Infrastructure for Live Broadcasting – State of Play and Future Challenges

A White Paper from
eco – Association of the Internet Industry,
prepared by the eco Competence Group Networks

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Content

Executive Summary

- **What is the impact of a major international sporting event on Internet traffic flows?**
- **What are the infrastructure challenges for delivering live sporting coverage via streaming?**
- **How do fans use second screens during international tournaments?**
- **How can providers offer their end-customers the best of both worlds when it comes to sport viewing pleasure?**
- **When will it be possible to have a fully immersive VR experience of live sporting events from the comfort of your own home?**

Consumption of non-linear television programming (for example, streaming or Video on Demand) is growing constantly. Use of video online has increased massively over the past few years, driving traffic growth in global networks and demand for high-speed Internet connections.

Sport, in turn, is a driver of live streaming, and a playing field for innovative technology trends. Recent years, for example, have seen more and more sporting events being live-streamed over IP – and some of these have not even been made available via traditional broadcasting signals.

Signals coming from any kind of device – ranging from the smartphone through to fully-fledged TV rigs – can be incorporated into the broadcast signal. Conversely, viewing habits are moving away from a simple television screen – viewing on the go via mobile devices, or consumption using multiple screens, to watch, replay, research, and tweet. User behavior is evolving, and this will transform the broadcasting industry as a whole.

Worldwide, bandwidth, access to fixed and mobile Internet, and satellite broadcasting signals vary drastically. And as the end-user technology continues to evolve, with UHD TV and VR on the horizon, accessibility and availability need to catch up fast.

This paper examines the current and future trends in consuming live broadcasting and the impact of this and emerging hardware and protocols on infrastructure and bandwidth requirements, providing forecasts and potential solutions for infrastructure providers.

Infrastructure for Live Broadcasting – State of Play and Future Challenges: Introduction

Usage of video online has increased massively over the past few years, and video is a major driver of traffic in global networks. Consumption of non-linear television programming is growing constantly.

Sport, in turn, is a driver of live streaming. As the trend towards consumption of live broadcasting via IP increases, so too do the demands on infrastructure and, not least, on broadband. One example of the growing interest in live streaming of sports was the 2017 IHF Men's Handball World Championship in France in January 2017, for which full live broadcast was only available in Germany, for example, via the official IHF website, and not via traditional broadcasting channels.

Sport footage is increasingly coming from very diverse sources using different formats and protocols, and end-users are consuming sport on a variety of connected devices, making interoperability a key issue in both the contribution and distribution side of live broadcasting.

As a result, the infrastructure demands for live broadcasting is a topic which the Working Group Networks at eco – Association of the Internet Industry has made a focal topic.

This paper presents the current and future challenges for networks in dealing with the changing media landscape. The focus of this paper is on the distribution side of the broadcasting value chain, looking at how user behavior and new broadcasting formats are driving changes in traffic, and what network operators need to be prepared for in the coming years.

The insights are a synthesis of the presentations and discussions at the event "After the Euros and the Olympics – Infrastructure for Live Broadcasting" in September 2016 in Frankfurt am Main, Germany at DE-CIX.

Klaus Landefeld, Board Member for Infrastructure & Networks, eco – Association of the Internet Industry

Trends, innovation, and the resulting broadband requirements for live streaming

Innovations in hardware at both the contribution and consumption ends of the spectrum are opening up new possibilities for viewing and experiencing live events. Sports are one of the main drivers for content for 8K streaming.

However, one major challenge for live streaming currently is bandwidth. Looking at broadband and IP broadcasting offers in international comparison, the differences are immense. While large regions in emerging markets, for example, on the African continent, remain almost completely without fiber connectivity, Japanese broadcasting networks today are already offering 8K HEVC broadcasting for sports and news events, with bandwidths of 400 Mbps.

In Germany, on the other hand, the public broadcasters ARD and ZDF claim on their online "Mediathek" that "certain broadcast programs are already being made available as HD streams. However, unfortunately it is currently not possible to offer a continuous HD livestream. Internet Service Providers are unable, as a rule, to make sufficient bandwidth available for this purpose" (retrieved from **http://www.daserste.de/specials/service/faq-das-erste-livestream-100.html**, April 2017). And this is despite the fact that they are only streaming at 2.5 Mbps.

