Case Study
RTBF in Belgium

FULL-IP OB TRUCK TIMES TWO

Also featured: An in-depth Look at the Flexibility afforded by Lawo’s C100 Blades
Executive Summary

In early April and September 2020, RTBF, Belgium’s public broadcaster for the country’s French-speaking community, took delivery of two groundbreaking, full-IP OB trucks. The 12m long trailers had to be configured remotely in order to be delivered on time, due to the covid-19 lockdown.

Perfect examples of how to leverage the flexibility of Lawo’s C100 FPGA blade, the OB Twins come equipped with a 100Gbps Arista-powered network core (audio, video and matrix) that revolve around Lawo’s V_matrix platform for SDI- and IP-based video and audio input/output as well as processing.

Lawo’s VSM talks directly to the XVS-8000 IP vision mixer using NMOS-IS04/05 protocols.

Each truck offers 36 vm_dmv heads delivered through C100 blades for multiviewing purposes. Overarching control and orchestration is handled by Lawo’s VSM IP control system and theWALL for multiviewer arrangement.

The OB Twins support all audio formats in two resolutions (24 and 32 bits), which are mixed using an mc² 56 audio production console and 512 DSP channels provided by Lawo’s A_UHD Core.

See right for a comprehensive list of Lawo products installed in and around RTBF’s full-IP OB trucks.

About RTBF

RTBF is the public Belgian radio and television organization of the Wallonia-Brussels Federation, an autonomous public enterprise with a cultural mission. Active in television, radio, on the web and social networks, RTBF is a 360° media player and the engine of expression and fulfillment for its audiences now and in the future.

As a public media service, its mission is to provide pluralist and independent information to the French-speaking community of Belgium (approx. 4.5 million people), but also to promote the community’s culture, heritage and talents, and as to ensure the transmission of memory.

Its mission is to entertain, educate and contribute to social cohesion as well as the development of local economies.

LAWO PRODUCTS DEPLOYED (in each of the two trucks):

- 21x V_matrix C100 (12x for streaming/gateway functionality, processing, glue and color correction + 9x for vm_dmv multiviewers: 36 head outputs, 210 video inputs)
- 2x V_pro8 (Dolby E encoding/decoding)
- 48-fader mc² 56 audio console, Nova 73 audio router core
- 2x A_UHD Core (main + redundant)
- 1x PowerCore in truck (local MIC preamps, line inputs/outputs, AES3, Dante)
- Audio stageboxes: 4x PowerCore + 4x LCU commentary, 1x DALLIS (pristine musical preamps)
- Video stageboxes: 3x V_matrix Silent Frame with C100 blades, 3x A_mic8 (additional audio connectivity + 8-channel GPI/O)
- VSM via separate network: overall stream routing, parameter control.
In early April 2020, RTBF, Belgium’s public broadcaster for the country’s French-speaking community, took delivery of the first of two groundbreaking, full-IP OB trucks. Due to the covid-19 lockdown, the 12m long trailer had to be configured remotely using TeamViewer, a few web cameras and microphones for confirmation purposes as well as via VPN. The second identical OB truck was configured by Lawo’s Jörg Mittag, Dave Leiveld and Andreas Hain in late August.

Open-standards-based IP technology is taking the broadcast—and the corporate AV—world by storm. One of its benefits is the convenience with which infrastructures can be configured and accepted remotely, with hardly anybody on site. Another is that social distancing and tight schedules of the most talented operators are no longer an issue.

Besides, thanks to ST2110 IP, distributed production scenarios are in the process of becoming the norm. Yet another benefit is the flexibility afforded by choosing the most malleable processors available.

Top-notch broadcast facilities all over the world have relied on Lawo for their productions for a few years now and confirm that ST2110-based IP is the future, not least because it allows for flexible tweaks to their workflows.
In the light of all this, RTBF’s decision to commission two identical full-IP OB trucks in 2019, when nobody even knew what “lockdown” meant, appears to have been far-sighted.

It was certainly in keeping with RTBF’s plans to equip its new broadcast center with an IP infrastructure, and to use its new OB trucks as additional control rooms whenever necessary.

Connecting the trucks to the facility’s network via IP is a simple matter of plugging a pair of optical cables into the right wall sockets. And turning the two trucks into one giant, mobile production facility for high-profile events is also a possibility.

