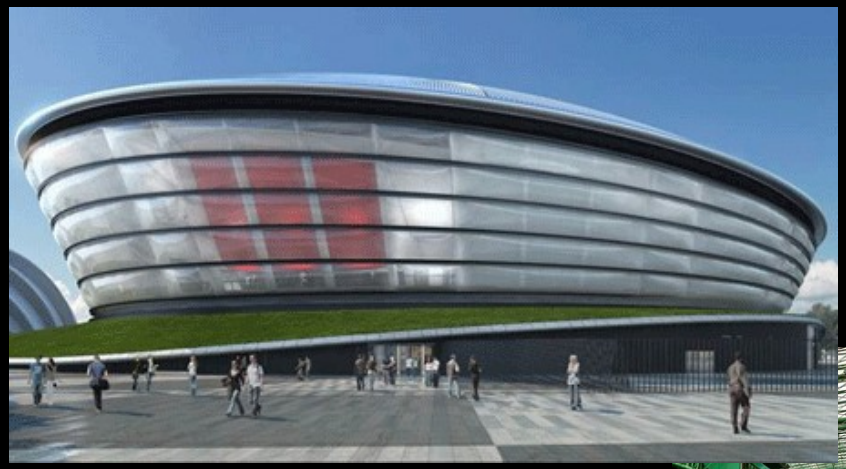
# IP End-to-End



# IP End-to-End

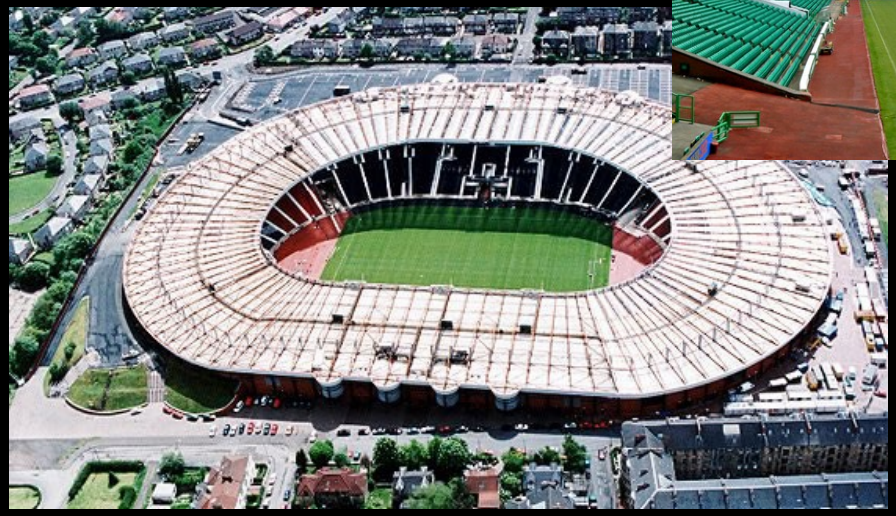
- Capture UHD 2160p50 at production quality
  - Intra H.264 at 800-1200 Mb/s with 100 Mb/s HD proxy
- Live Multicast RTP streaming between sites and cities
  - Supplemented with HTTP transfer from capture location to main store
- Distributed production
  - Video in Glasgow, audio in London, monitoring in Salford
- Multi-resolution working
  - HD proxy in production gallery, UHD in BBC Scotland server room
- IP-based comms (Mumble) and camera tally
- Web-based monitoring and control
- HEVC (35 Mb/s, Main Profile) DASH via BBC R&D CDN trial
  - Also via DTT

