Connect & Produce Anywhere
How we resource live events is changing

Mix of on-site and remote working

Functions will be accessed on-site, in-facility and remotely

• Video, audio edit, graphics, monitoring...

Users are starting to expect this, and don't want to be concerned with the technical details
It's not just “do everything in the cloud”

Often providing those functions on-site, or at a broadcaster’s facility makes sense for operational or performance reasons

- We would like the choice
- Need to avoid use of different systems / technologies depending on what we choose
- Focus on software and how it can be deployed in different cases
Cloud
Highly scalable
Connectivity can vary significantly
Usually provided and managed by 3rd party
OpEx-heavy

On premises
High bandwidths available
Much production activity happens here
Can fit a lot of compute in a facility
Often self-provided and self-managed
CapEx-heavy

Edge
Sufficient compute and bandwidth on location for what matters
Can self-provide or use 3rd party
Cloud vendors increasingly offering edge products
Very large pipes will be needed for the highest tier
Where this is not feasible, we'll certainly need some resource to be local.
And if we want to support different types of production we will need to think about all these tiers

<table>
<thead>
<tr>
<th>Connectivity</th>
<th>Bit rates</th>
<th>Formats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broadcaster dedicated fibre</td>
<td>Many Gbps</td>
<td>UHD 50/60P, uncompressed or lightly compressed</td>
</tr>
<tr>
<td>Venue-supplied Internet</td>
<td>Hundreds of Mbps</td>
<td>HD 50/60P, compressed</td>
</tr>
<tr>
<td>5G / LEO</td>
<td>Tens of Mbps</td>
<td>HD 50/60P, compressed</td>
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</tbody>
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The challenge

Dynamically move live production media processing stages between cloud and edge computing at the event.

• Do this so that the operators don't notice!

Allow us to deploy software to the best location making the most efficient use of resources in a bandwidth constrained location.

• Do this so that production experience is not impacted by bandwidth
Cabled cameras and audio

Encoder 5G Modem

Wireless Cameras

Remote Production Edge Software

5G Bandwidth Management

Bonding Router

MNO 4G/5G Router

MNO Public Network

LEO Satellite

5G LTE

Production Hub or Distributed Production

Bonding Router

Public Internet

LEO Landing Station
What we are exploring...

• How can we run live production software on different software platforms?
• Can we run them on servers at an event?
• What are the sustainability implications?
• What can be done now and what is expected for the future?
**Edge First**

- By deploying Edge compute can we reduce the connectivity required for ground to cloud solutions
- Edge could be deployed as a 'mobile data centre' instead of a scanner
- Option to run whatever services we require in the same way as they run in a cloud
- Enable low-latency local feeds as required
Constrained Bandwidth

- Venues don’t always have the connectivity required to send multiple feeds to the cloud
- Operational environment could be anywhere if we remove bandwidth constraints
- Connectivity is biggest blocker to remote production
A note about latency

• It's not necessarily bad to have significant latency for some parts of the operation – a few seconds may be ok when generating a web stream

• But latency needs to be consistent between multiple video and audio sources so that mixing is viable

• And operational control can't be delayed by slow or inconsistent connectivity
Work Anywhere

• Editorial choice on where operational staff are located
• On site, in office or at home
• Choice of tools dependant on licence not hardware
Sustainability

• Remote production can reduce our carbon impact
• Sunk carbon in hardware and multiple duplicated build
• Reuse and better sharing or resources
• Think about how we measure and track
Test environment at Techex, Bracknell, UK

- Vision and audio mix, graphics, playout and distribution streaming applications
- Deployed on local (edge) cloud servers (Dell/AMD)
- Azure Stack HCI and Google Distributed Cloud
- Local NDI sources – target mid/low tier production
- Access to cloud-based distribution
- View and monitor at IBC!
Azure Arc-enabled infrastructure leverages hyperconvergence

Hyperconverged infrastructure (HCI)
- Ethernet switches
- Standard x86 servers
- Local drives
- The magic of software

HCI is a software-defined, unified system that combines all the disparate and siloed elements of a traditional datacenter.
What we have learned so far

- Observability of the network is critical
- Mixed environments are a pain SDI needs careful consideration on how you handle it in a software native environment
- How we measure sustainability
- So far cloud deployments have been vendor specific, we need to move towards a more standardised container type deployment
- Open APIs and not all APIs are equal need to start the conversation to a common API approach, end user requirements are key,
- Building the stacks is non-trivial, especially with specialised features such GPUs
- It took longer than expected not because of supply or tech but logistics concepts are harder to resource than known deployments but drive more innovation because risk profile is different
- Startup procedures at an event need to be well understood... possible new skills needed
- How do we enable an app based infrastructure?
- Routing and interop?
This is just the start

Test bed will be extended after IBC
• More and different applications
• More connectivity types (ST 2110, JPEG-XS, etc)
• Environmental monitoring
• Orchestration
• Business case and licence options

Incubator for further work and trials
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