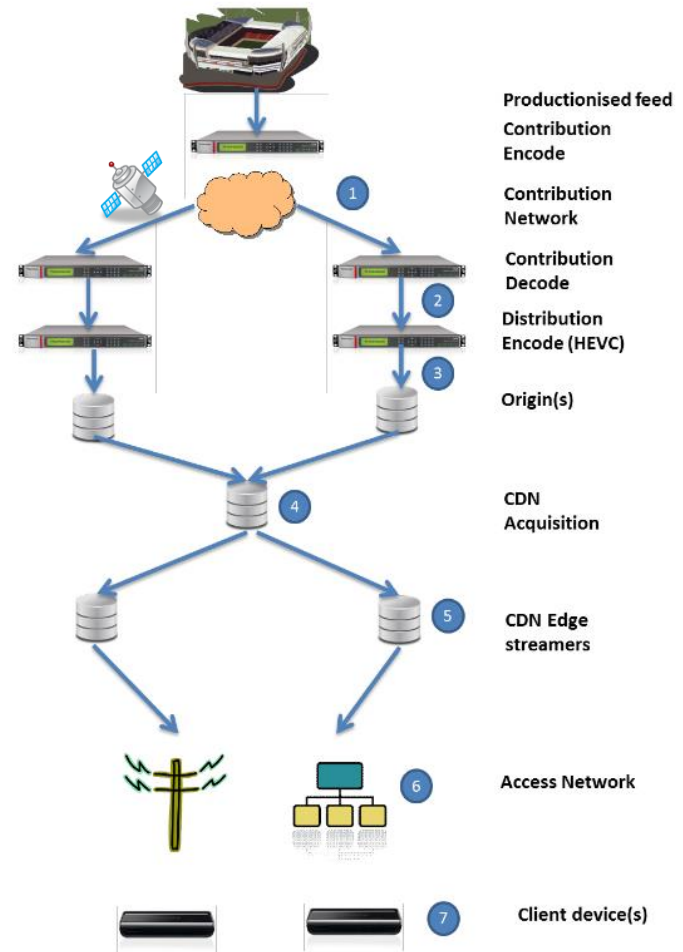# BBC and BT
UHD Internet Distribution

Phil Layton - BBC R&D

Barry Crabtree - BT Research

Proof-of-Concept

- OTT live distribution of World Cup (Brazil) & Commonwealth Games (Scotland) in UHD

- World Cup p60
  - satellite contribution

- CWG p50
  - end-to-end IP delivery
  - from camera to screen

Productionised feed
Contribution Encode

Contribution Network

Contribution Decode

Distribution Encode (HEVC)

Origin(s)

CDN Acquisition

CDN Edge streamers

Access Network

Client device(s)

Technologies Used

- DASH
  - Dynamic Adaptive Streaming over HTTP
- HEVC
  - High Efficiency Video Codec (H.265)
  - Reduce bitrate by 30-50% compared to H.264
- p50/p60 Video
  - No interlace
  - Impact on motion blur with sporting content
  - Need for p100/p120?
- Main 10 profile (CWG only)
  - Bitrate efficient
  - Better linearity
    - High dynamic range (future use)

Live video delivery via DASH

✓ No special infrastructure required

    ✓ Compatible with existing CDN architectures

✓ Client adaptation between video rates to mitigate network variability

✓ Flexible audio/video combinations (manifest)