# Commonwealth Games Venues



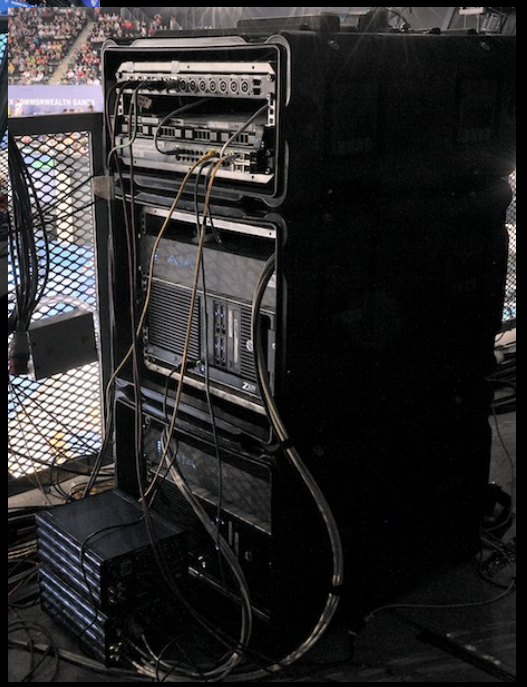
The Hydro: gymnastics, boxing, netb

Celtic Park: opening ceremony

Hampden Park: athletics, closing cer

# UHD IP capture at The Hydro

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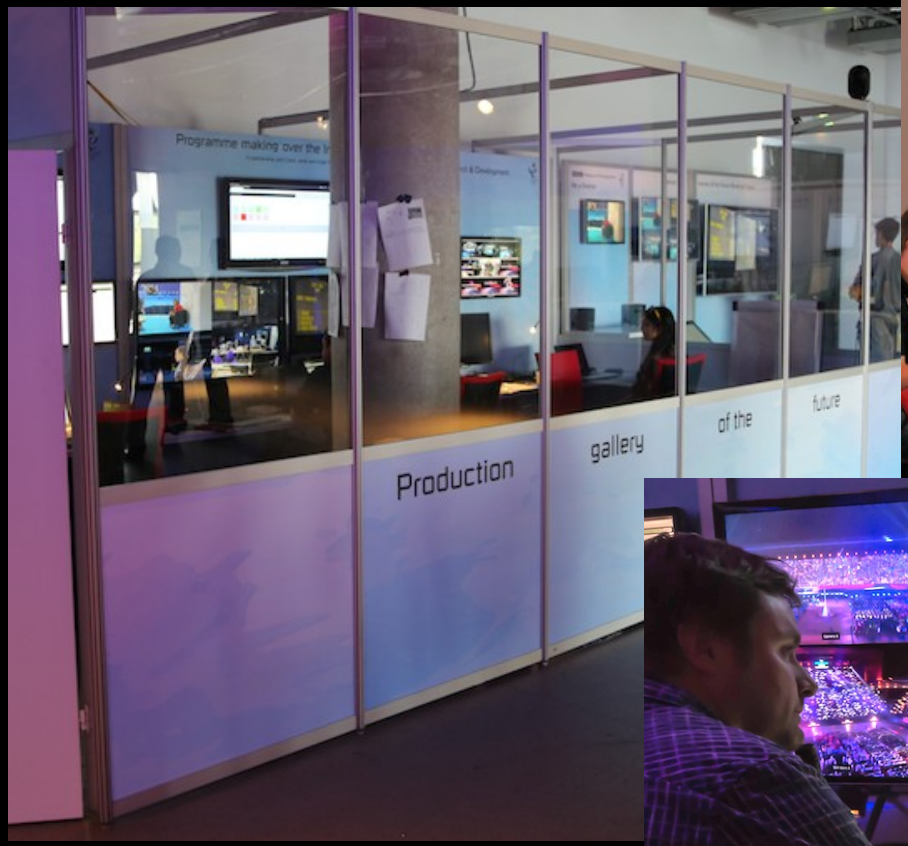
# IP Production Gallery (Glasgow SC)

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# IP Production Gallery (Glasgow SC)