But there was more: the significantly reduced rack space, weight and cable runs inside the trucks are excellent news for the environment, while the OB truck operators are at liberty to use the software-defined V__matrix units for a variety of applications, including SDI–IP gateway streaming, video processing, embedding/de-embedding, color correction, audio and video delay, multiviewers, audio shuffling, and audio processing.

Despite the massive processing power they house, the four racks inside RTBF’s full-IP OB Twins are still fairly empty. And only one of those racks contains Lawo’s V__matrix software-defined IP-routing, processing and multiviewing units.

Just in case you were wondering: the reason for commissioning two identical full-IP OB trucks is rumored to have been that RTBF’s management wanted to provide the same advanced infrastructure for two crews covering different events to avoid lengthy discussions beforehand…
Vital Statistics

RTBF’s 12m long OB trailers come equipped with a 100Gbps Arista-powered network core (audio, video and matrix) that revolves around Lawo’s V__matrix C100 platform for SDI- and IP-based video and audio input/output as well as processing.

They are based on the ST2110 suite of open standards provided by the Lawo gear they contain.

V__matrix and V__matrix Silent Frames for:
- Video,
- SDI-derived audio,
- Video and audio processing,
- Multiviewing (36 head outputs capable of displaying every incoming signal as well as 3 tally layers).

The audio section features:
- 48-fader Lawo mc² 56 Audio Production Console with a Nova 73 router,
- A redundant pair of A__UHD Core ultra-high-density IP DSP engines for mc² consoles (512 DSP channels each),
- Power Core I/O and processing nodes,
- A__mic8 audio edge devices.

Lawo’s VSM system (with support for NMOS-IS04/05 protocols) controls the V__matrix units, the vm_dmv multiviewers, the Sony vision mixer (in- and outgoing streams, tally information and label transfers) as well as all other devices and stream routings.

The 10 stageboxes (five 19” flightcases per truck) assembled for the OB Twins were designed for both outdoor and indoor use in studios and venues. The Power Core edge devices in the audio flightcases not only accept MIC/line and AES3 signals, but also support MADI and Dante—for direct sourcing from a PA system during concerts and other events.

“NEP Belgium’s and Lawo’s guidance was invaluable and provided the highest benefit for RTBF. We consider our two full-IP OB trucks the first building blocks of our future Media Square facility.”

—Cécile Gonfroid, CIO, RTBF
Example of the audio stageboxes built for RTBF’s OB Twins. Audio I/O and processing are provided by the Power Core.

For music applications, RTBF requested one DALLIS stagebox per OB truck because of the superior sound quality of its 48 microphone preamps and their exceptional 128dB signal-to-noise ratio. Each full-IP OB truck comes equipped with 180 microphone preamps per truck.

Lawo furthermore supplied six LCU commentary units that can be connected to the desired stagebox. All stageboxes are equipped with an Arista network switch that delivers power over Ethernet (PoE). Connectivity for Riedel Bolero antennas is also included. An additional Cisco switch has been installed for the distribution of VSM control signals.

One interesting aspect about RTBF’s OB Twins is that the audio received via the SDI inputs is also transmitted to the mc²56 audio mixer after being de-embedded, and that these audio streams are available in both the ST2110-30 and -31 formats (see also below).

The video stageboxes, finally, are each equipped with a V__matrix Silent Frame for SDI-to-IP gateway operation and an A__mic8 stagebox for flexible ad-hoc audio connectivity and GPI/O control. As stated earlier, audio can also be ingested via the SDI inputs.

Example of the video stageboxes built for RTBF’s OB Twins. The A__mic8 provides ad-hoc audio I/O accommodation and GPI/O connectivity.

“I very much enjoyed collaborating with the Lawo team on tailoring the solution to RTBF’s needs.”
—Geert Thoelen, Technical Director, NEP Belgium
On Your Marks…

RTBF’s full-IP OB trucks transmit SDI signals and IP streams to the outside world and can be linked to each other via a network connection, which turns them into one big control room compound.

The first truck was delivered on 4 April 2020 after having been configured and commissioned remotely. Due to covid-19, traveling between Belgium, the Netherlands and Germany had suddenly become impossible, while delivery in early April 2020 had already been confirmed, and was expected.