✓ Pause/rewind are straightforward

❖ Introduces startup delay

World Cup Final - BT Tower Demonstration

5 superfast broadband lines to BT Tower
- 3 set-top boxes
- 1 reference board
- 2 IDTVs LG & Samsung
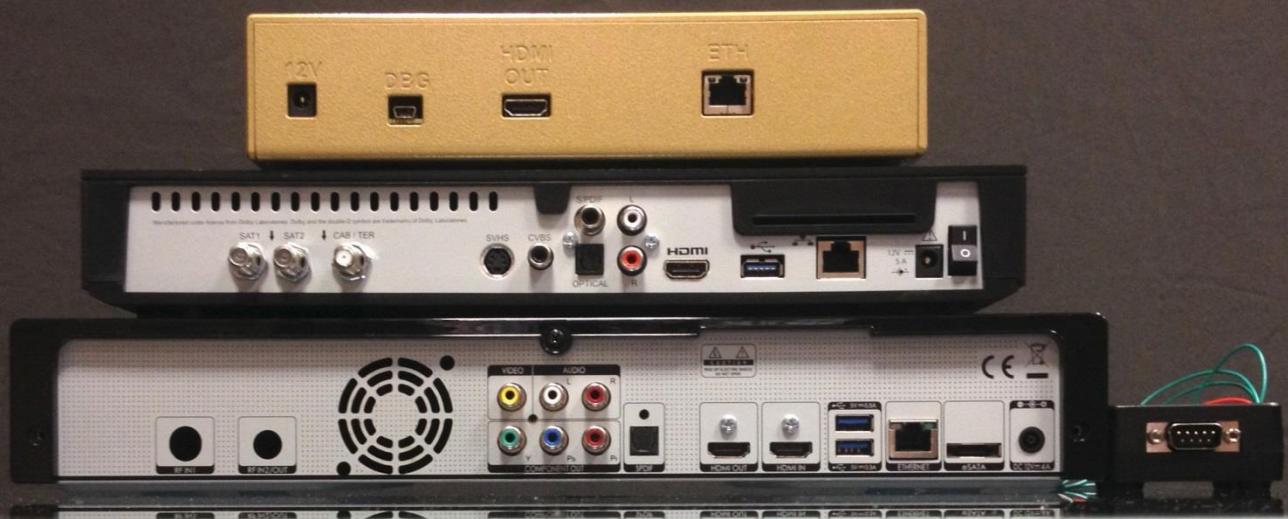- 4K p60 @35Mbits/sec

