Our SDI and AES over IP journey

BCE at RTL City

BCE main activities

MEDIA SERVICES

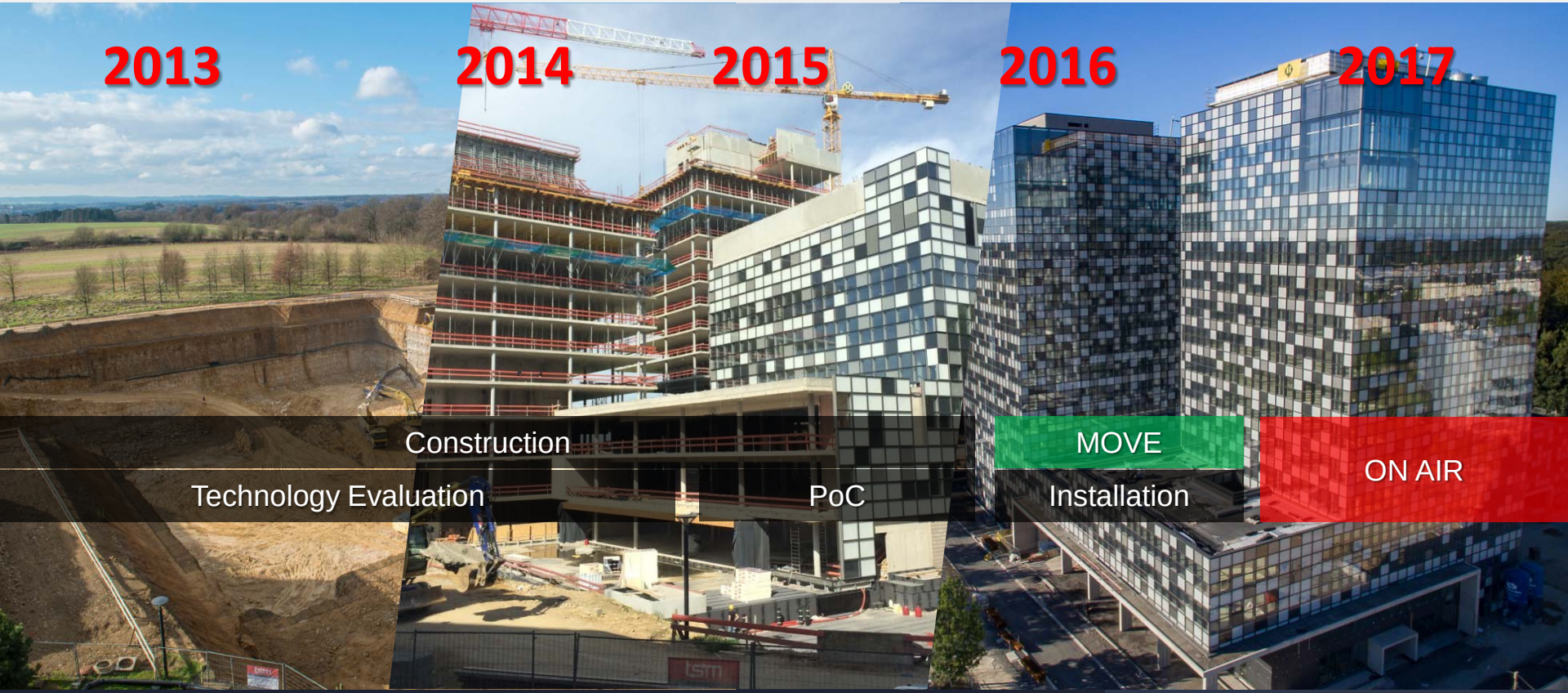
Broadcast
Datacentre
Digital Media Operations
IT Managed Services
Telecom
Teleport
Transmissions

SYSTEM INTEGRATION

Television/Radio
MAM and Newsroom
Post production
Production
Transmissions
Teleport
Telecom
Multimedia
IT

SOFTWARE SOLUTIONS

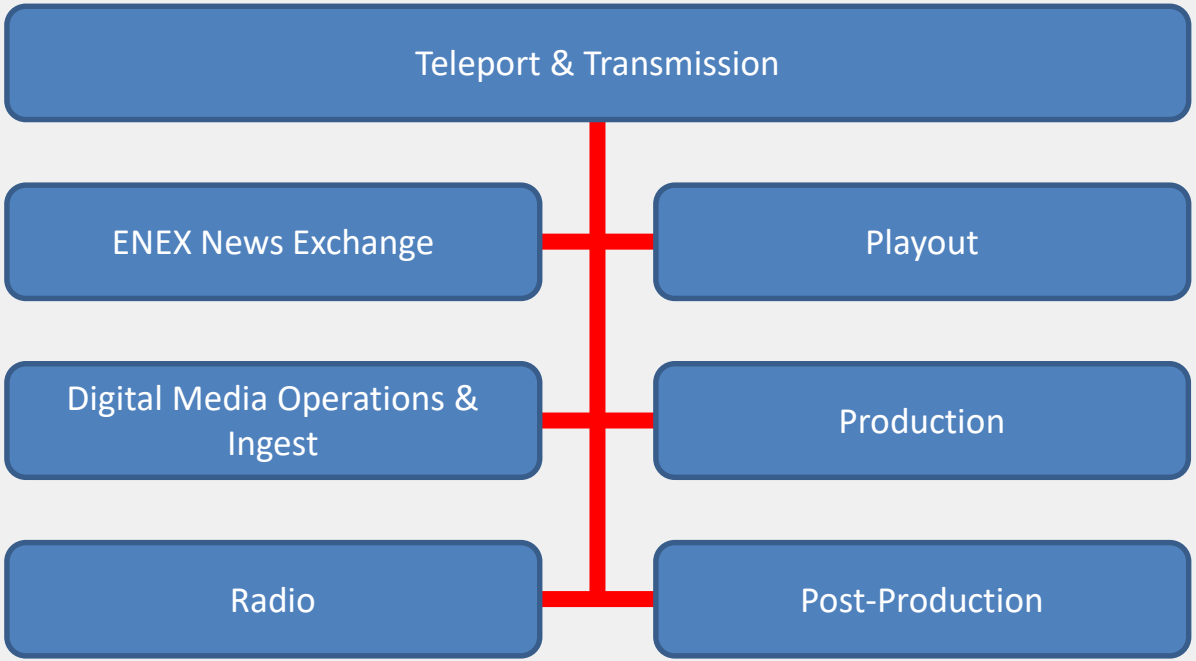
Mass digitisation
Content Management
Traffic
Distribution
Playout
WebTV
IPTV
Non-linear