# Audio Gallery and Commentary (London)

# Network, storage, processing (BBC Scotland)

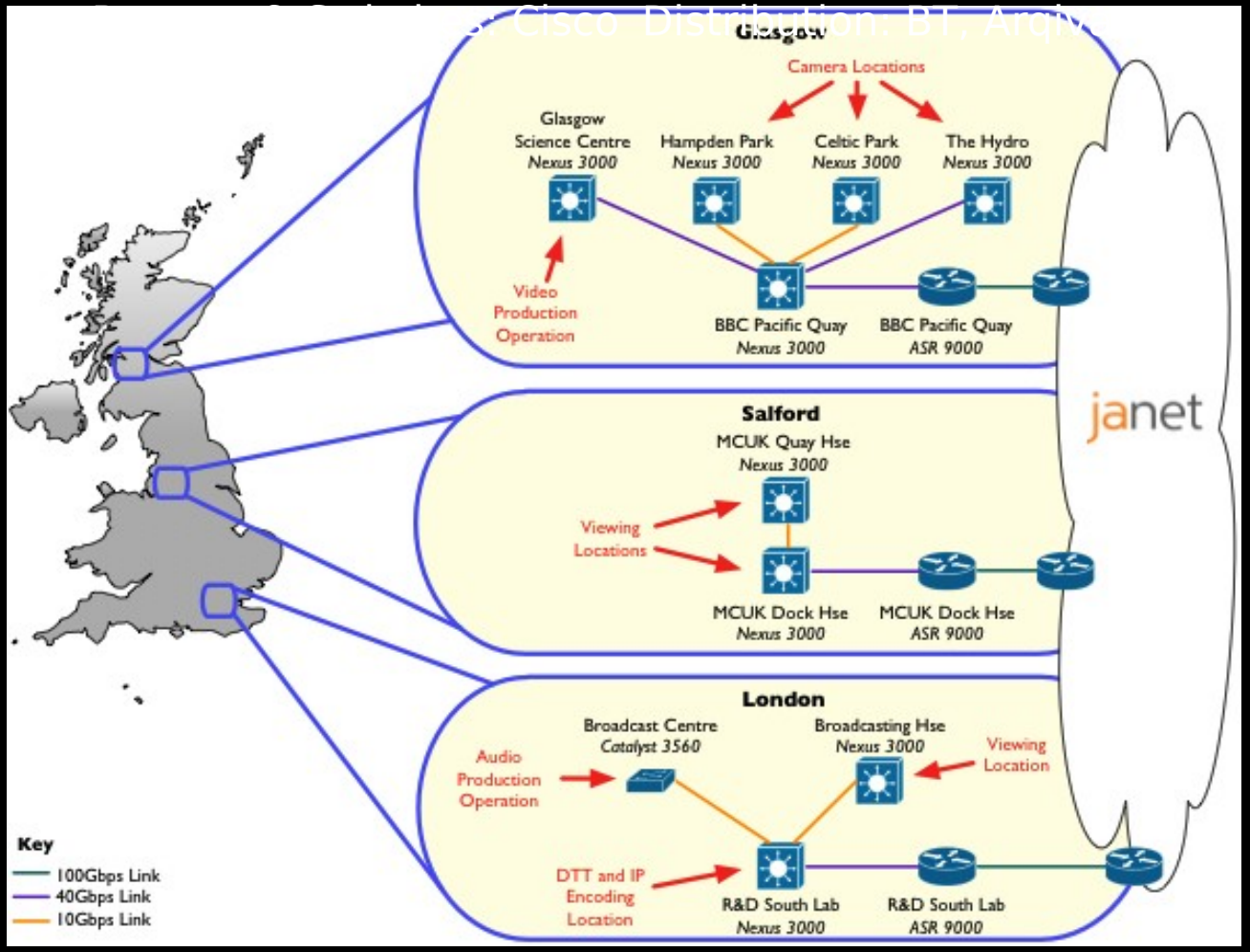
# CWG network overview

Network Partners

Connectivity: metro fibre Virgin Media Business, UK

100G: Janet

Cisco Distribution: BT, Arq



# Thanks JANET

- JANET not obvious to GCS visitors but crucial
- Original plan: 100G waves between all sites
  - 12Gb/s UHD uncompressed, many devices have issues >10G flow
  - Limited loan kit availability and no time to test and change = risk
  - Ran out of time and budget to get the waves in
- Switched to JANET routed IP
  - 100G JANET IP port at each site.  Needs Cisco<>Juniper multicast
  - VM fibre to JANET POP, >20km @ Glasgow and Salford, 40km in London. Only LR4 optics available. Fixed with Cube Optics SOA
  - Requires moderate compression, 1.2Gb/s per stream
  - Now no L2 so transport for LTE trial needs to be tunnelled – L2TPV3 not working on ASR9000, thought it