Although HD streaming for YouTube has more modest requirements, 4K streaming requires a minimum recommended bandwidth of 15-25 Mbps, with 35 Mbps suggested as ideal. In Germany, 30% of households currently have Internet connections capable of supporting 15-25 Mbps, while another 30% could not order them even if they wanted to.

Looking at video compression from the contribution perspective, HD requires a minimum of 9 Mb (for news), but at least 15 Mb for sports, going up to 60Mb in MPEG4 format. While standards like HEVC may offer greater compression efficiency, the use of the format for 4K and 8K content means that, despite compression, the bandwidth requirements continue to increase.

Looking ahead, UHD is on the horizon, and this will require 120 Mbps. The availability of UHD TVs and the emerging 360° video formats will require vastly increasing amounts of bandwidth. There have been a range of advances in combining VR and live streaming of sporting events, like the test broadcast of a friendly football match between France and Russia in March 2016, in April 2016 it was the Masters Golf Tournament, and then the broadcast and replays of the American NBA series, starting in October 2016. And it's not only the introduction of 360° camera that is enabling the trend: video stitching software also allows multiple independent feeds – like spectators located at different vantage points within a stadium – to be combined into an immersive broadcast experience.

But all this requires bandwidth. Carriers surveyed in Q2 of 2016 forecast average download speeds demanded by German customers of 170 Mbps in 2020, jumping to 400 Mbps by 2025, and this growth is being driven by video. In contrast, in Asian markets, networks are in the process of upgrading from 1 G to 10 G, in order to meet the bandwidth demands.

The technologies to transform the viewing experience largely already exist. However, developing this into a commercial model of broadcasting remains currently unfeasible, as the audience does not yet exist. A critical mass of end-users with VR headsets would be necessary to make such offers financially viable. Autostereoscopic technology could change this, though – allowing a 3D experience without the inconvenience of needing glasses or headsets. But this would require the wide availability of 8K content – and that means a minimum of 260 Mbps.

Challenges for networks

One challenge on the contribution side today is the enormous range of different styles and qualities of transmission that are becoming available to inject content into networks, ranging from user-generated content from a GoPro, smartphone, or an inexpensive mobile backpack, through to the aforementioned 360° video.

The challenge for network operators on the distribution side is to introduce new services fast, keeping up with new formats as they increasingly rapidly emerge, scaling with usage growth as user behavior shifts, ensuring end-to-end provisioning and monitoring, as well as dealing with the current trends in virtualization of network elements, like SDN, NFV, and Cloud.

Dr. Thomas King, CIO, DE-CIX

Impact of live sporting events and user behavior on traffic over an IX

Analyzing traffic flows over public Internet Exchanges and relating the findings to real world events offers insight not only into the demands made of Internet infrastructure in different contexts, but also into the user behavior driving these demands. This, in turn, can help to support the forecasting of future demands on the public Internet.

International sporting events offer just such an insight, as they have relevance and allow a comparison across a range of countries with varying access to connectivity. Here, we look at international soccer tournaments, most specifically, the 2014 World Cup.

Starting by looking at a more recent tournament, the DE-CIX Frankfurt Internet Exchange recorded no discernible change in traffic flows during any of the European Cup games in the summer of 2016. This could be attributed to a number of causes – that the games were largely viewed via traditional media; that streaming in itself is becoming a more popular pastime, so many of the viewers may have been streaming another program at that time anyway; or that the traffic flows over the DE-CIX exchange are so enormous that it takes a much bigger, more global event to have an impact (like the release of iOS 10, for example, which resulted in a 5.5 Tbps peak in September 2016). Even so, the more global Soccer World Cup in 2014 also showed no discernible impact on the DE-CIX Frankfurt Exchange. But if the DE-CIX exchange is taken out of the equation, then it is possible on other exchanges to see an impact on the traffic for some of the World Cup 2014 games.