2013
2014
2015
2016
2017
Construction
Technology Evaluation
PoC
MOVE
Installation
ON AIR

OUR BUILDING DESIGN

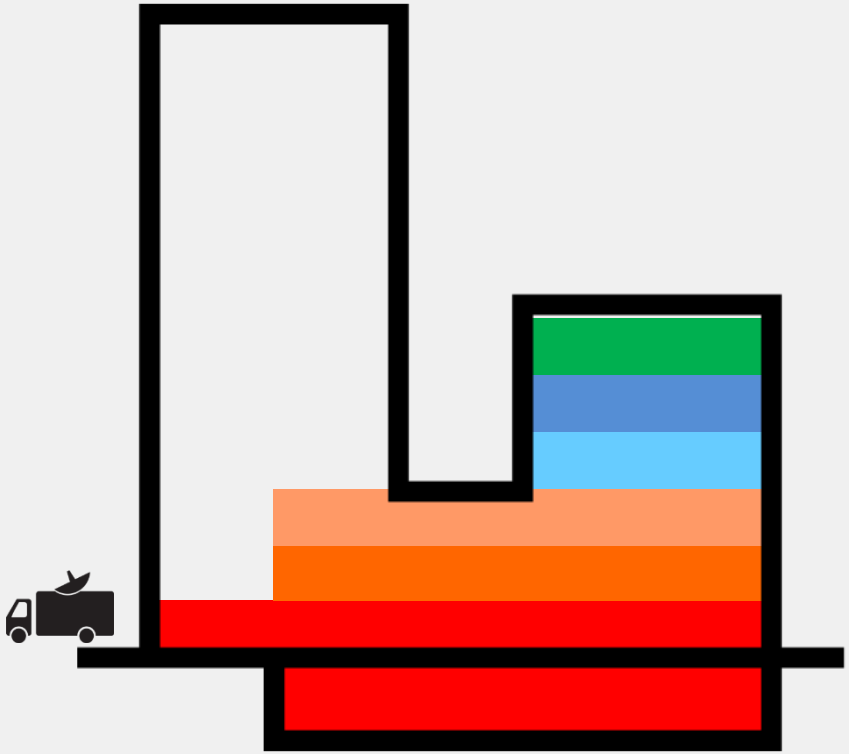
And our constrains

Overview of systems and activities



Building and Floor Layout

It’s an office building



5 Management
4 IT
3 Engineering
2 Playout
1 Post Production
0 Radio studios
-1 Datacenter & TV studios

Building constrains

- The floors -1, 0, 1 and 2 are suitable for Broadcast operations
- Limited cooling power for the media operation rooms
- No equipment room on floor 0, 1, 2

