4K UHD HDR AND IMMERSIVE AUDIO LIVE STREAMING 2018 FIFA WORLD CUP RUSSIA FOR SAMSUNG SMART TVS APP

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ABSTRACT

This paper aims to present the experience, challenges, techniques and results obtained by Globosat, in partnership with Samsung Brazil, with live streaming 56 matches of the 2018 FIFA WORLD CUP in Russia for connected TVs with 4K UHD HDR and immersive audio.

INTRODUCTION

Globosat, in partnership with Samsung Brazil, live streamed 56 matches of the 2018 FIFA World Cup in Russia for connected TVs with 4K UHD HDR and immersive audio.

The agreement between the parties involved the live streaming of 4K UHD HDR signal produced by Globosat with immersive audio mixing and another feed with only the 4K UHD SDR 180 degrees central camera signal with international audio. In addition, VOD deliveries of 4K UHD HDR with immersive audio from the 56 games and 10 minutes highlights from each game were also contracted.

The 4K UHD HDR live production at Globosat consisted of audio mixing for immersive audio and SPORTV (sports channel) talents (announcer and sport analyst), branding and commercial insertions. The opening of the live streaming occurred 15 minutes before the start of the game and closed 5 minutes after the end of the game.

The technical specifications set for live streaming signals for the app were UHD 2160p @ 60Hz, BT.2020, HDR-10 with Dolby Atmos audio. At the beginning of the tests, the initial live stream delay in the app was about 2 minutes. After performance and quality adjustments, like bit rate and chunk sizes, the delay dropped down to 18 seconds and then three transmission profiles were defined.

Regarding VOD, time to deliver the full video to the consumer was assumed to be 12 hours after the end of the match, but the average time taken to do all the operation needed was about 1 hour after the end. Already for the delivery of the 10 minutes of best moments, the initial agreed time was 3 hours after the end of the match, but this delivery was able to be done immediately after the game.

CONTRIBUTION CHAIN

The signal transport requirements from the International Broadcast Centre in Moscow to Globosat TV headquarter consisted of 2 (two) 4K UHD TV contribution feeds (IDs A and B).

The A-Feed transported the 4K UHD program coming from Globosat's premises at the International Broadcast Centre in Moscow. This feed's specs were 2160p/50, BT.2020 including HDR and WCG (Wide Color Gamut). Distribution standard at International Broadcast Centre in Moscow was 4x3G-SDI, 2970 Mbps, SMPTE-424M (Level A) with 16 embedded audio channels (as 8 AES/EBU stereo channels in Group 1-4, SMPTE-299M). The UHD-HDR signal was distributed in 2-Sample Interleave method (2 SI) and the standard for the optical electrical transfer function (OETF) was S-Log3. The encoders were equipped with auto-sense capability to change from 59.94Hz to 50Hz videos.

The ID B-Feed transported the Virtual Studio Backdrop Feed (180º UHD camera) coming from Globosat's premises at the International Broadcast Centre in Moscow. This feed's specs were 2160p/50, UHD SDR. Distribution standard at the International Broadcast Centre in Moscow was 4x3G-SDI, Quad-link, 2970 Mbps, SMPTE-424M (Level A) with 16 embedded audio channels (as 8 AES/EBU stereo channels in Group 1-4, SMPTE-299M). This signal was converted to 2-Sample Interleave method (2 SI), through Sony HDRC4000 converter. As at the other feed, the encoders were also equipped with auto-sense capability to change from 59.94Hz to 50Hz videos.

The Main Contribution Feed (ID A) from International Broadcast Centre in Moscow to HQ Globosat was transported compressed with H.265 encoders at 120 Mbps total bitrate (video + audio + headers).

The Secondary Contribution Feed (ID B) from International Broadcast Centre in Moscow to HQ Globosat was transported compressed with H.265 encoders at 80 Mbps total bitrate (video + audio + headers).