Looking at the traffic in different locations on several days of play, certain conclusions can be drawn. There seems to be less usage of streaming services to watch important national or regional games – games that locals are more likely to watch via the television broadcast signal (perhaps at one of the large outdoor public screenings that have become popular in recent years). As a result, it is possible to see dips in Internet traffic during national games within the respective country, and then – especially in the case of a win – an elongated drop after the end of the game. This was seen on the AMS-IX Amsterdam exchange for the Dutch team's win over Spain, and was visible as a massive drop in traffic on the Sao Paulo IXP PTT Metro for the game Brazil vs. Cameroon. The assumption which can be made here is that a large number of home-team viewers watched these games on TV, and then celebrated the win after the game, without recourse to the Internet. This in turn meant less use of the Internet for other entertainment during this time.

Although there was no impact on traffic at the DE-CIX Frankfurt exchange for the Germany vs. Portugal game, traffic over the Irish Internet Exchange INEX demonstrated behavior similar to the games mentioned above, with a slight drop in traffic during the playing time. This would suggest that it is not only nationally-relevant games that can impact traffic flows, but also regionally-relevant ones.

In contrast, for games that had no direct relevance to a particular regional audience, the reverse is perceptible. Other games over the AMS-IX exchange had no impact on traffic, suggesting that the viewers in the Amsterdam region may have been less interested in games that did not involve their team. Internet users there maintained their normal Internet usage habits – some perhaps streaming games, others enjoying their standard streaming content.

Conversely, other games over the Sao Paulo IXP PTT Metro showed an increase in traffic levels. Here, it can be assumed that viewers were accessing their chosen games via streaming, and this was causing a noticeable increase in Internet traffic in a region where Internet usage is still comparatively low.

Looking at games in more detail, the half time is discernible. In games where traffic dropped during the game, the half time is visible as a slight rise between two dips in several sets of traffic statistics: a time when viewers can check their emails or look up player statistics while they're waiting for the second half to begin. During the Dutch game, the progressive fall in traffic throughout the second half of the game is clear to see, leading to an uncharacteristically low point, just after the end of the game, for that time of day.

In the case of the games showing an increase in traffic in Brazil, a slight dip between the two small periods of increased traffic represents half-time, as viewers presumably take the chance for a break from the screen.

Most of the games – whether they are the regionally relevant ones or not, show a difference in traffic between the two halves of the match.

It is interesting to compare these examples of infrastructure load with examples from other infrastructures, to get an impression of how a soccer game impacts national infrastructure as a whole. This can be seen by looking at the water usage during a game, in this case in Berlin during the Germany vs. Ghana game. Here water consumption drops strongly during the halves, more strongly as the game moves towards full time, only to jump dramatically at the end of the first half and at the end of the game – as viewers presumably make hurried use of the facilities.

References:

For a detailed comparison of several games in the 2014 FIFA World Cup, see "Internet Traffic During the World Cup 2014", found at **https://labs.ripe.net/Members/emileaben/internet-traffic-during-the-world-cup-2014**

Dr. Stefan Lietsch, Chief Technology and Product Officer, Zattoo

Impact of live sporting events on distribution platforms

Business Case: Zattoo OTT service

Zattoo's statistics for OTT services show a very different picture to the traffic statistics at DE-CIX. Here, the statistics represent much more directly the end-user behavior of customers of a particular streaming service, rather than the public Internet as a whole.

Looking specifically at the topic of soccer games, Zattoo sees an increasingly strong impact. For the 2016 European Cup final, Zattoo experienced one of their highest peaks ever, with almost 200,000 concurrent users. User behavior is represented very differently in statistics for an OTT service than via an IX – in this case, the dips in traffic are during the breaks, and the longer the game continues, the higher the peak gets (penalty shoot-outs take the peaks even higher). One possible cause for the change in behavior throughout the game is that as it gets later in the evening, viewers move from their traditional television viewing to their second screen, to continue watching the game in bed.

The peaks during the European Cup soccer games represent significant traffic flows of almost 0.5 Tbps – around two to three times Zattoo's normal Sunday evening viewing peak. We are seeing a change towards OTT delivery, as end-users get used to the availability of this alternative to broadcast TV. Every two years, Zattoo needs to double their capacity to be ready to deliver the quality necessary for broadcasting the next soccer tournament. This is done by doubling their capacity at exchange platforms, but also by working directly with ISPs – by adding more pipes into their networks, and by adding caches into their networks, much the same as Netflix and YouTube do.