- Common equipment room
- Complex wiring must be avoided

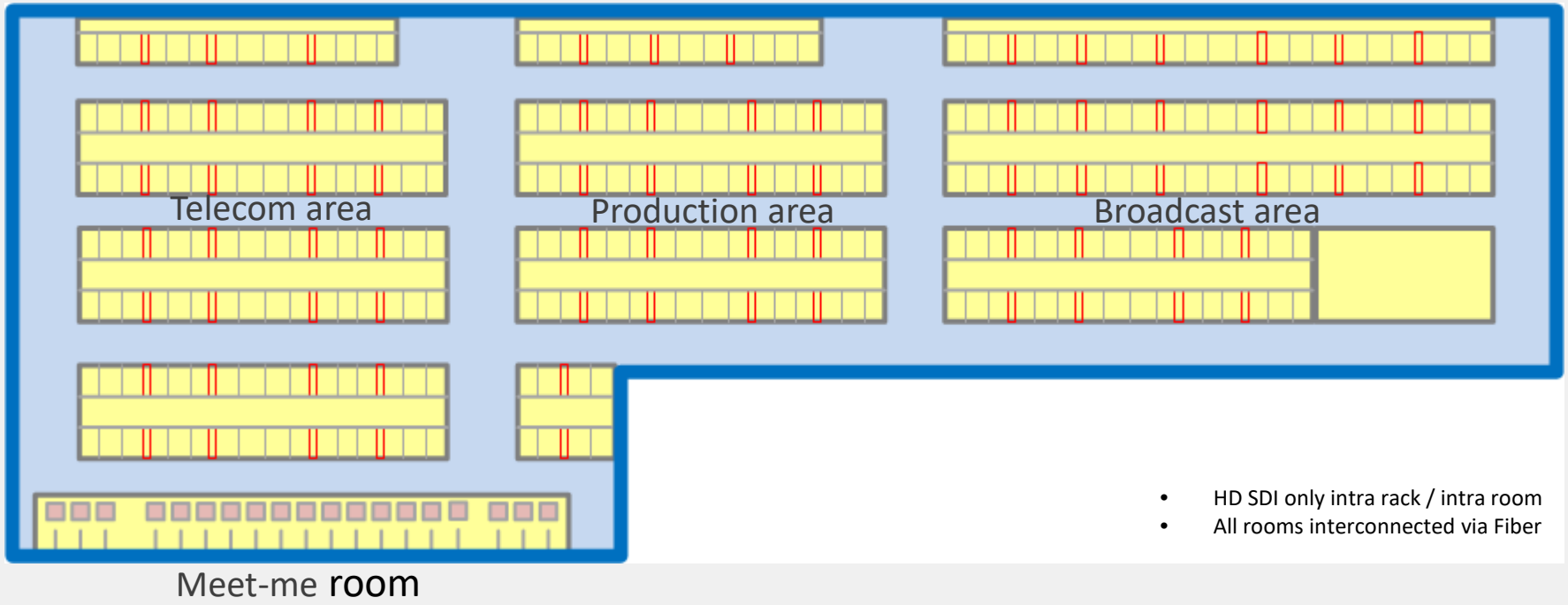
Broadcast operation floors & rooms

CLT-UFA Multi-playout

DATACENTRE

Centralized Equipment Room

1000 sqm at RTL City – 366 / 51U Racks



- HD SDI only intra rack / intra room
- All rooms interconnected via Fiber

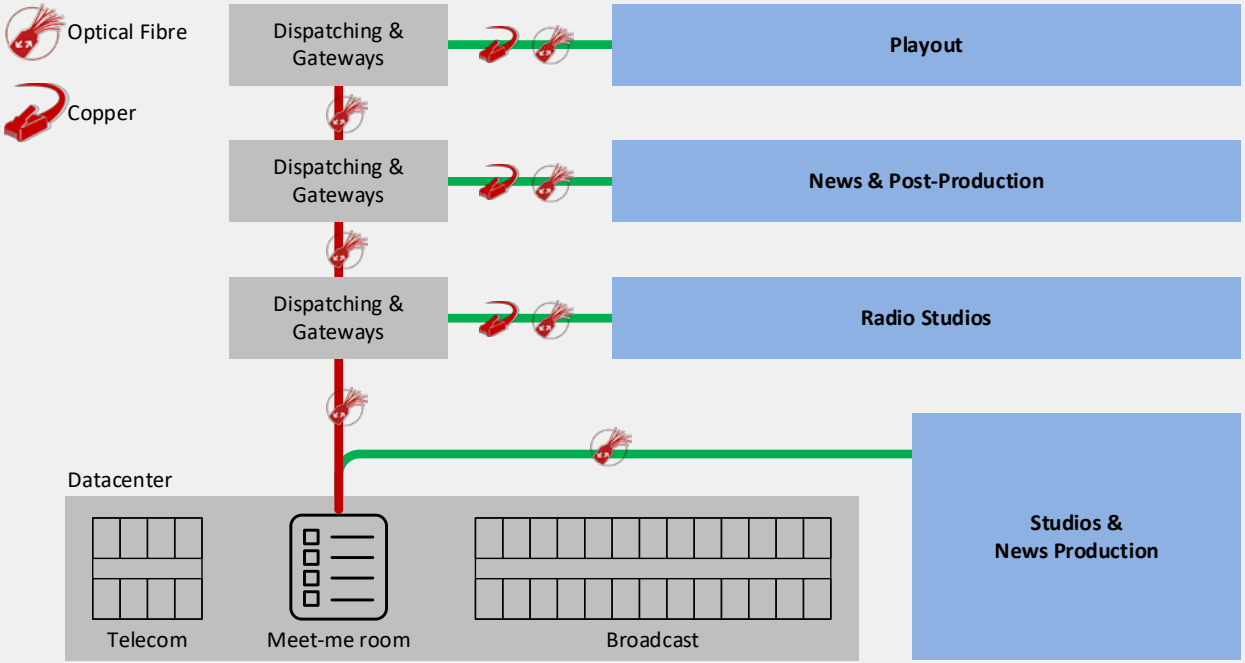
In Row Cooling

366 Racks
In-Row Cooling
UPS 2 x 1,1MW
420 km Broadcast Cabling
Fiber and Copper

Tier 2 Datacenter

10

Inter-Floor Connectivity by Fiber



Floor 2

Floor 1

Floor 0

Floor -1

All connectivities outside Datacenter by fiber. AV over IP, KVM

SYSTEM REQUIREMENTS

Based on our Building design and the decision for an IP solution

Requirements

- SMPTE ST 2022-6/-7 (for SDI over IP and stream redundancy)
- AES67 for audio signals in the same network
- Evolution towards ST 2110 Standards/Interop
- Format agnostic (1080p, UHD, HDR, HFR) – Future proof
- Source & destination audio stream & channel swapping
- Viewing anywhere - Scalable distributed IP multi-viewer architecture
- Dual Central Switches architecture preferred. Scale to Spine/Leaf. Support a minimum of 7500 multicast routes.
- Reduce TCO
- Multivendor selection
- COTS equipment
- Reduce complexity
- Innovation

Achievement vs Expectations

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Basic Concept

- Edge devices based on 40G technology for IP gateways, production Switcher, Multi-viewers, etc.
- Edge devices based on 10G technology for cameras, video servers, audio mixer, video encoding, etc.
- Design based on SMPTE ST 2022-6/-7, AES67, RFC4175, VC-2, Metadata as for TR-03
- Start using the system with SMPTE ST 2022-6/-7 and AES67 as for TR-04
- Control & Monitoring System based on IP router controller & user friendly controller GUI
- Timing & Synchronization - PTP & BB for legacy SDI equipment

- Software upgrades unlock future standardization (e.g. ST2110 family)

CLT-UFA Multi-playout

Proof of Concept at BCE Labs

Individual Proof of Concept with each suppliers in Luxembourg

Tests and Measurements made by BCE and IRT

Proof of Concept @IRT

Proof of Interoperability at IRT, München

Tests and Measurements made by BCE and IRT

OUR SYSTEM

Standards applied today @ BCE

- SMPTE ST 2022-6/-7 for SDI over IP

and

- AES67 for audio over IP
- DANTE In use for all the Radio services

- VSR - TR04

- Software upgrades unlock future standardization (e.g. ST2110 family)

Key IP components used for our system

- 2 Core Switches
- Long Range QSFP+/SFP Transceivers, 40 and 10 GB/s (second generation)
- Video and Audio gateways
- Multiviewers
- Audio processing (channel shuffling and AES67 <-> MADI conversion)
- Cameras
- Vision & Audio Mixer
- Playout Servers
- Contribution Encoders
- PTP Master clock