Vixs

Sagemcom

Humax

Vixs
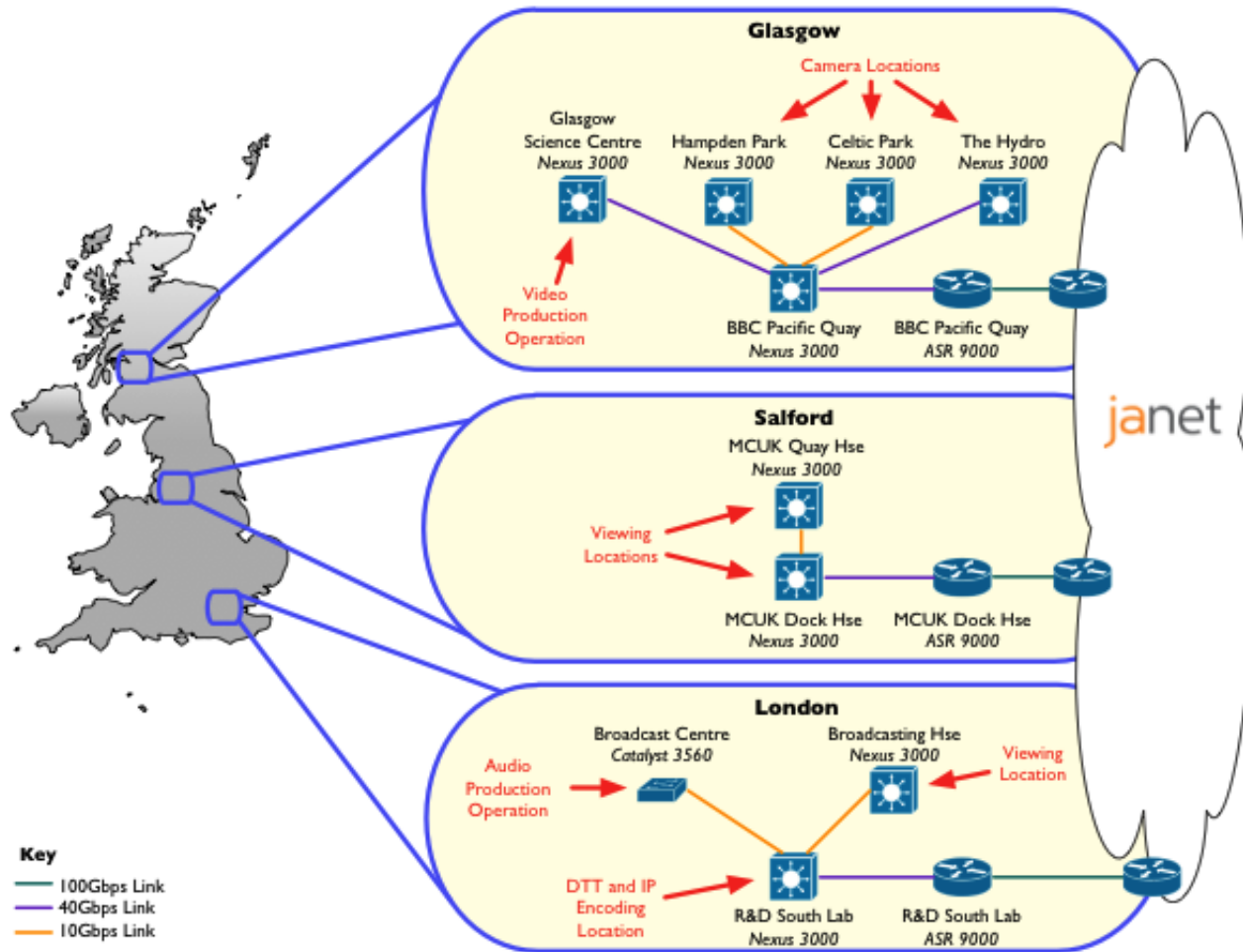- Xcode 6400 series SoC
- libDash

Sagemcom
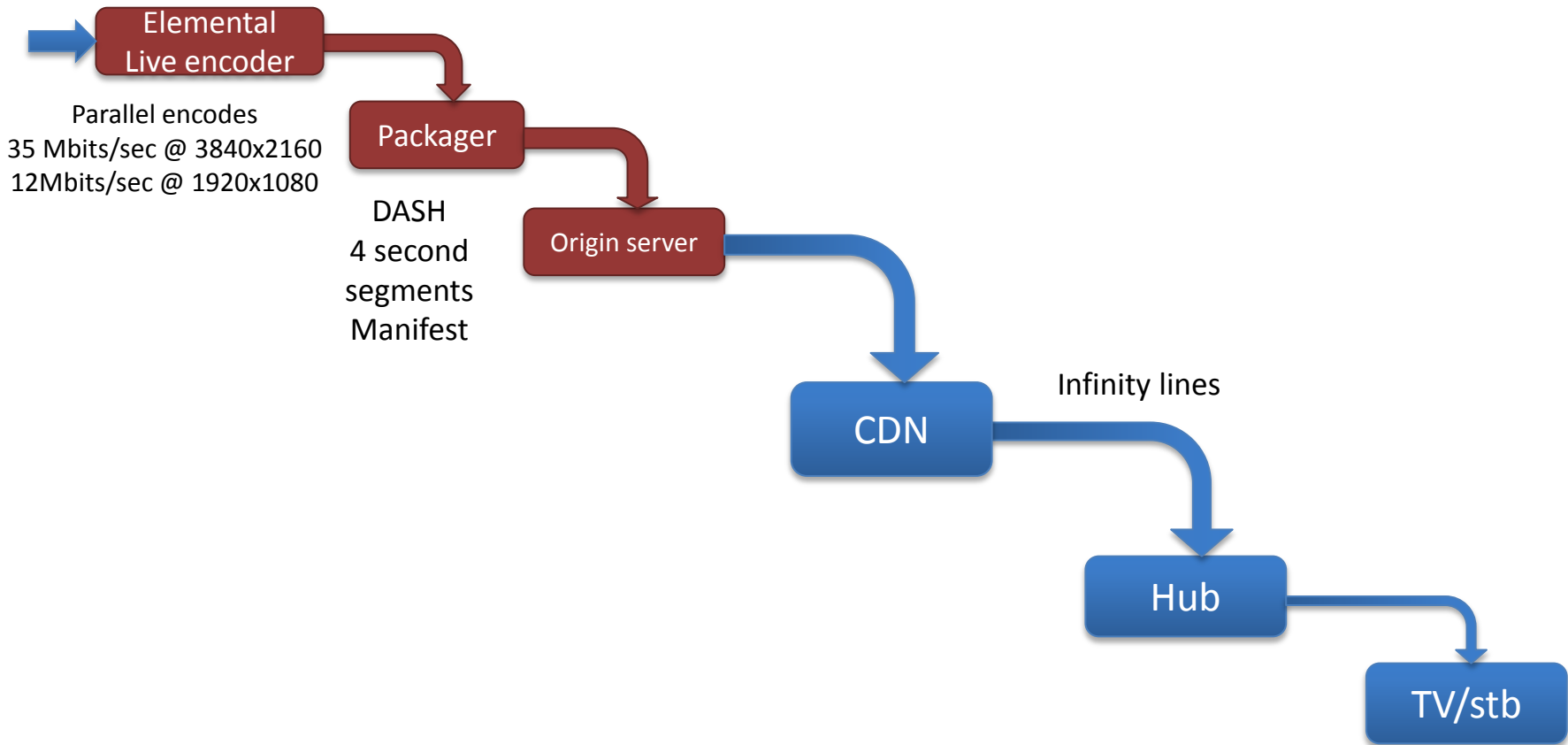- Broadcom