For these two Contribution Feed, there were 2 (two) dedicated sets of encoders with aggregated ASI output, with at least two ASI outputs, each one with full 4K content. Each ASI output was connected to 2 (two) Media Gateways in the International Broadcast Centre in Moscow. This means, one ASI output to Media Gateway #1(MG-1) and one ASI output to Media Gateway #2 (MG-2).

The decoding of these feeds was done in Globosat HQ. As we can see in Figure 1, the Media Gateway #3 (MG-3) in Globosat delivered the ASI outputs to 2 (two) decoder sets. Each decoder set provided a SMPTE-424M (Level A) 2160p/50Hz 4K UHD output signal (4 x 3G-SDI signals). Was considered a single Media Gateway in Globosat, but with hitless switching 'Gaggioni (1)' between the routes.
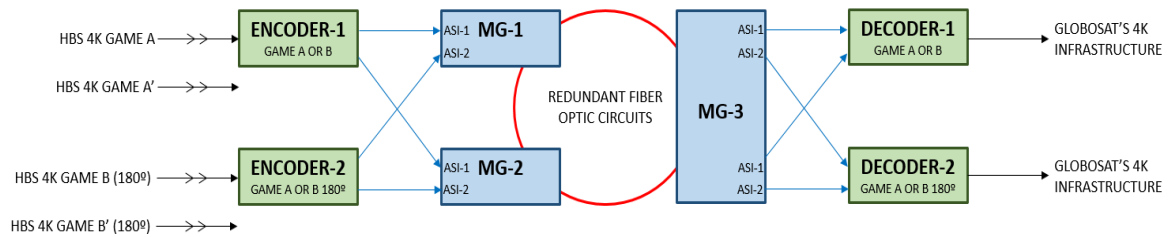
Figure 1 – 4K UHD Contribution Feeds from International Broadcast Centre in Moscow to Globosat HQ

PRODUCTION CHAIN

To do the production of this 4K event, Globosat has built a brand new operational area, including a new control room called internally CTRL-2, using the technology available on the market at that time 'McCaskill (2)'. The production workflow can be seen in Figure 2 below, and a picture of the Operational room with audio mixer can be seen in Figure 3.
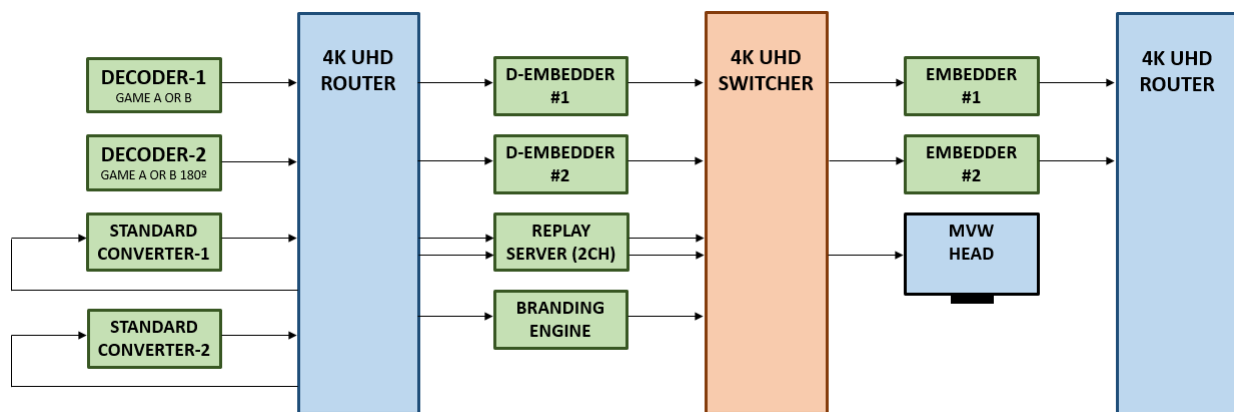

Figure 2 – 4K UHD Production Globosat

At the beginning of the operational workflow, we used two Standards Converters, one to A-Feed and the other to B-Feed, so that in case of a fail, the A-Feed had priority in use of B-Feed contribution chain as redundancy. This was necessary because of the TV frequency pattern used in Russia being different from the one in Brazil.