CLT-UFA Multi-playout

Key IP components by manufacturer

- Arista and Juniper Core Switches

- Arista Long Range QSFP+/SFP Transceivers, 40 and 10 GB/s

sam
- IQMIX
- IQMADI
- Multiviewers
- Audio Shuffling
- Routing Controller
- Vision Mixer

harmonic
- Servers
- Encoders

Tektronix
- SPG/PTP Generator
- T&M

- Cameras

MEINBERG
- PTP Master Clock

STUDER by HARMAN
- Audio Mixer

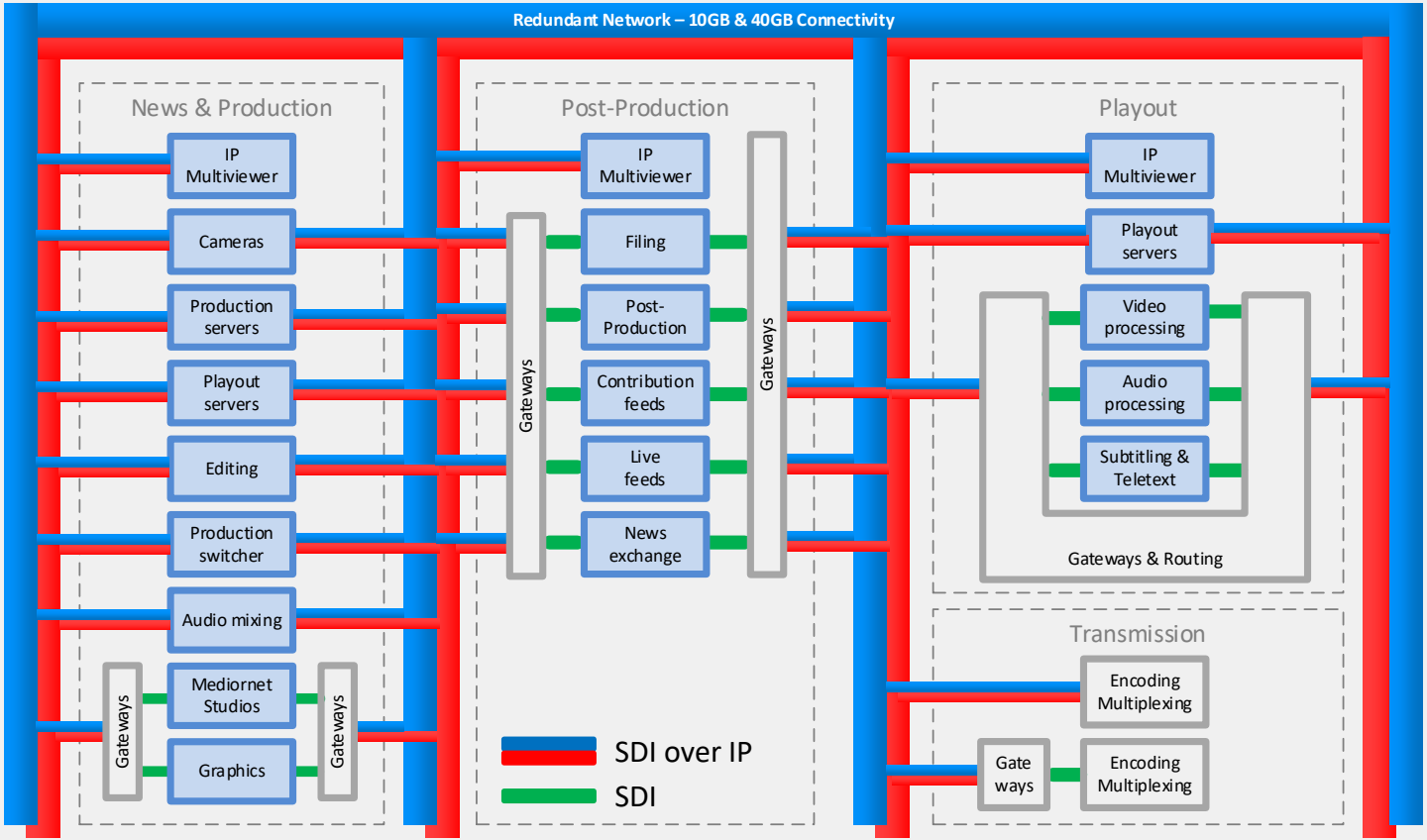
DHD.audio
- Radio Audio Mix & Routing

Our configuration in figures

Gateway devices	Ports	Configured as VSF TR-03	Configured Flows	Currently as VSF TR-04	# of Flows
163 Boards = 2608 Gateways	1104 Sources 1628 Destinations	2022-6	9888	2022-6	1200
		RFC 4175			
		VC-2			
		AES67 – 8 AES3		AES67 – 8 AES3	1300
		Meta			