Outlook from the distribution perspective

One forecast is that TV hubs will drive TV delivery in the future – connecting the distribution side and the content providers with the modern device landscape. These hubs need to support different streaming formats, have digital rights management, and provide storage, for example.

Another hypothesis is that Unicast (HTTP adaptive streaming) will become the universal standard to deliver video. YouTube and Netflix already use this, and it is also becoming standard for live television. Multicast is a bridging technology, but eventually the advantages of unicasting will overcome the multicast benefits. Monetization will be possible through dynamic ad insertion, which will convince the content owners and broadcasters to embrace the change. The big question is whether the backbone and the last mile will be able to support this scenario.

By extrapolation, Zattoo forecasts a further increase in viewers for the World Cup 2022 – expecting 1.6 million concurrent viewers in Germany and Switzerland, which would result in 3-5 Tbps of traffic.

Steve Bisenius, Vice President of Sales Engineering, SES

Complementarity of satellite and terrestrial networks

News business models: SES

Current trends and drivers

Six consumer preferences which are driving the evolution of broadcasting are:

- multi-screen viewing
- value for money
- HD and Ultra HD quality
- maximum choice
- links to social media, and
- convenience

HD is a growing trend, which is expected to rise to 75% of channels in the European market by 2019. It is becoming the standard, and Ultra HD is around the corner.

Linear television is still predominant – leading by a factor of 10 in the US market and more in most other markets. Non-linear viewing hours are increasing, but there is still a long way to go. Consumers want a combination – they want ease of use and mobility, but also quality since screens are getting larger and more performant.

Challenges

Terrestrial broadband is not able to deliver HD broadly – an HD service distributed by OTT in Europe today requires approx. 700 Gigabytes per month per household (35 times current average consumption), and requires a sustainable peak rate of 20 Mbps per household. This means only 54% of European households are currently able to view HD via the terrestrial networks. Ultra HD will result in 100 times the throughput consumption. Another medium for broadcasting of high quality video content is required, and that is satellite.

The ecosystem is changing – future demands will be for multiple devices, in any location, which will mean the infrastructures will be multiplied, and reception from all of these infrastructures will need to be seamless. The satellite and terrestrial worlds will need to work together, to make it seamless for the broadcasters and the consumers.

Outlook: Bundling satellite and terrestrial services to optimize and meet future bandwidth and coverage challenges

Satellites cover a region, a country or a continent, immediately completely and with no gaps; terrestrial networks cover 81% in developed markets, and 34% in developed markets with connectivity for HD, and only 5% of world's population can access 100 Mbps via terrestrial networks. One satellite can offer throughput to a single user of 4-5 Gbps, simultaneously to any number of users.

Certainly, the CAPEX (capital expenditure) for a satellite is high, but it can reach a whole region. At a threshold of 4,000 users, a satellite becomes more cost efficient than a terrestrial network. On the other hand, telecom companies can provide all of the services – telephony, Internet, mobility, live TV, and VoD – but they cannot cover all of a region. Telecoms could bundle services, and offer their normal terrestrial service combined with a package delivered by satellite. SES has worked with the industry to create a standard (Sat to IP) that converts satellite signals into IP, making the content available via the home Wi-Fi – delivered to all devices in the home network in HD and, in the future, Ultra HD quality.

Major TV operators are already offering such services, and some telecoms are providing hybrid services to their consumers.

The opportunities for hybrid solutions are:

- **The emerging markets – there is enormous growth in viewers in Africa. Africa is fed by undersea cable connectivity, but there is hardly any connectivity away from the coastline. Satellite footprints cover the areas of high population densities instantly.**
- **New applications – mobile satellite links to provide Wi-Fi hotspots at unconnected sites, connectivity for emergency management, and autonomous emergency connectivity for the energy industry, for example – to provide completely independent connectivity, unaffected by network outages.**

An example of emergency management is the service developed by SES in conjunction with the Luxembourg government: emergency.lu. It is used by the WHO for emergencies – the service can deploy an inflatable balloon with an antenna, which can be set up within 24 hours and offers 3G connectivity, voice communication, maps, etc. for rescue situations.