Lawo, NEP Belgium’s Geert Thoelen and Broadcast Solutions’ Matthias Hahn therefore suggested moving the acceptance tests and configuration tasks to the virtual realm, using a VPN connection to the OB truck. This approach had to be revised, because no viable VPN connection could be established.

As a result, Broadcast Solutions set up five computers running TeamViewer in Bingen (Germany). All virtual attendees had their own TeamViewer access. “VPN would have been faster, because we would have been able to insert the required data directly in the right places. But we nevertheless managed to accomplish what needed to be done,” comments Dirk Sykora.

This remote scenario required a dedicated computer to which all configuration files were transmitted, allowing the team to configure and test the OB truck from afar.

During this three-week stint, daily video conferences were held at 1pm where RTBF, NEP Belgium, Broadcast Solutions and Lawo reviewed what had been completed and what needed to be done next. This was necessary to ensure that everybody was moving in the same direction, which isn’t always obvious with teams scattered across several locations.

The remote acceptance scenario was greatly facilitated by the OB truck’s full-IP backbone. All devices and solutions were readily accessible to the configurators and RTBF operators in three different countries.
A Look at the End-to-End IP Network

IP Network Core

IP networks are based around switches—in the case of the OB Twins switches manufactured by Arista are used. Given the network’s relative complexity, one switch acts as “Spine”, i.e. a switch that aggregates the streams received from, and transmitted to, subordinate switches, which are called “Leaves”. The “STUDIO/FOP” Leaf switches are located in mobiles stageboxes for flexible deployment.

Audio Network

The audio signals ingested via the audio stageboxes (and possibly an A__mic8 in a video stagebox). The audio end devices accept analog, AES3, MADI and Dante™ signals, which are converted into streams and then mixed and processed. Both ST2110-30 (24 bits) and ST2110-31 (32 bits) are supported—in any combination.
The video network (pink devices) is based on the V_matrix platform whose C100 blades are used to generate multiviewer heads (vm_dm, “Multiviewer”), convert the SDI signals coming from the cameras into video streams (“Streaming”), and to provide video and audio processing. Video streams are essences that are transported and handled independently from audio essences (see left). This provides almost endless possibilities regarding video/audio stream combinations. Nevertheless, all features required by the OB Twins fit into 12 units of rackspace.

The V_matrix units in the video stageboxes are so-called “Silent Frames”, which are almost inaudible and can therefore be placed on the studio floor, close to the SDI cameras.

The control network (purple) revolves around Cisco switches. All devices in the OB Twins are managed by Lawo’s VSM virtual studio manager software that (re)configures the required devices and provides access to deep-dive editing at the press of an on-screen button. The control network—which also manages devices manufactured by EVS and Sony—is considered the heart of the OB trucks.
C100: The Ace of Blades

Both future-proof OB trucks are equipped with 21 Lawo C100 blades. These are FPGA processing units whose function is defined by the software that is uploaded to them.

Housed in V__matrix units, the C100 blades can be programmed to provide all functions requested by RTBF. They can be retasked at any moment simply by uploading different software.

The latter will come in handy when RTBF decides to replace the SDI cameras currently in use with IP models. The blades in charge of converting their SDI signals to IP streams will not become obsolete in the process: operators can simply use them for other tasks. This was one important reason why Geert Thoelen of NEP Belgium, who architected the OB trucks’ infrastructure, together with Dirk Sykora, was in favor of installing Lawo’s C100-based V__matrix units.

Initial Brainstorm

The entire IP system of RTBF’s full-IP OB Twins evolves around the power of Lawo’s C100 blades, which can be configured according to the customer’s needs.

While looking at the tender documents, NEP Belgium and Lawo already had a good idea of what RTBF would need, but they wanted to be sure to address all requests in the most effective way. After all, specifying boxes is only the first step for such a big project.

It was therefore decided to organize a one-week training/brainstorming session at RTBF during which Lawo presented and demonstrated the potential of the V__matrix C100 blade (depending on the V__matrix size, two or more such blades can be installed). This was deemed important to ensure that the RTBF task force grasped the numerous options provided by the C100 blades, and to keep configuration time to a minimum once everybody was clear on what was expected. “The C100 blade is so flexible that there are usually several ways of achieving a given result. All of us were looking for the most efficient solution for the project at hand,” observes Lawo’s Dirk Sykora.
Overview of the three software blocks inside RTBF’s C100 blades used for streaming and processing: PTP, Video and Audio. See below for details.
(Additional C100 blades are used for vm_dmv multiviewer generation.)