CLT-UFA Multi-playout

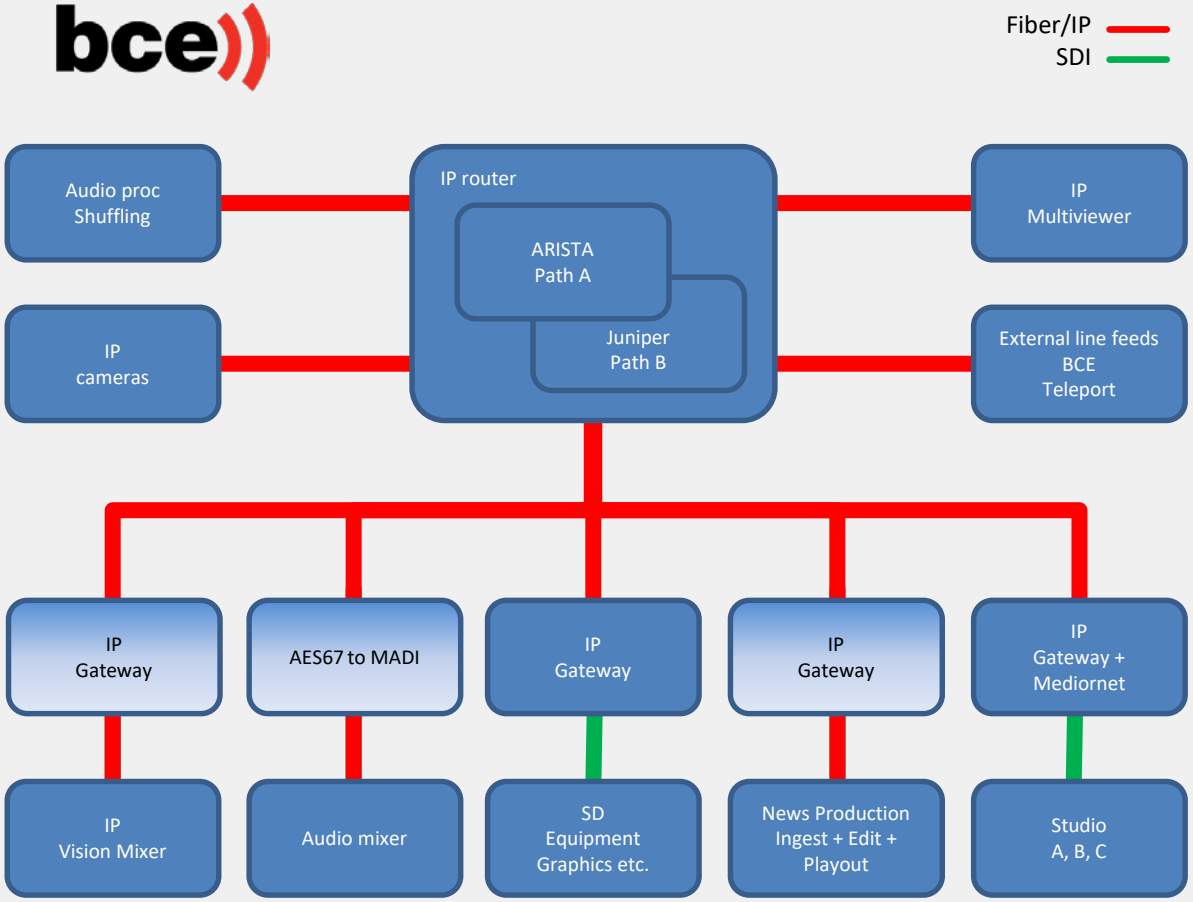
OVERALL SYSTEM OVERVIEW


Redundant Network – 10GB & 40GB Connectivity
News & Production
IP Multiviewer
Cameras
Production servers
Playout servers
Editing
Production switcher
Audio mixing
Gateways
Mediornet Studios
Graphics
Gateways
Post-Production
IP Multiviewer
Gateways
Filing
Post-Production
Contribution feeds
Live feeds
News exchange
Gateways
Playout
IP Multiviewer
Playout servers
Video processing
Audio processing
Subtitling & Teletext
Gateways & Routing
Transmission
Encoding Multiplexing
Gate ways
Encoding Multiplexing
SDI over IP
SDI

PRODUCTION SYSTEM DESIGN

News and Entertainment

Production (one of two)



IP World

Gateways

SDI and/or IP equipment (some interim)

PLAYOUT SYSTEM DESIGN

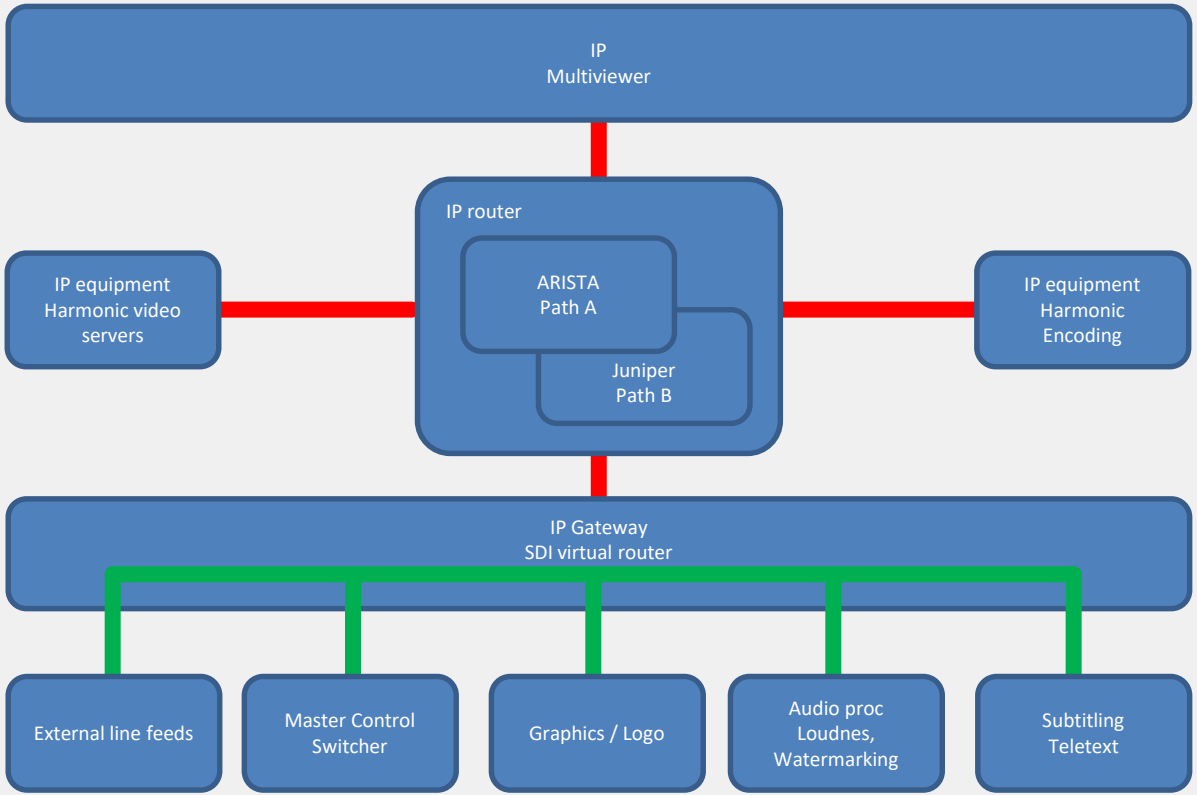
Decentralized control rooms

37 channels from Luxembourg

IP technology based Broadcasting center

- 36 HD channels and one UHD channel Broadcasted over Europe and abroad (France, Belgium, Netherlands, Singapore, Hungary, Luxembourg)
- 24x7 Monitoring
- Broadcast Services
- Digital Media Operations

CLT-UFA Multi-playout



Playout

One of 12 premium &

25 thematic channels

(1x 4k channel)