As the B-Feed had no audio processing, the next step was to deliver the A-Feed to the 4K UHD Switcher through two D-Embedders (main and backup) which were also in charge of delivering the audio to the Dolby Atmos audio mixer. The Replay Server shown in the figure had the task of making the 10 minutes highlights of each match as well as the final VOD version of the entire PGM. The audio Conceptual Diagram is shown at Figure 4, and the

Figure 3 – CTRL 2 Control Room

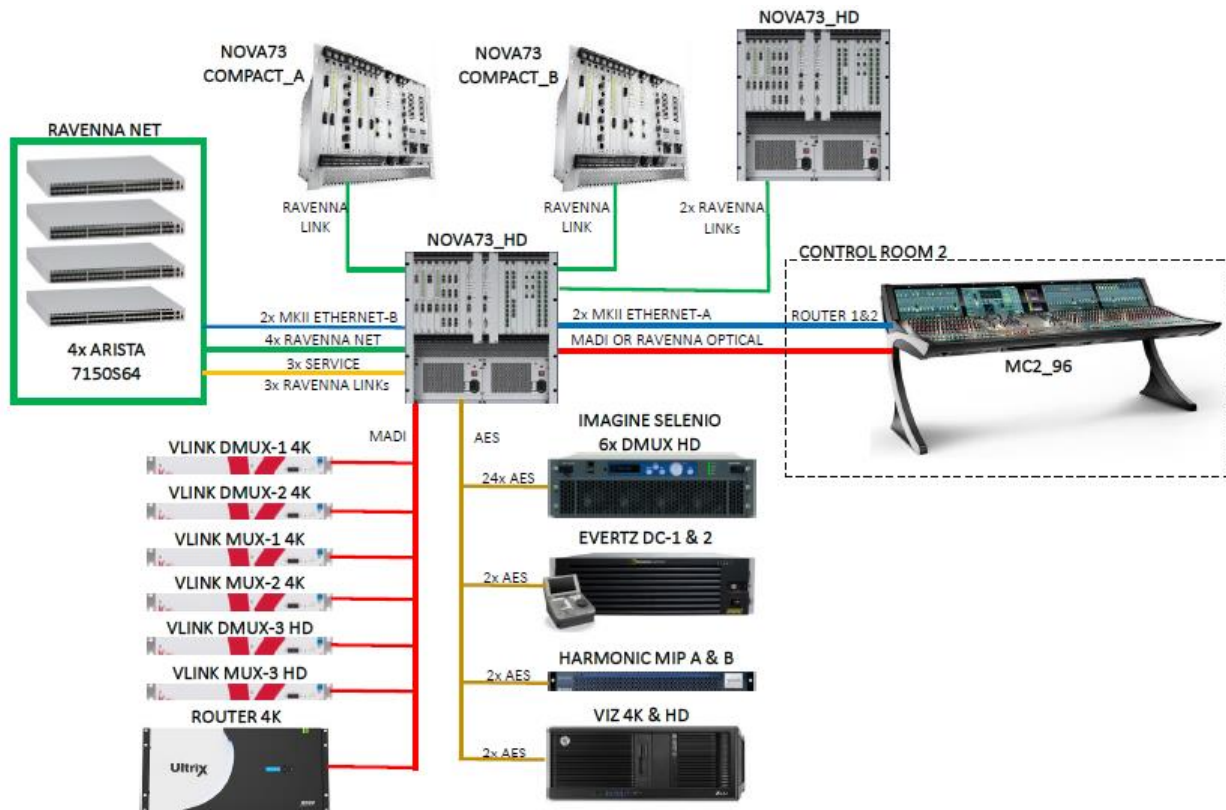Audio Feeds Overview as it came from International Broadcast Centre in Moscow can be seen in Figure 5.