Conclusion

With the forecast increase of high quality TV consumption, network operators will face massive investment challenges in backbone infrastructure and serving consumers through the last mile with inadequate networks. TV is mass market content and should be delivered via the most efficient infrastructures, e.g. through a hybrid approach: Satellite broadcasting for linear and terrestrial networks for non-linear content.

Telecoms are moving more and more into providing TV content and media services, in a consolidating market. The winners in this ecosystem will be the ones reaching the largest number of eyeballs at the lowest cost.

Jürgen Sewczyk, German TV Platform

Live streaming in the living room

The Smart TV

Interview with Jürgen Sewczyk, German TV Platform (Association Partner)

Mr. Sewczyk, can you give us an overview of smart TV access and Hybrid broadband broadcast TV?

There are two different modes of access to smart TV – either via the "red button" broadcast in the TV signal, or via the smart TV vendor platforms, although the latter requires a contract with the manufacturer or platform provider. Many smart TVs also allow Internet surfing via an installed browser.

Hybrid broadband broadcast TV (HbbTV) offers web content over the television. Basically the URL is sent with the DVB TV signal – so content can be hosted on a web server for the HbbTV service. After pressing the red button on the remote control, the content will be delivered via Internet from the online CMS to the television screen.

The HbbTV ETSI standard is now 3 or 4 years old, with the current release 2.0.1 which contains HTML5. It can deliver UHD and MPEG dash, allows multiscreen viewing, and includes DVB CI+. HbbTV is already deployed in 25 countries around the world, especially in Europe, and 13 more are planned or in testing.

Smart TV vendor platforms use several different standards, and in recent years we have seen an increase in standards. Will the number continue to grow or will we see more harmonization in the future?

On the smart TV vendor platforms, several different standards are used, including HTML5, Android, WebOS 2.0, Tizen and Fire TV. There are a huge range of apps for smart TVs – for the first time, newcomers can achieve market entry via the TV set. I expect more harmonization: the majority of content providers will focus on 3-5 platforms, because it is too expensive to adapt the content for all technical standards.

How many households now have smart TVs, and are they connected to the Internet?

31% of German households are already using smart TVs. Usage is mainly for viewing video content. According to a representative survey conducted by the gfu (Society for the Support of Consumer and Home Electronics in Germany) in 2016, 74% of the smart TV sets are connected to the Internet.

What options are there for monetarization on smart TVs?

New models for monetization are becoming available – personalized ads, preroll and midroll ads, smart TV pay models, and e-commerce applications, allowing viewers to buy goods live from shopping channels. There will be more and more personalized and individualized content in future.

Personalized ads, preroll and midroll ads – will these formats be accepted by end-consumers or will they drive even more traffic to streaming platforms like Netflix?

Due to personalization, the ads will be more interesting and enjoy better acceptance from consumers. The ads are short (15-30 Sec.) and less disturbing than traditional ad breaks, which can sometimes take upwards of 10 minutes.

Content is distributed today via the Internet and TV broadcast signals – How much traffic is going through which channel today and how much do you expect in 5 or 10 years' time? Do you expect more traffic via IP or broadcast in the near future?

Broadcast has the real advantage that it does not matter how long, which quality and how many viewers are watching once the signal is on air. Regardless of the increase of VoD, streaming and OTT content, television viewing time has been constant since 2010 at approx. 220 minutes per day.

Via Internet in 2016 we had 13.8 Exabytes (13,800,000,000 Terabytes) of traffic with fixed broadband connections in Germany. In the last few years, the increase has slowed down to 20% per year (in 2013 there was growth of 42%). I expect a growth of 20% per year for the next 5 years, so that we will have approx. 34 Exabytes of traffic via fixed broadband. I expect that the mobile traffic will not play a significant role in this because videos via mobile are mostly consumed in Wi-Fi networks. An estimation for the next 10 years is simply not possible, as all estimations concerning the Internet over such a long term have failed.

