Cardiff Central Square
An Update

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BBC Major Projects Infrastructure

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About BBC Wales

- Content production in Welsh and English across all platforms
- TV for BBC1 / BBC2 / S4C including co-productions with network
- BBC Radio Wales, BBC Radio Cymru & Network radio
- Online/mobile: e.g. BBC News, BBC Sport, BBC iPlayer, Cymru Fyw
- BBC National Orchestra of Wales
- Production facilities – supporting all network and local programming and services
- Largest BBC newsroom outside of London
- Drama production at Roath Lock – the BBC's largest drama studio site



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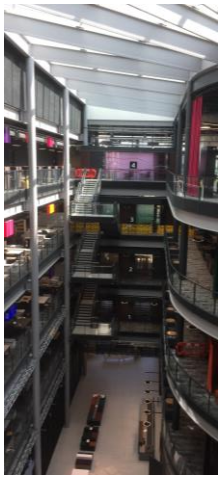
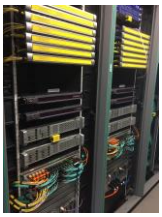
The Site

- In the centre of Cardiff, regenerating the heart of the city
- Adjacent to Central Railway Station & new bus station
- Close to the Principality Stadium

Project Facts & Figures

- Building Size: 150,000ft2 (~14,700m2, 72x72x33m)
- Studio Height 6.3m or 5.5m, Office Floor Height 3.5m
- 1x large general purpose studio with AR (230m2, 8 cameras)
- 1x flexible production area (168 m2, lit and gallery controlled)
- 1x VR/AR news studio (168m2, 3 cameras)
- 1x VR news studio (45m2, 2 cameras)
- 22x edit suites
- 3x dubbing suites with associated VO booths
- 2x tracklay suites
- 4x multi purpose suites (audio & TV)
- 6x flexible media areas
- 4x news edits with VO booth
- Numerous live to air radio studios/workshops (incl. band area)
- 10x audio editing booths
- 1x operational support area with viewing rooms





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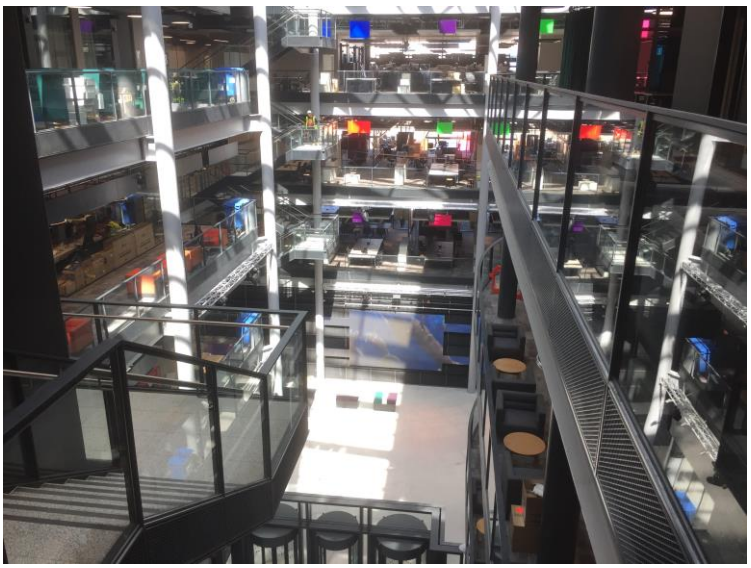

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Opportunities

- New technology to support production and creativity
- New ways of working – open plan, collaborative, agile
- Flexible production spaces
- Audience engagement

Challenges

- New technology will require new skills to be learnt
- Change can be difficult - whether it is people moving offices or introducing new technology, and we're doing both at the same time!
- Personal changes for staff (reduced car parking, agile working etc.)
- Balancing public access with security in a City Centre environment

Key Achievements

- Building certified ‘BREAAM Outstanding’
- All major technical contracts placed
- All major technical designs agreed
- Virtualisation platforms designed, built and running key broadcast systems
- New more efficient approach to apparatus room power & cooling with integrated hot aisle containment
- Technical fit out largely complete
- Technical Acceptance Testing underway

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LIVE IP – Top Benefits

- **Future proofing**, in particular the ability to adopt new formats
- **Flexibility**, supports new ways of working with more dynamic assignment of resources. Allows facilities to be scaled up more easily
- Will be the **industry standard** in roughly the same timescale as Central Square
- Will eventually be the lowest cost model due to adoption of **COTS** hardware and ability to move broadcast functions onto a more generic **platform** with a **distributed** routing core