Figure 4 – Audio Conceptual Diagram

UHD Embedded Audio channels

Vision	Channels	Description	Format	Availability	
				Venue	IBC
UHD HDR	1 + 2	5.1 Bed L/R	5.1 bed/MCIS		x
	3 + 4	5.1 Bed C/LFE	5.1 bed/MCIS		x
	5 + 6	5.1 Bed Ls/Rs	5.1 bed/MCIS		x
	7 + 8	4.0 height Lf/Rf	4.0 height object		x
	9 + 10	4.0 height Lr/Rr	4.0 height object		x
	11 + 12	Stereo Fan Corner L	Stereo object		x
	13 + 14	Stereo Fan Corner R	Stereo object		x
	15	English Guide Commentary	Mono object		x
	16	Stadium PA Announcer	Mono object		x

Figure 5 – Audio Feeds Overview

As we can see at Figure 4, the infrastructure to do the Dolby ATMOS becomes large, especially because the immersion effect's driver is directly related to the number of channels delivered to the consumer 'Silva (3)'. We worked with sixteen audios as described in Figure 5.

The partnership with Dolby in this process was decisive. They were involved from the beginning, supporting us with all the configuration and setup of the Dolby infrastructure and they also suggested operational guidelines for our audio professionals to correctly mix the audio objects and assure a good downmixing for non-enabled Dolby ATMOS audio monitors.

At the end of this production chain, we used two embedders with the task of combining the audio and video for delivery to playout and the Dolby Atmos Encoders.

PLAYOUT & TRANSMISSION

The 4K router was shared between Production, Playout and Transmission, so it was easy to administer the signal deliveries.

The equipment involved in this chain, can be seen at Figure 6. We made use of our regular automation system, acting in Playout Servers 1 and 2, to trigger the advertising breaks at half time. During the live game, the signal coming from the Embedders just passed through the Playout Servers to then be delivered to the rest of the process. The branding and logo were also provided by the Playout Servers, under automation control.
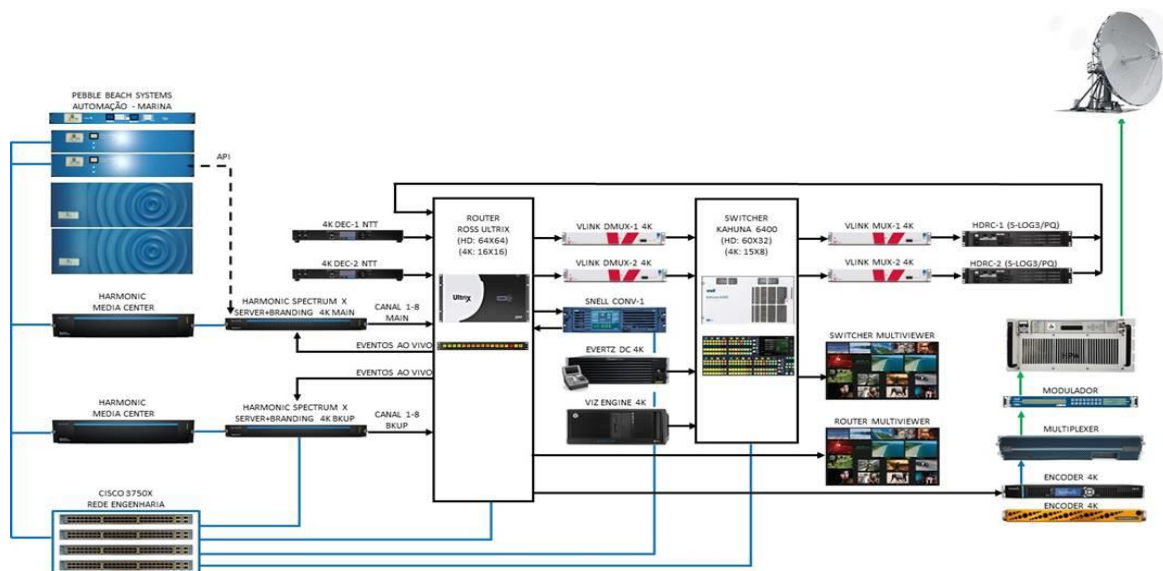