# 100G fail

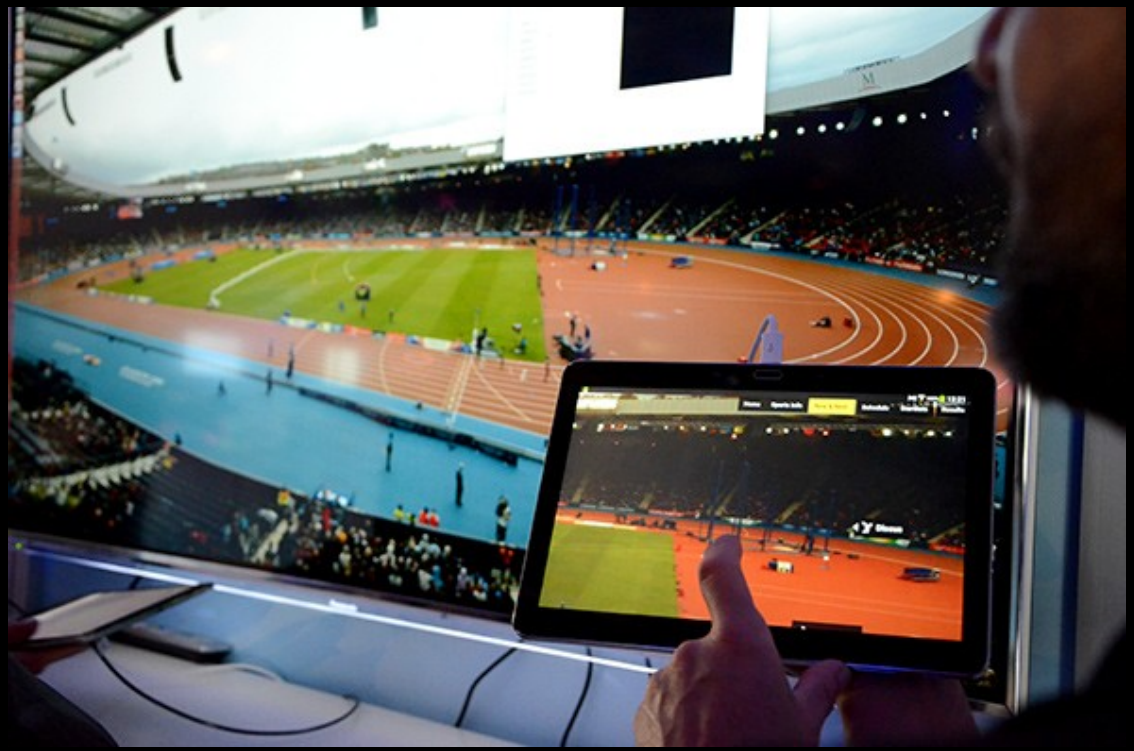
- 100G ASR9000 fault delayed Glasgow testing, some lanes would not lock. Optic replaced, turned out to be line card
- Link up but packet loss  >5% Glasgow, masked <1% in London. 0% Salford (loss is only one direction at each site)
  - Concern SOA problem but suitable kit to diagnose not available at short notice. Plan B's quickly arranged
  - Hijacked London JANET multicast PI port, upgraded it to 10G, patched to a hijacked wave to W12 (thanks JANET & RobL)
  - Glasgow close to not needing SOA, JANET bypassed a bunch of intra site cross connects with trailing fibre, loss low enough to not need amp. Loss 0%. SOA thought OK
  - Reduced feeds into London to stay under 10G
- All up at 1900h, opening ceremony starts at

# Result

- Multi-camera live production and distribution possible over IP networks – including at UHD quality
  - Hybrid approach provides both low-latency live feed and reliable transfer to production storage
- Distributed approach to production
  - IP Studio content and synchronisation model (PTP) allows flexibility of where operations are located and what formats are used
    - Supported by “first-class citizen” approach to data
- Dynamic provision of facilities
  - Web-based service and discovery model allows simple configuration
    - This approach can be extended to “cloud-based” provision

# Venue Explorer

A prototype web app. Viewers interactively explore UHD panoramic video of a live event, zoom into areas of interest, with audio being automatically re-mixed to match the view