- DASH-js

Humax
- Broadcom

Commonwealth Games

Commonwealth Games Contribution Network
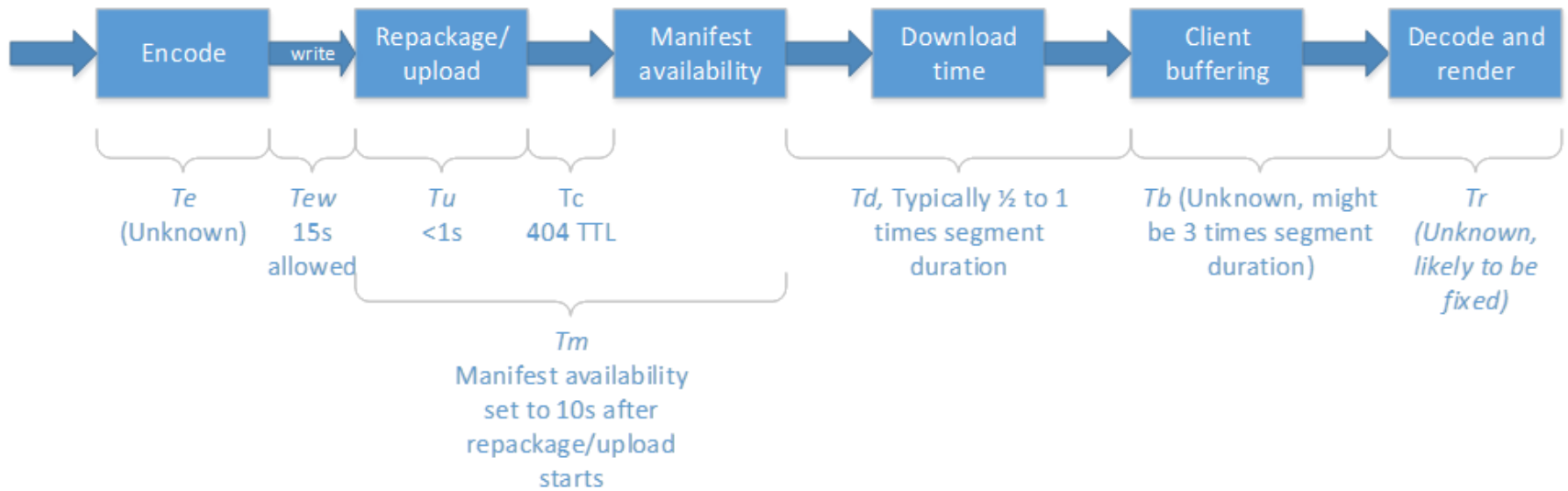
Distribution Architecture