Considerations that played a part were: should RTBF use ST2110 or ST2022 streams, and would they need to accommodate Dolby E signals often used for satellite downlinks? This informed the decision to support both ST2110-30 (24 bits) and ST2110-31 (32 bits) audio, which is rather unusual. The reasons for this two-pronged strategy are detailed on page 14.

Explaining that a C100 blade is initially a blank page, or a box of Lego bricks that allow users to build what they have in mind, is always a good start.

While some blocks are mandatory, others are only needed for specific applications. Knowing which ones are required for the project at hand is always a great help.

Additional C100 blades, with a different configuration, are used for vm_dmv multiviewer generation.

I. PTP Configuration of the C100

Each C100 requires a synchronization path to a PTP clock generator. This means that a PTP Reception Agent needs to be created and assigned to a domain and a port to supply the blade’s system clock.

The next question is whether one or two PTP Reception Agents are needed. A redundant network requires two. In RTBF’s case, there is only one PTP receiver per C100 blade, because the OB trucks’ network is not redundant. This may change in the future, and adding a second PTP Reception Agent at a later stage only requires inserting this software-based functionality.

The PTP Agent is usually connected to a PTP Shifter to create video timing offsets against the truck’s clock.

Next in line is the blade’s PTP clock to which all video signals are synchronized. The System Clock block inside a C100 generates a timing reference for log entries. If no offset information is required, the System Clock is connected directly to the PTP Agent. Otherwise, it can be patched to the PTP Shifter block.
II. Video inside the C100

Similarly detailed explanations were given for two other important blocks inside each C100 blade: video and audio.

The video “section” consists of SDI inputs, incoming video streams (ST2110-20), video delay as well as a Color Bar and a Video Black generator, both of which are created internally by the blade.

These inputs are connected to a matrix where any signal can be routed to any destination. In RTBF’s case, the matrix sends out SDI signals and video streams.

The first 11 streams transport the received SDI signals as ST2110-20 streams to the network, the next three carry the output signals coming from the processing insertion blocks (color correction and video delay). These blocks can be freely assigned to any incoming essence (SDI or IP).

For the RTBF OB truck project, each C100 blade was configured to provide three such processing blocks. In other projects, up to eight color correctors are possible. RTBF uses:

- 1x C100 blades for streaming/gateway functionality, processing, glue and color correction (for a total of 36 processing blocks),
- 8x external stageboxes with V__matrix Silent Frames that handle streaming tasks.
- 9x C100 blades running vdm_dvr distributed multiviewers (36 head outputs, 210 video inputs).

Even though all installed C100 blades share the exact same configuration, the VSM control system has been programmed to only access the processing blocks of the blades inside the OB truck—not the ones in the stageboxes.

This was done for practical considerations: disconnecting (or not connecting) a stagebox also disconnects (or not connecting) a stagebox also

C100 CONFIG RTBF – Streaming blades 1-12

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Video Configuration

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III. Audio inside the C100

All audio streams inside the OB trucks had to be available in the ST2110-30 and ST2110-31 (for Dolby E) formats. Additionally, RTBF had expressed the desire to work with 8-channel audio streams, which made things slightly more complex.

ST2110-30 audio streams can be sample-rate converted where necessary. The provided SRC blocks are bypassed for Dolby E streams, because Dolby E does not support sample rate conversion.

The C100 blades furthermore contain a matrix for audio reshuffling, plus audio delay processing blocks for alignment with the video delay (in ST2110, audio and video essences lead separate lives).

As RTBF chose to work with 8-channel audio streams, while SDI uses 16 audio channels, an audio matrix block had to be included to split incoming 16-channel blocks into two groups of 8, which may require multiple signal splits and combinations.

As stated above, each audio input on the network is able to handle 24- and 32-bit audio. The reason why 24-bit operation needed to be provided is that EVS and Riedel devices require ST2110-30 (24 bit). V__matrix C100 blades as well as Lawo’s mc² consoles accept both ST2110-30 and ST2110-31 (32 bit).