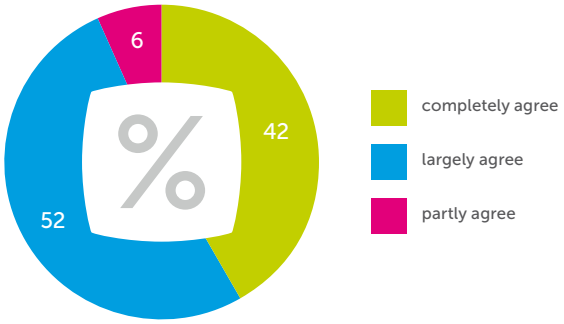
Survey on Infrastructure for Live Streaming of Sporting Events

As part of the focus on Internet broadcasting, the eco Association undertook a survey in Q3 2016 of over 30 experts from the broadcasting sector.

Key findings of the survey include:

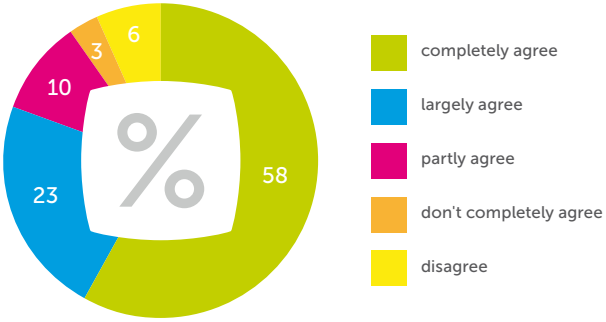
- 94% of survey participants largely or completely agree that the demands on Internet infrastructure will sharply increase in relation to sports events in the future

The demands on Internet infrastructure will sharply increase in relation to sports events in future



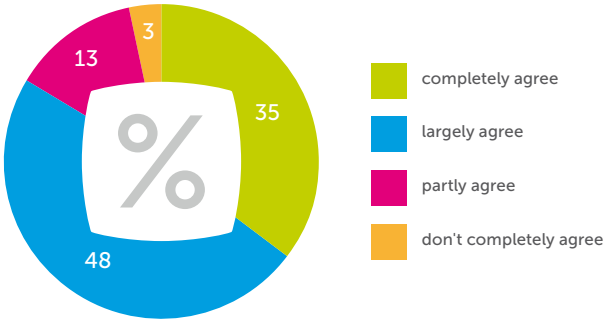
- Almost two thirds of experts surveyed completely agree that Internet TV is becoming more important than classical TV, and a further 23% largely agree

Internet TV is becoming more important than classical TV



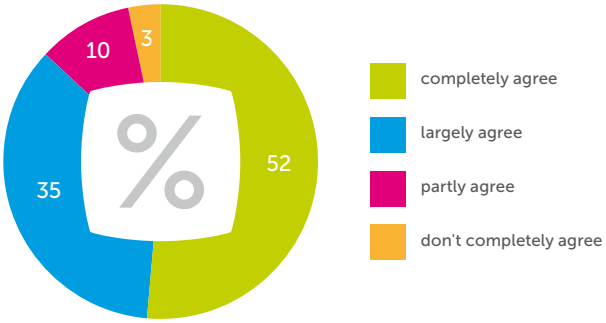
- 83% see the media behavior of consumers as becoming increasingly diverse

The media behavior of consumers is becoming increasingly diverse



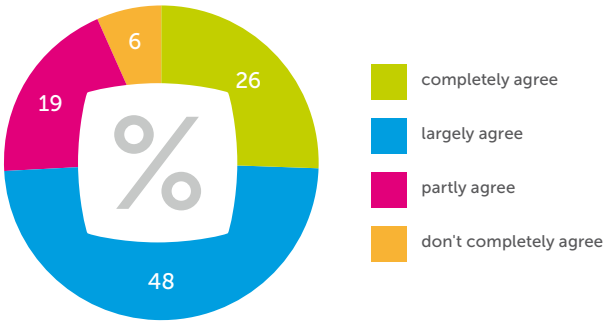
- 87% of those surveyed believe that the importance of IPTV will continue to grow strongly in the next few years