Figure 6 – 4K UHD Playout & Transmission

Following this process, we did Dolby Encoding and UHD HDR conversion. The challenge at this point, was the need to convert the HDR curve from S-LOG3 to HDR10. We choose S-LOG3 curve to be used as the "main" curve, because it had the intrinsic ability to derive other curves 'Gaggioni (4)', if necessary, with minimal loss of quality. It was the case of HDR10 curve used by Samsung displays.

Four encoders were used at the end of Transmission process. It's not the focus of this paper, but A-Feed was also delivered to Cable and DTH operators in Brazil, so a separated set of encoders were necessary.

Three profiles for each Feed were delivered to the Samsung App: 2160p@15.2Mbps, 1080p@8.5Mbps and 720p@3.5Mbps. The Dolby Atmos was delivered at 448Kbps.

One big challenge at this stage, was related to the highlights and complete PGM delivery. To fast track these deliveries, we used the Replay Server as a baseband generator, so, during half time, the first half of the match started to be delivered to VOD and right after the end of the match, we delivered the highlights and the second half of the match. This simple operation allowed us to efficiently deliver the highlights almost immediately after the match and the entire PGM less than 1 hour after the match end.

APP

The App was developed using HTML5 and which we chose to outsource. The decision was based on the good offer of companies with background in this area in Brazil and the short timeframe that we had at that time.

The biggest challenge that we faced, was to deliver 4K live feeds with reduced latency and in case of VOD, the shortest possible publishing time. Speaking of football in Brazil, no viewer likes to watch games knowing that his neighbour is watching the same game with seconds in advance of them and worst of all, knowing that his neighbour will scream "goal" before he has seen the scene. With that in mind, latency could be a serious problem.

The APP had the proposal to deliver more than a regular football match. It would provide an immersive experience at high resolution, so we knew that a minimum latency value would be acceptable by the consumer and we worked to make this as small as possible during the testing phase and the final delay after the fine tuning was 18 seconds.

Another minor but very important challenge was to maintain the video feeds and app data synchronized during the use by the consumer. We knew that a small failure in this case, could decrease the viewers confidence in the APP. By monitoring the social media comments about the operation, we had positive feedback about this. About the GUI of the