Live IP - Top Risks

- Interoperability still not proven standards are very new
- There is an obvious Cybersecurity risk
- New skills are required to deliver and support Live IP. There is a possibility of change saturation and also an overspend on training
- More resources may be required to support delivery of Live IP than planned (this includes resources and capabilities of Systems Integrators)
- Refresh cycles are much faster and don't align well with traditional capital plans

Live IP Progress

- Main contract awarded to Grass Valley
- Control network topology designed and procured
- Control methodology for integration with BNCS delivered
- Control system (BNCS) virtualised
- ST2110 media network topology agreed and deployed
- Gateway I/O built using a mix of GV Nodes and GV IQ-UCP Cards
- Multiviewers built using GV Nodes with KMX Cards
- 4 rounds of intensive formal testing completed,
- Final commissioning on site and acceptance testing in progress

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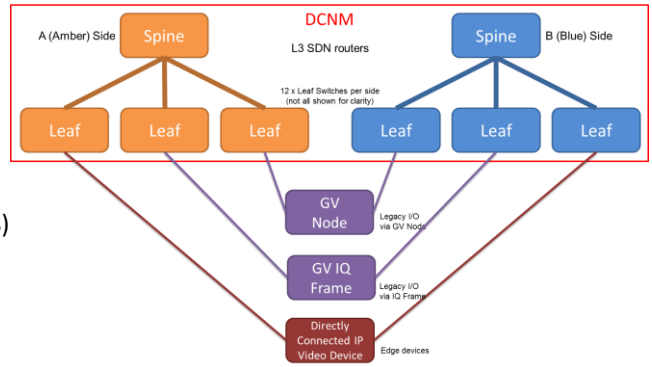
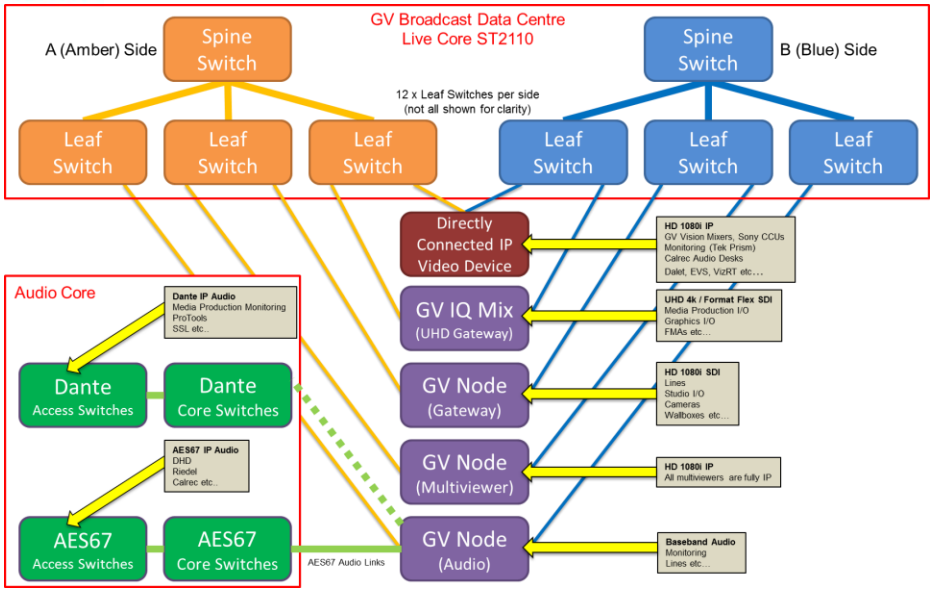
ST2110 Media Topology

- There are 2 separate (A/B) media networks for ST2110 IP flows
- There is another separate control network (a shared broadcast control network)
- The media networks use a leaf-spine architecture with 1 spine switch (Cisco 9508) and 12 leaf switches (Cisco 9236) per side
- The media networks are fibre based using Single Mode MPO optics at up to 100Gbps



- The media networks are controlled using Cisco DCNM (a form of SDN)
- There is a pair of leaf switches provided on every floor with multiple leaf switches in the CAA



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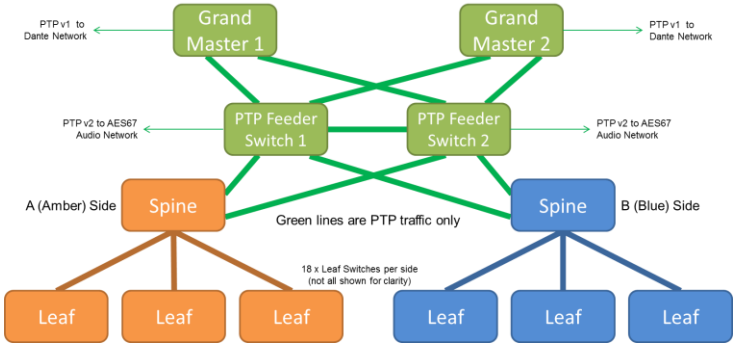
Control Methodology

- Separate & secured control network
- BNCS control interface to GV Convergent using NP0017
- GV Convergent controls the network fabric via Cisco DCNM
- GV Convergent connects GV edge devices via GV APIs
- Intention was to integrate NMOS IS-04 and IS-05 but the necessary level of interop has not matured in time.