VSM, the overarching broadcast control system used in the OB Twins, has been programmed to be destination-aware: depending on where an audio stream needs to go, VSM automatically selects the -30 or the -31 version. When an SDI signal needs to be routed to an EVS recorder, for instance, VSM automatically selects the associated 24-bit stream. For streams going to RTBF’s mc² 56 console, on the other hand, VSM picks the 32-bit variety.

Lawo also “built” an AV matrix into RTBF’s C100 blades that switches streams in groups of eight from any source to any destination: SDI inputs, signal generator on a variety of frequencies, etc. The audio contained in the SDI signals can be sourced from anywhere—even from the patchbay at the back of the truck, which provides 32 SDI inputs to which any desired output can be connected: feeds coming from a satellite vehicle, external feeds, cameras, audio signals coming from the stage during an event, etc.

The audio processor inserts programmed for RTBF’s C100 blades handle audio delays. In addition, each SDI input has its own delay setting.

The reason for accommodating Dolby E end-to-end is that RTBF wanted to keep all options open with respect to the source signals. One likely scenario, for instance, involves connecting a satellite truck to the OB truck's external patchbay. If that satellite feed transports Dolby E signals, the OB truck’s inputs need to be able to process them. Predicting where the RTBF crew will insert such signals is difficult, however. Hence the dual ST2110-30 and -31 scenario.
Intuitive VSM Control

All aspects and areas of RTBF’s OB Twins are managed by Lawo’s VSM broadcast control system, on a separate Cisco-based network (a so-called out-of-band control network).

VSM was chosen for reasons of tight integration, smooth support for the overall solution as well as for its proven IP track record. “Building panels and changing settings in VSM has become so easy in these OB trucks that one hardly needs to spend time on the server anymore,” observes NEP Belgium’s Geert Thoelen. (Most VSM functionality was programmed remotely, due to the covid-19 lockdown, and completed within a mere 15 days.)

Special attention has been devoted to making the software operations “under the hood” as transparent as possible. All VSM display pages shown here were custom-designed for RTBF’s IP OB trucks.

VSM’s “CCU” tab on the “Video XY” page (see left), for instance, allows operators to route the desired CCUs to the required destination (video mixer, etc.). Each CCU input provides GAIN controls that set the audio signal connected to the camera body.

In the blue strip to the right (see below), all of the selected source’s parameters can be set on-screen: Dolby E on/off, Frame Phaser on/off, Video Delay on/off, Audio Delay on/off, etc. Changes to the available parameters are indicated by means of orange LED indicators below the corresponding source button.

The “Visual Link” section provides at-a-glance information about the routings in effect.

Additionally, operators can create labels for each source and destination right on this page: no need to deep-dive into the parameter tree. Any label changes are immediately mirrored to all relevant sections: the Sony visual mixer, Lawo multiviewers, etc.
The “Panel Build” page (see right) allows operators to select an area inside the truck by pressing it, and to configure the VSM hardware panels of that area.

This allows operators to quickly change panel layouts without altering the truck’s basic configuration.

On the “Audio X/Y” page, operators can set parameters related to the mc²56 console, including the signal assignments to the monitor speakers, for which separate LEVEL controls have been prepared.

The “Status” page shows pictures of all C100 blades and other units. It can be used to check the status of each individual blade or device.

VSM furthermore allows to perform color corrections and to control the mc²56 console as well as the Nova73 router.

Thanks to this approach, the VSM control system in RTBF’s OB Twins is a sophisticated, highly intuitive remote control.
Other Devices and Control

The Sony visual mixer in each OB truck is connected directly to the Arista-based ST2110 spine/leaf network, as are the three EVS machines used for recording, play-out and slow motion. The latter are equipped with 10Gbps interfaces.

The tender documentation specified that vision mixer control was to be based on NMOS. As a result, the necessary IS04 and IS05 drivers were developed by Lawo’s VSM team to avoid back-and-forth conversions between Lawo and the Sony vision mixer. The EVS machines, on the other hand, are controlled via Ember+, because EVS was more experienced with that protocol.

The baseband cameras are connected via SDI to the CCUs, and from there to a V_matrix unit. As stated earlier, the SDI cameras will be replaced with native IP cameras at some point.

“RTBF’s two new OB trucks are among the most advanced on the planet. The ST2110-based approach has resulted in highly flexible tools for OB assignments of any scale.”

—Geert Thoelen, Technical Director, NEP Belgium