APP, it was designed to have clean and smooth use of the remote control of the TVs. Figure 7 below has a screenshot of the GUI. Figures from 8 to 11 show statistics from the event.
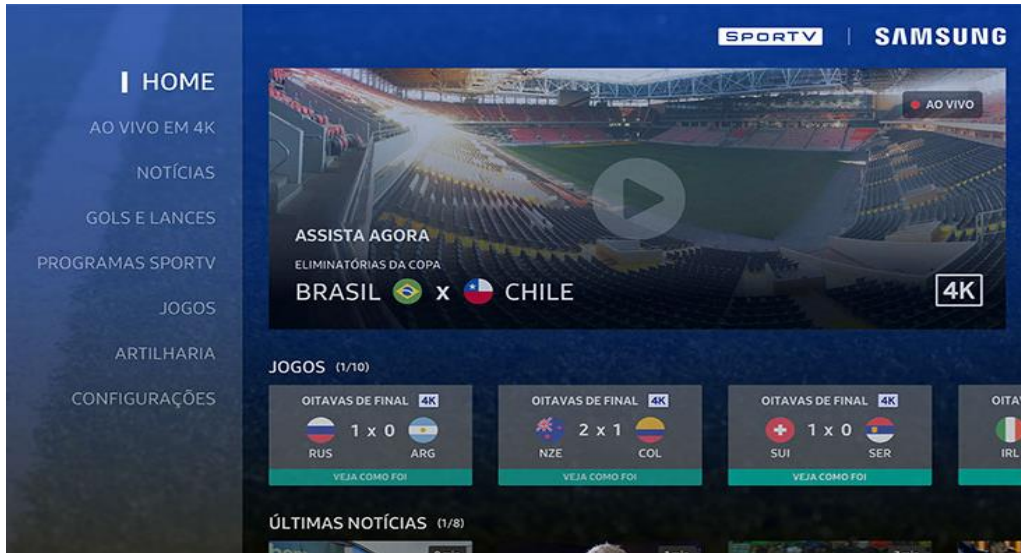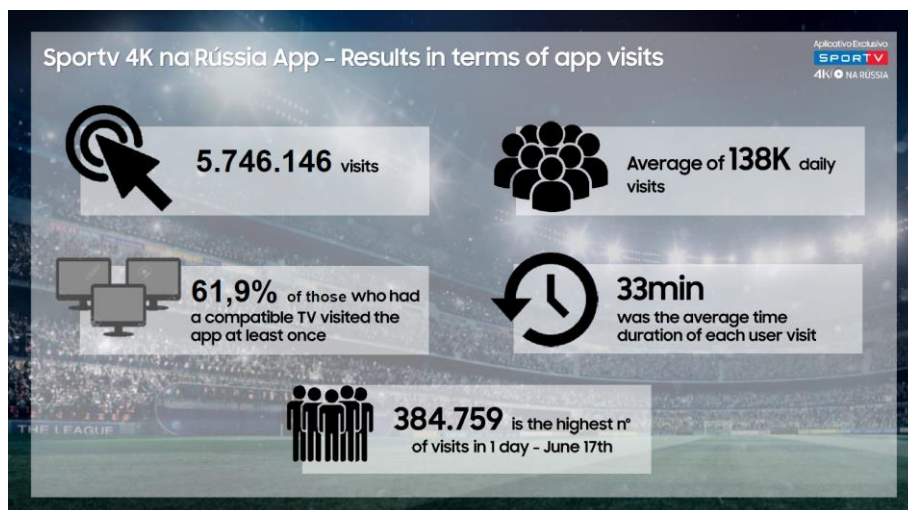

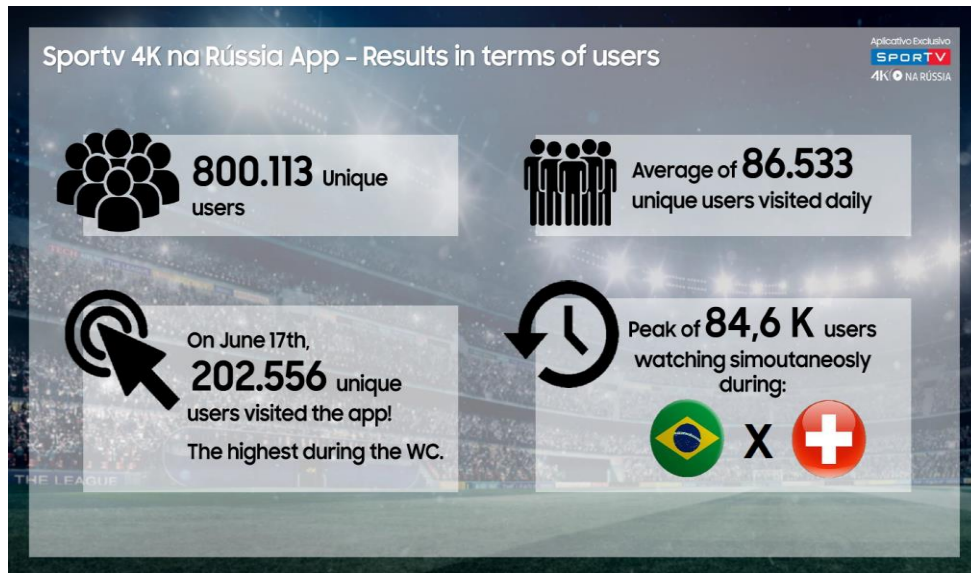Figure 7 – Home of App GUI

Figure 8 – App visits

Figure 9 – App users

Figure 10 – App content usage

Figure 11 – App consumer´s interactions

CDN

Globosat is a member of Globo Group who has a CDN in Brazil, called Globo.com. To deliver the Live Stream and the VOD content, we used one private dark fibre between Globosat and Globo.com.