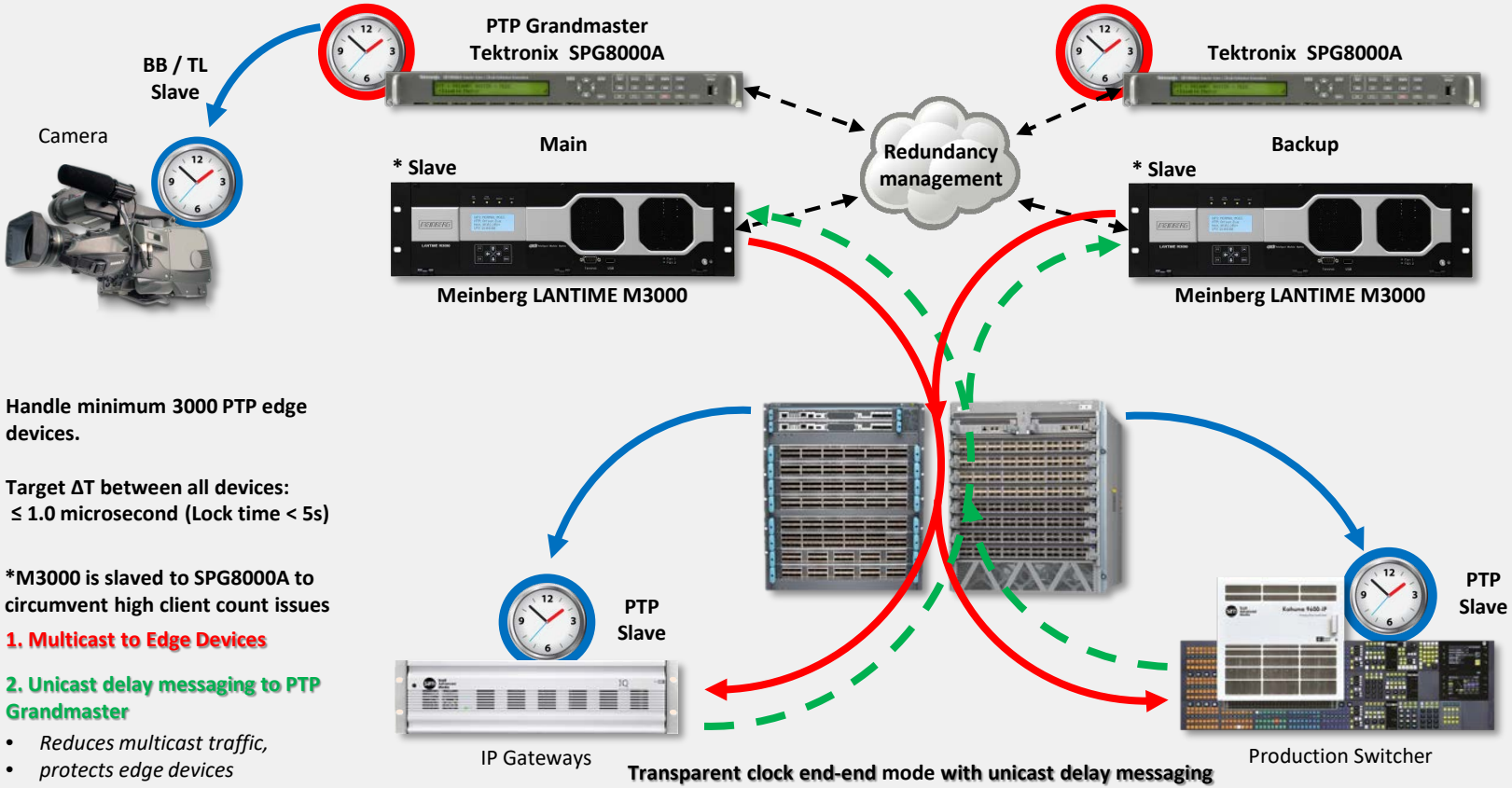
IP World

Gateways – Frame / one per playout

SDI legacy equipment

SYNCHRONISATION

ST 2110-10 (System Timing); SMPTE ST 2059-1/2; AES67



Handle minimum 3000 PTP edge devices.

Target ΔT between all devices:
≤ 1.0 microsecond (Lock time < 5s)

***M3000 is slaved to SPG8000A to circumvent high client count issues**

1. Multicast to Edge Devices

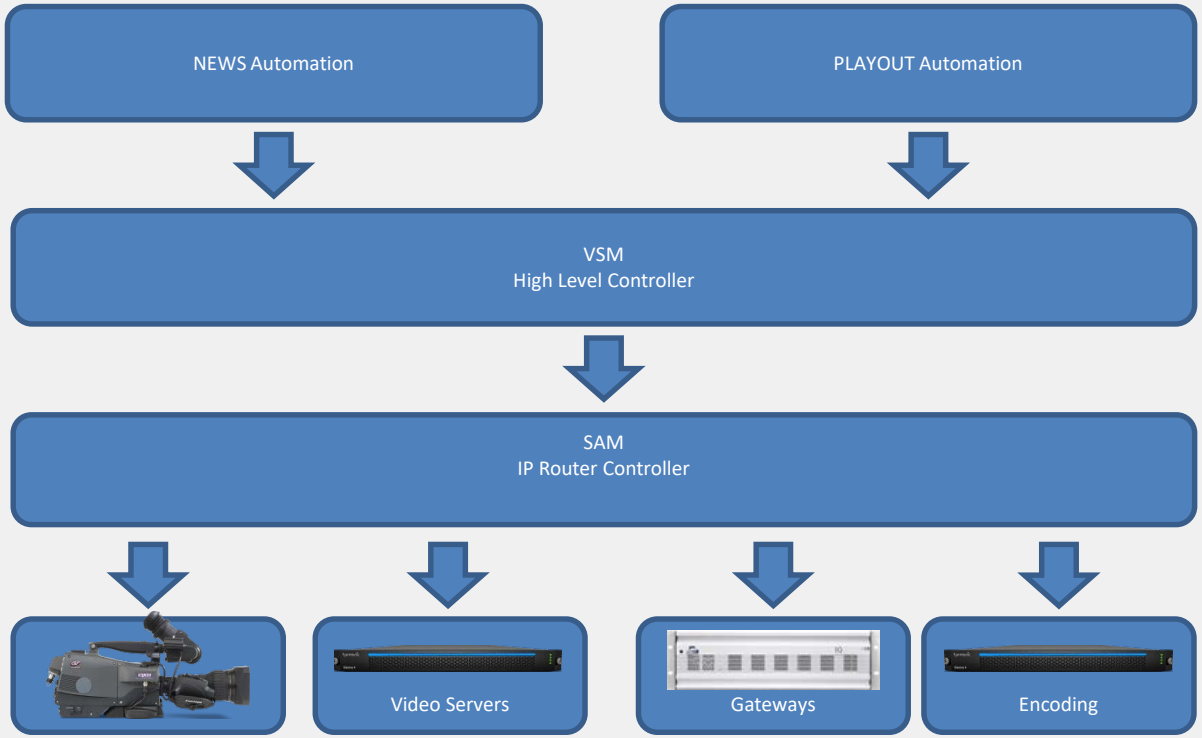
2. Unicast delay messaging to PTP Grandmaster