12Gbits/sec input
    (4 3G SDI)

Elemental
Live encoder

Parallel encodes
35 Mbits/sec @ 3840x2160
12Mbits/sec @ 1920x1080

Packager

DASH
4 second
segments
Manifest

Origin server

CDN

Infinity lines

Hub

TV/stb

Distribution delays

Encode → write → Repackage/upload → Manifest availability → Download time → Client buffering → Decode and render

T_e (Unknown)

T_{ew} 15s allowed

T_u <1s

T_c 404 TTL

T_d, Typically ½ to 1 times segment duration

T_b (Unknown, might be 3 times segment duration)

T_r (Unknown, likely to be fixed)

T_m Manifest availability set to 10s after repackage/upload starts

Lessons Learnt

- HEVC encoding
  - Live HEVC encoding very new technology
    - Bitrates 40% higher than estimated from offline encoding tests
    - Consistent across a number of encoder implementations
  - Insufficient processing capability to encode multiple representations in real-time
  - Main 10 support is not ubiquitous in decoders
- Client adaptation to variable network throughput
  - Unable to test thoroughly with 2 representations
    - DASH implementations were very simple
    - Clients did not track network bandwidth
- End-to-end delay
  - Typically 45s late compared to UHD broadcast
  - Delay increased in some receivers as event progressed
  - Delay is inherent but a better implementation should achieve 20s
- Network/Client interaction
  - Numerous detail issues identified
    - Number of connections opened by a client
- Home Networking Throughput

UHD – just more pixels?

- **Better Pixels**
  - Benefits to all screen sizes
  - High frame rate
    - 25fps → 50fps → 100fps
  - High dynamic range
    - 10 bit path
  - More colours – BT2020
  - Interaction with HEVC encoding
- **Better audio**
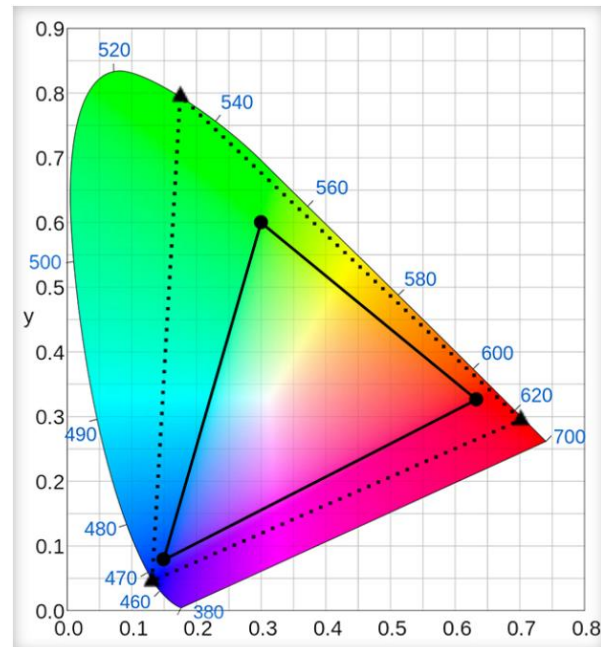
Conclusions

- Delivering UHD via DASH is viable
  - 3 BBC Sites
  - BT Tower event
- BT CDN infrastructure worked as expected
  - UHD bitrates supported
- Distribution encoders
  - Currently typically support 1UHD+1HD stream
- Production architectures
  - 4 x 3G is very difficult to use

BBC

BT

Conclusions