The importance of IP TV will continue to grow strongly in the next few years



- Three quarters of the broadcasting specialists believe that it is not always easy to keep up with the changing media behavior of consumers

It is not always easy for providers to keep up with the changing media behavior of consumers



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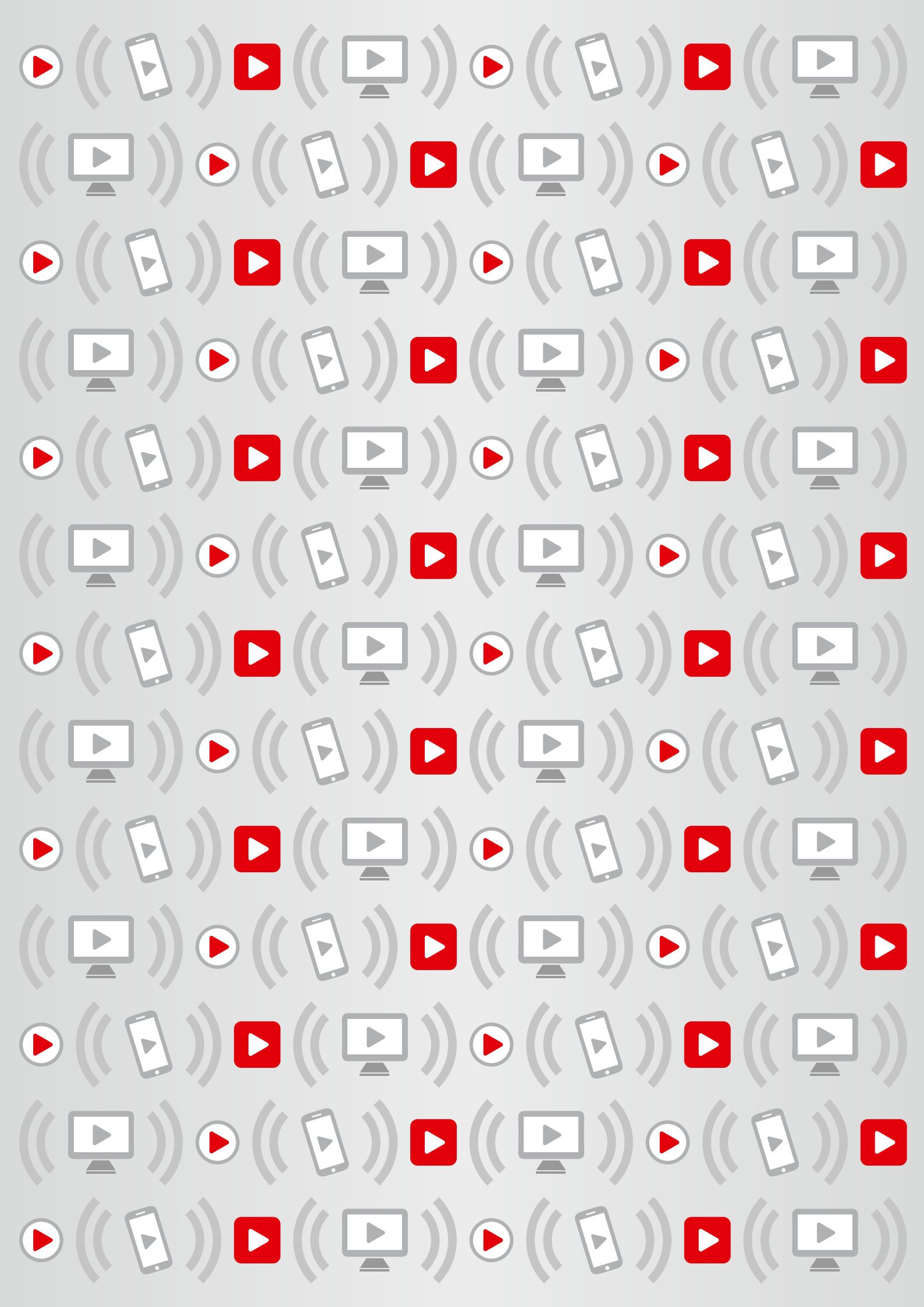

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