- *Reduces multicast traffic,*
- *protects edge devices*

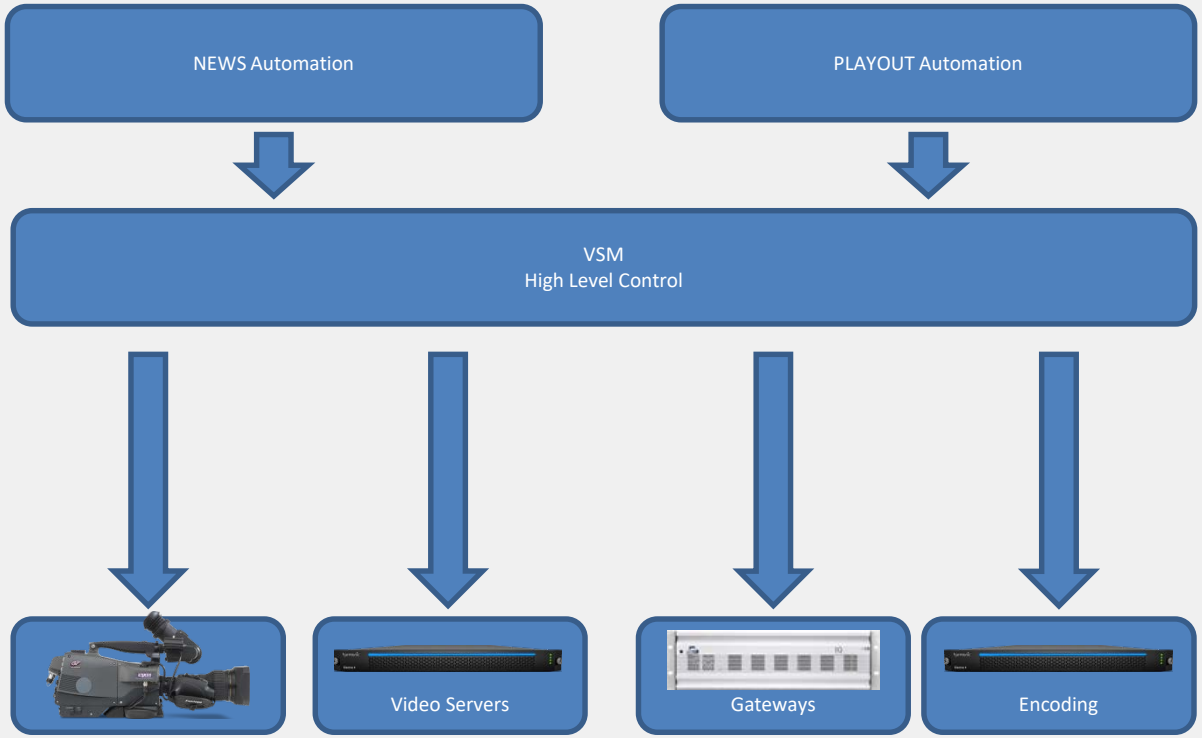
SYSTEM AND IP ROUTER CONTROLLER

Control Layers Today

Inbound Control



Target entire System Control



SUMMARY

Learnings, application hints, key findings

Learnings

- Two different vendors for the dual central switches. For hardware and software redundancy
- Data plan performance is an issue in case of different switch vendors
- Monolithic core network switches removes complexity as well as the associated blocking/hashing issues as for Spine/Leaf architecture
- Clean switching is not mandatory for most of the signals
- Do not underestimate the switch latency behaviour (IGMP3) for playout systems
- For emergency purposes and/or system upgrades, need for an additional concurrent IP router control solution
- Third party brands integration is still complex and time consuming
- Cost saving effect does not yet exist

Application Hints

- IP control systems can be single point of failure
- “Ghost” streams experience
  - Clean and safe interruption of flows is important
- Inbound control layer test using packet storm
- PTP distribution performance and scalability
- Fiber connectivity and QSFP’s
  - Requires an absolute clean fiber connectivity
  - Validate the QSFP quality with all your components (second generation at BCE)
- Don't underestimate the Flow allocation and the Network IP address and port design efforts
  - Several thousands of IP addresses assignment
  - No tools on market
- The compliance of the IP edge devices with respect to specifications or recommendations
  - Future proofed system
  - Establishing a link between devices is quit easy but for the new Discovery & Registration features, it is a must to be compliant towards the recommendations and specifications.
  - SDP for stream information
- Network latency
  - 40GB is smaller than 25GB and 10GB but jitter is worse
- Dante for radio
  - Dante network synchronization constraints

CLT-UFA Multi-playout

Key Findings

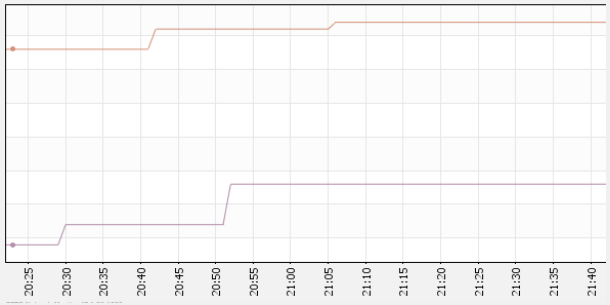
- Monitoring solutions do not really exist
- Test, PoC and then test again
- Design period is the most important and is very complex
- Skillset of Broadcast Engineer
  - Needs to be adapted (network knowledge needed)
- Installation efficiency - less cabling & quicker physical installation