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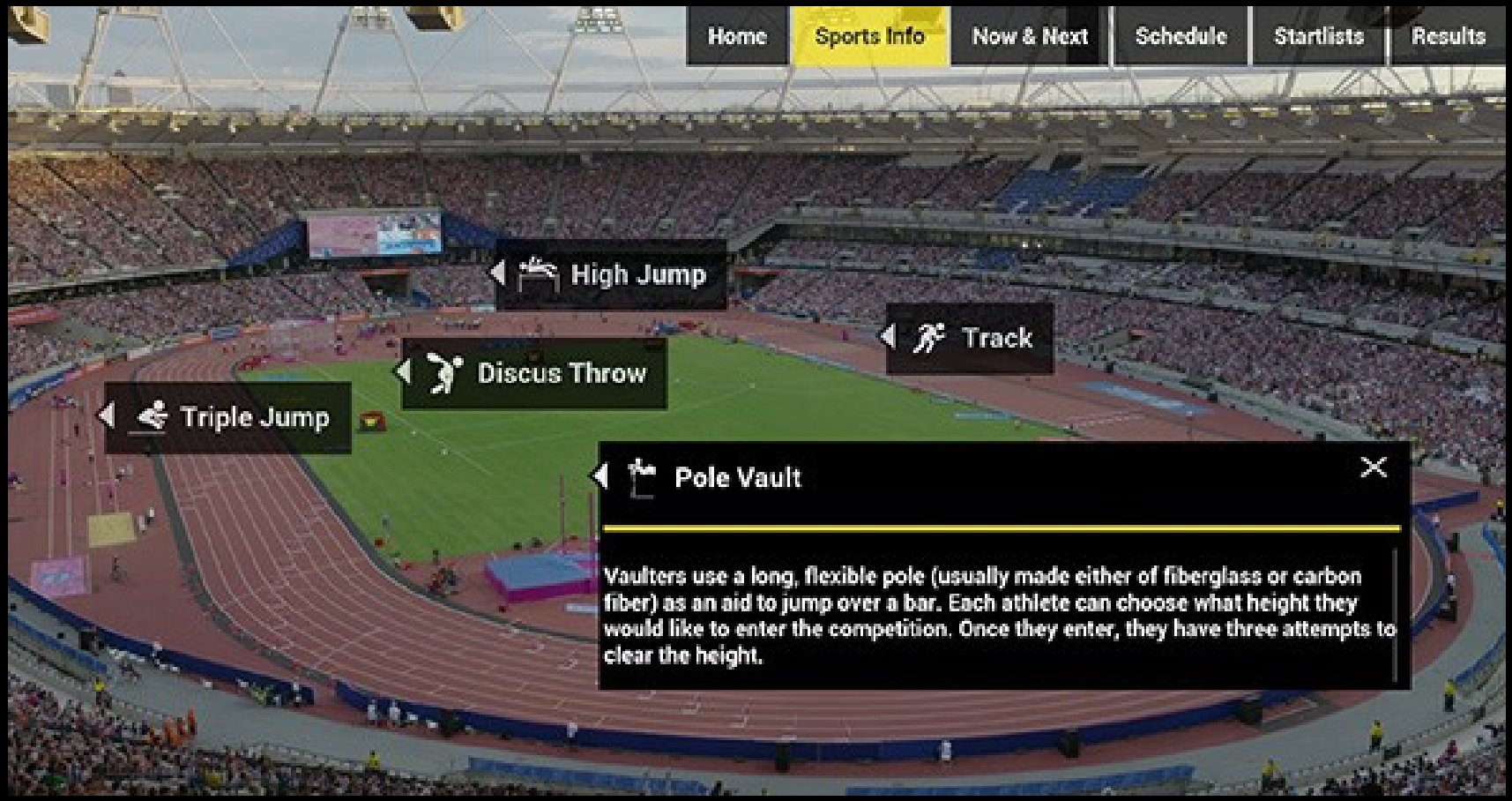
# 360-degree video - Virtual Reality's back

- 360-degree video camera in The Hydro Stadium streams to a VR (Oculus Rift) headset at the Glasgow Science Centre

# Augmented Video Player



# Cisco living room

# LTE eMBMS broadcast

LTE eMBMS (a broadcast mode defined in the current 4G specifications but not used much yet) to broadcast live action from The Games to 4G mobile handsets – a first in the UK – to bring streaming TV to mobiles without buffering

# High Frame Rate

As the resolution increases the frame rate also has to increase to avoid flicker and maintain the resolution of moving images.100 frames per second enables the human eye to fuse motion in a realistic way and is also high enough to avoid visible flicker.

# TV White Spaces

Demonstrating the use of TV White Spaces to provide extra spectrum to deliver multimedia to content to portable devices

# DTT vs Internet

Which is best?

# Further work

- Shrinking capture requirements
  - Build on work done with Stagebox at HD
  - Engagement with industry
- Smart network provisioning
  - Driven by expected production requirements (SDN?)
- Connecting the user experience
  - Use production data to drive downstream offe
    e.g. reframing for multiple devices based on
    analysis of programme content


- Standards
  - Content model, sync, streaming transports, service discovery
  - EBU/VSF/SMPTE Joint Task Force on Networked Media