The encoders that we used, delivered the Live Stream for each of the three profiles for both Feeds (A and B), using HLS protocol to an Origin Server and a Packetizer located at Globo.com. For this live ingest we have adopted HLS with 1 second segment length. This choice was motivated by the reliability of this HTTP based protocol.

At the distribution side HLS was used because of the expected higher complexity to configure MPEG-DASH to work using HTML-5 used by the APP, as it is not native on DASH 'MDN (5)'. Also, we noticed that the native Samsung player had some issues with DASH and because of the delivery deadline we decided to focus on HLS. A series of tests and tuning were performed until we reached the best configuration to balance quality and latency. For instance, to avoid buffering on the screen we had to set the chunk size to 2 seconds. Even if our wish was to have a 1 second chunk size for a smaller latency.

For the expected amount of connected simultaneous users, a CDN to CDN connection from Globo.com to Akamai Technologies was made. So, when a user requested a connection, the Akamai CDN backed the Globo.com origin server.

The ingest of VOD materials was done by FTP transfer connected to an Encoding Factory cluster at Globo.com. To reduce the delivery time, we ingested the best moments of each game using a solution called 'VOD Ingest Live'. During the game the instant replay operator built the whole clip, before being generated in real time using a live encoder. This equipment was connected directly to an Aspera solution ingesting in near "real time" on the platform.

Using this solution, the highlights were available on the app by 30 minutes after the match end.

For the full match VOD product, the whole game was available after a couple hours because it was using a traditional offline file transcoder workflow.

ADJUSTMENTS

During the Rio 2016 Summer Olympics Games we delivered 56 live streaming channels and we learnt a lot of lessons at that time, that were very useful for the 4k Samsung APP delivery. Even with this experience, a lot of testing and fine tuning on the full production chain was necessary to reach the SLAs agreed with Samsung.

Several adjustments were necessary to deliver the right HDR curve, Dolby Atmos mixing, latency fine tuning, the choice of best bit rate for each profile, APP development and CDN transmission protocol definition and integration.

The involvement of the professionals from internal teams, Globo Group and our partners, especially Samsung, Dolby, Lawo and AWS Elemental, helped us to pass successfully from the adjustments steps to going live.

RESULTS

Brazilian broadband speed is improving, but even with 4K live streaming being mature it is still not plug and play. Brazil has a vast geographic area to cover and different realities regarding internet bandwidth and quality.

In this scenario, the realization of a project of this type was not only a question of internal engineering, but a matter of taking risks, especially regarding the capability of delivering the final product, which was 4K live streaming, to everyone who bought a Samsung TV with the core intention to use the APP to watch the FIFA World Cup.

Almost two thirds of those who had a Samsung compatible TV visited the app at least once; there were over 5 million visits with a daily average of 138 thousand; more than 800 thousand unique users with a visit daily average of more than 80 thousand and average time online of 33 minutes of use per visit. On June 17, 2018, we had almost 400 thousand visits to the app, with 200 thousand unique users. The maximum peak of simultaneous users was about 84 thousand in the game of Brazil vs Switzerland.

Samsung Brazil used a very interesting marketing campaign this time, where the exposition of Globosat Sports Channel brand, called SPORTV was used to invite consumers to buy a new 4K TV. This kind of association, between top brands, is always good for both parties and looking into the achieved results, the described operation was very successful.

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