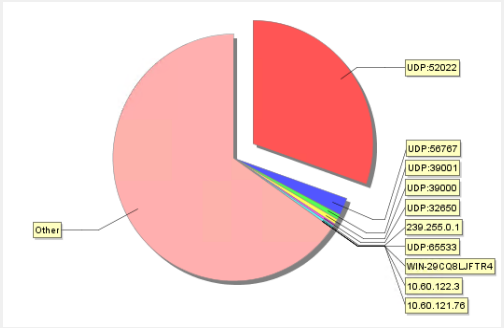
MONITORING

Tools used in our case

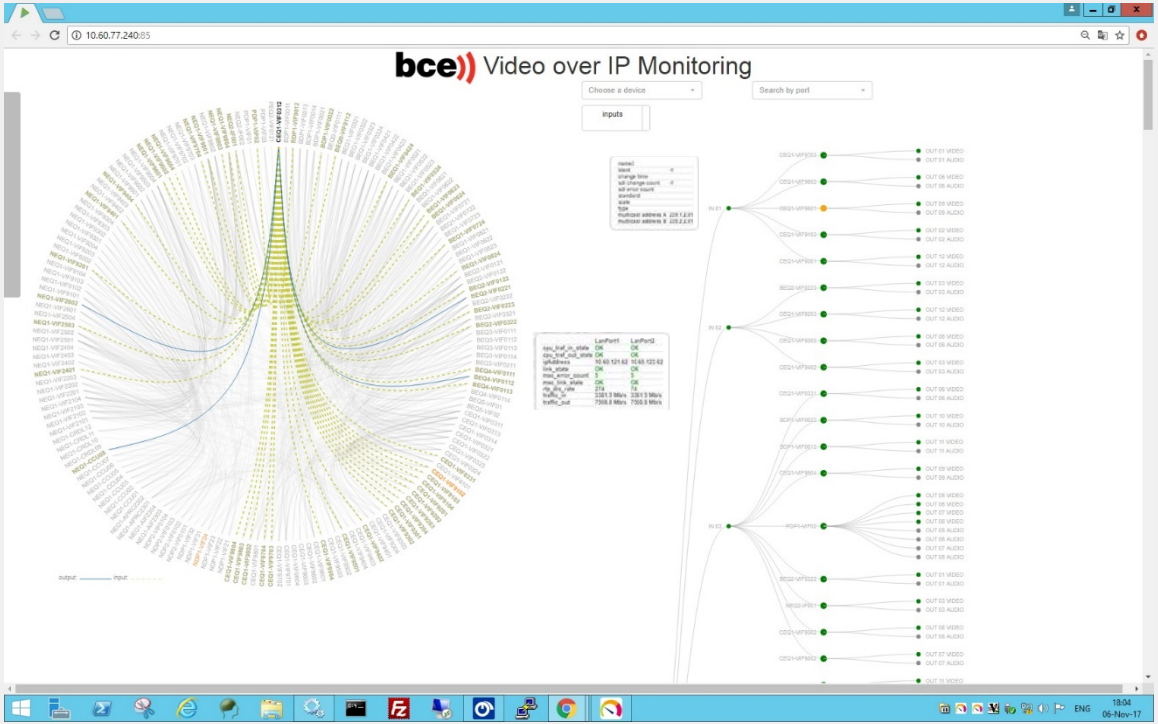
Monitoring

- DATAMINER and ROLLCALL (Alarms)
- PRTG, Syslog and sFlow (Logging)
- TIMEKEEPER (Timing Monitoring)





BCE Monitoring tools example



name3	
ident	-1
change time	
sdi change count	-1
sdi error count	
standard	
state	
type	
multicast address A	239.1.2.81
multicast address B	239.2.2.81

	LanPort1	LanPort2
cpu_traf_in_state	OK	OK
cpu_traf_out_state	OK	OK
ipAddress	10.60.121.62	10.60.123.62
link_state	OK	OK
mac_error_count	5	5
mac_link_state	OK	OK
rtp_dis_rate	274	74
traffic_in	3381.5 Mb/s	3381.5 Mb/s
traffic_out	7508.8 Mb/s	7508.8 Mb/s

THANK YOU

Patrick Bernard

patrick_bernard@bce.lu

SPARE SLIDES

Patrick Bernard
patrick_bernard@bce.lu

Switch latency example

	Stream Change Latency Factor	Device/Location	Typical Latency	Cumulative Latency	Minimum value	Maximum value	Constant / variable
1	Send source change command to IP router control system	Automation	<2ms	<2ms	1ms	2ms	constant
2	IP router control system sends command to Gateway	IP router control system	<2ms	<4ms	1ms	2ms	constant
3	Gateway send IGMP join	IQMIX	<2ms	<6ms	1ms	2ms	constant
4	Switch gets Join command	Switch	~2-26ms	<8-32ms (Note1)	2ms	26ms	variable
5	Switch sends source	Switch	<2ms	<10-34ms	1ms	2ms	variable
6	Core Network Latency	Switch/Network	<2ms	<12-36ms	1ms	2ms	variable
7	De-Jitter buffer	IQMIX	~4ms	<16-40ms (Note2)	1ms	4ms	variable
8	Gateway send IGMP leave command	IQMIX	<2ms	<18-42ms (Note3)			variable
9	Previous stream shut off	Switch	~5ms	<23-47ms			variable
					8 ms	40 ms	

1 Switch gets join command – We have taken this to mean the time taken for the network to converge after the IGMPv3 request – so if this is layer2, its snooping operation, or if layer3, then the SSM path needs to be built and pruned as necessary. The numbers quoted range from layer2 to layer3. [layer2 (faster) /layer3(slower)]"

2 De-jitter buffer. The size (and so latency) required here is lumped into our backend synchronisation function. We have pulled out here the pure jitter handling requirement, which allows us to re-align multiple streams (lipsync, switching video etc) and also to create continuous streaming outputs like SDI."

3 Depends on the mode – break before make is pretty much instantaneous, make before break will require to hand on to the stream until after the perfect clean switch has been implemented."