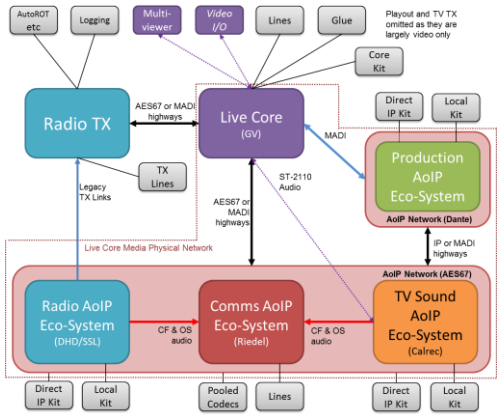
PTP Timing

- Getting the PTP design correct is difficult!
- 2 separate Meinberg master clocks with GPS and GLONASS antennas
- Each master clock has multiple PTP v2 outputs connected to feeder switches
- The feeder switches connect to the spine switches
- All switches operate as boundary clocks
- Separate PTP v1 feeds are used for the Dante network
- PTP is expensive to implement!

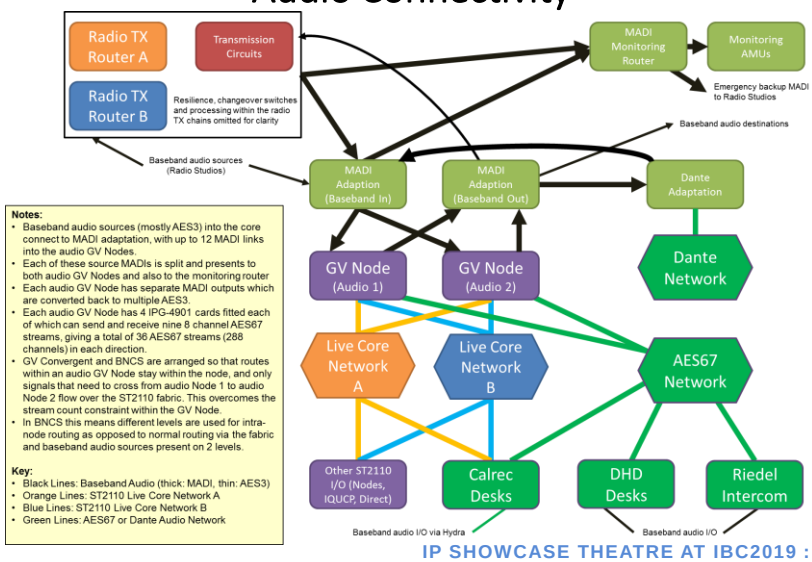


Audio Issues

- ST2110-30 and AES67 are almost compatible but there are differences that add complexity
- There are a lot of different profiles and details that hinder interoperability (16 channel C 125µs, 1-8 channel A 1ms)
- Video vendors are adopting NMOS control but Radio vendors already have LiveWire+, Dante & EMBER+
- Our media network is dual presented via 2022-7 but a lot of audio kit uses a different resilience model
- We also have to deal with Dante for much of our post production audio. Dante needs a different PTP profile
- MADI is an effective bridge between eco-systems



Audio Connectivity



Notes:
- Baseband audio sources (mostly AES3) into the core connect to MADI adaptation, with up to 12 MADI links into the audio GV Nodes.
- Each of these source MADIs is split and presents to both audio GV Nodes and also to the monitoring router
- Each audio GV Node has separate MADI outputs which are converted back to multiple AES3.
- Each audio GV Node has 4 IPG-4901 cards fitted each of which can send and receive nine 8 channel AES67 streams, giving a total of 36 AES67 streams (288 channels) in each direction.
- GV Convergent and BNCS are arranged so that routes within an audio GV Node stay within the node, and only signals that need to cross from audio Node 1 to audio Node 2 flow over the ST2110 fabric. This overcomes the stream count constraint within the GV Node.
- In BNCS this means different levels are used for intra-node routing as opposed to normal routing via the fabric and baseband audio sources present on 2 levels.

Key:
- Black Lines: Baseband Audio (thick: MADI, thin: AES3)
- Orange Lines: ST2110 Live Core Network A
- Blue Lines: ST2110 Live Core Network B
- Green Lines: AES67 or Dante Audio Network

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ST2110 Interop

- dB Broadcast tested various equipment for direct ST2110 connection
- Market availability constrains where we use end-to-end ST2110:
  - GV Kahuna Vision Mixers
  - Sony Studio Cameras (also wired via SDI as backup)
  - Tektronix Prism Waveform Analysers
  - EVS & Viz Engines
  - Dalet Brio
  - Multiviewers (integrated within Grass Valley Nodes)
  - Embrionix for Back of Monitor connections
  - Calrec Sound Desks (which also connect to AES67)

NMOS Issues

- Our original deadline for NMOS IS-04 & IS-05 interop was November 2018. This was extended to March 2019 then finally to18th April 2019.
- Despite extensive testing by our SI with input from BBC R&D and multiple updates from key vendors, practically no satisfactory interop was achieved by the final deadline. Each update moved closer to a working solution but unveiled new problems.
- Apparent success at various ‘plug fests’ has not matured to available supported product where NMOS works as promised. Vendors seem to have interpreted IS-04 & IS-05 slightly differently resulting in incompatibility. NMOS only seems to work when ‘curated’ by expert R&D engineers. Linking the ‘plug fests’ to marketing messages regarding NMOS readiness has given a false impression. NMOS is coming together but needs more time.
- There seems to have been insufficient thought from AMWA regarding version control and compatibility. New features implemented by one vendor can prevent core functionality working with another vendor.
- Vendors have adopted different approaches regarding in-band or out-of-band control and this has caused complications, especially where NMOS control traffic is on shared interface.

NMOS Fall-Back Solution

- We are planning to use NMOS in a very limited way, for example with Tektronix Prism monitoring units.
- Our fall-back for senders is that directly connected senders will stream all the time, DCNM will block streams when not required.
- Our fall-back for video receivers is to route via an intermediary GV IQ-UCP gateway frame. GVC will control the route to a 'turnaround point' from where the signal will be statically routed.
- Our fall-back for audio-only receivers (such as Calrec desks) is to use a pair of GV Nodes with no I/O cards fitted. These provide a similar 'turnaround point' for ST2110-30 streams under GVC control.
- This fall-back approach avoids the need for API integration for which we don't have time, it uses the tested GVC control mechanism and it can be removed in the future when wider NMOS interop is available. It does however add delay of 1 video frame.

Lessons Learned From Testing

- Interoperability testing is vital
- Involvement from the Systems Integrator is essential from an early stage
- New skills and new test equipment are required
- A formalised approach using IT techniques (in our case TestRail & JIRA) is essential to manage regression testing and to track progress
- Large ST2110 systems are very complex to find faults in, with many layers
- Configuration errors can be missed by vendors which cause key tests to fail
- The testing approach can unexpectedly break the system under test
- Testing takes much longer than expected, timelines based on legacy planning need extending

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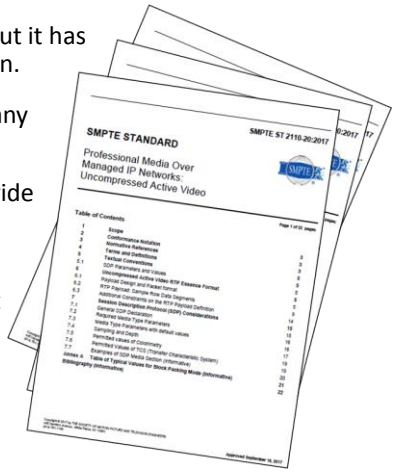
What's Keeping Us Awake?

- Lack of working NMOS interop has forced us to adopt a fall-back solution. Without NMOS or an equivalent control mechanism we cannot realise the full benefits of IP regarding flexibility of use.
- Configuration of the system is complex and requires too much manual intervention. The vendor's deployment tools are lagging in maturity.
- New tools are required to monitor the system but only limited test equipment is available. Developments like the EBU's LIST are essential.
- Availability of ST2110 equipment is still limited. In particular very little equipment supporting single-stream UHD is available.
- Control from BNCS still depends on legacy protocols.
- Audio interop is a particular problem and the solution is complex.

Thoughts on ST2110 Readiness

- ST2110 promises to be the 'go to' IP standard for broadcast signals but it has still got some way to go before it is a simple and universal proposition.
- ST2110 as a media transport standard works well, albeit with too many options, but it's only the top of the pyramid.
- Vendors need to work on configuration & management tools to provide 'plug and play' functionality that are appropriate for broadcasters.
- NMOS integration is key to enabling systems to function together but it isn't yet sufficiently mature. There still needs to be a confident leap from the R&D labs to mature and reliable product.
- The more projects that specify and install ST2110 equipment the sooner all this will happen but the issues with NMOS are holding broadcasters back from moving to ST2110.



Thank you

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