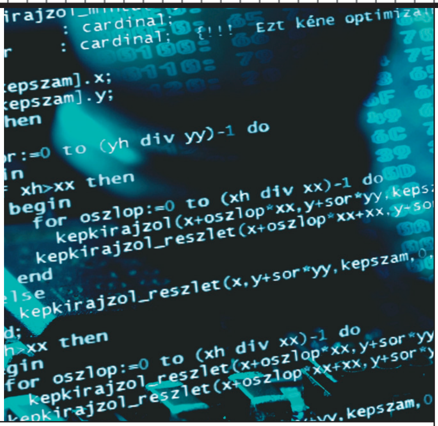
When TV Dies, Will It Go to the Cloud?



Karin Breitman and Markus Endler, *PUC-Rio, Brazil*
Rafael Pereira and Marcello Azambuja, *Globo.com*

Coupled with the expected growth in bandwidth through the next decade, cloud computing will change the face of TV.

The increasing popularity of videos on the Internet, allied to recent advances in network technology, are drastically changing television as we know it. In the past few decades we experienced a very clear role distinction: TV channels and independent companies produced video footage to be distributed by broadcasters and consumed by passive general audiences. Roles and responsibilities were clear down the line, and everyone was happy.

A few years ago this "family around the TV set" scenario began to crack. Television faced several daunting challenges as cable multiplied the number of viewing choices and hardware prices let middle-class families own as many TV sets as there were members in the family.

SEA CHANGE

The Internet brought the potential to completely reinvent TV. First, it let users see what they wanted, when they wanted, while suppressing the need for additional hardware. Digital video recorders, notably the TiVo, popularized the concept of letting users choose more convenient times to watch their favorite programs. However, with the increase in bandwidth availability for the last mile—via cable and asymmetric digital subscriber line (ADSL) technology—it makes more sense to stream the content directly from the Internet than record it for later use.

Second, and more importantly, the Net removes the barrier that separates producers, distributors, and consumers. On the Internet, anyone can produce and distribute high-quality content. As a result, there is much more content available, making the competition for audiences tougher and changing viewing habits irreversibly.

Third, the Internet allows mixing and matching of multisource content. It has become commonplace for networks to mix their own footage with user-generated content to provide a more holistic experience. Video production, distribution, and selection are no longer the privilege of a few. Users now have a front seat, forcing media giants to explore new business models.

From a technical viewpoint, huge challenges remain, however, including the ability to process, index, store, and distribute nearly limitless amounts of data. This is why cloud computing will play a major role in redefining TV in the next few years.

RAMPING UP

Electronic devices that can be used to consume content on the Internet are proliferating at an increasing rate: PCs, tablet and laptop computers, PDAs, mobile phones, handheld video game consoles, and eBook readers, not to mention router-type devices that let regular TV sets display Internet content.

It seems our lives are driven by media displays, as Steve Jobs demonstrated with his recent unveiling of the iPad. It is easy to imagine a middle-class adult in the work force soon having access to two or more such displays on a regular basis.

Displays can be organized in five strata, according to their evolution (B. Mazloff, Le 5éme écran – Les medias urbains dans la ville 2.0 – editions Fyp - 2009), as Figure 1 shows. Movie projection screens were the first to appear, in open public spaces. Then came the TV and PC—no longer public, but still collective. Mobile devices followed, for personal use in both private and public environments. More recently, public electronic displays on everything from billboards to bus stops are changing the urban landscape.

Fifty years ago, video was produced in a single format since its consumption was restricted to some specific displays. Today, on the other hand, several different versions are required to enable access on PCs, iPhones, PDAs, game consoles, and other devices. This is a critical problem for broadcasters, as video processing is as computationally expensive as it is data intensive, consuming time and resources.

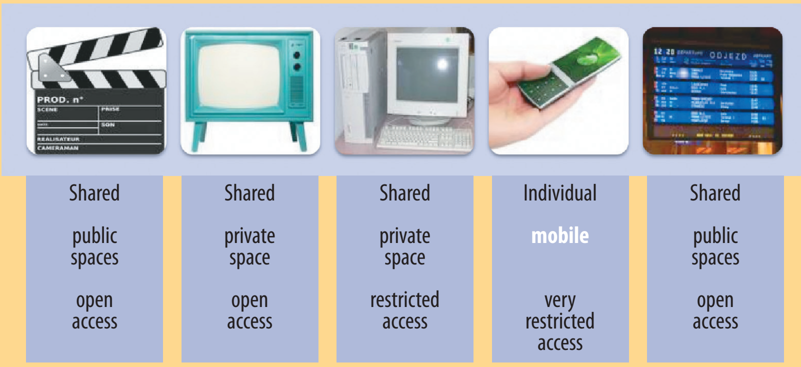


Figure 1. Evolution of media display types. The Internet is enabling the rapid proliferation of electronic displays.

Besides the proliferation of different devices, it is not uncommon for the market to prefer particular platforms. A decade ago, RealNetworks's RealVideo and RealMedia took the lead, followed by MS Windows Media and Adobe's Flash, with the future looking toward HTML 5. Each of these technologies defined a set of associated formats, codecs, and transport protocols that everyone must follow. On top of that, the last mile is pushing the demand for high-quality content and high-definition videos that require many more computational resources.

SPLIT AND MERGE

Split and Merge is a cloud-based platform for distributed video encoding that can overcome these drawbacks. The basic idea is to use the cloud's elasticity to engage resources dynamically, then distribute and parallelize the video-encoding processes. The Split and Merge platform, shown in Figure 2, was designed to reduce video-encoding times to fixed thresholds, independently of the input size of the video file, using only dynamic resource provisioning in the cloud.

Split and Merge fragments every video received, processes the fragments in a distributed cloud environment, and merges partial results. As in most map-reduce implementations, it makes efficient use of available computing resources. It also allows for the customization of techniques used in the split, distribute, process, and merge steps as needed. This ensures flexibility, adaptation, extensibility, and the accommodation of different applications. In the case of video processing, allowing a choice among codecs, containers, audio streams, and different splitting techniques is paramount.

Considering the growth of Internet video use along with the demand for higher-quality HD-level content, dealing efficiently with transcoding processes is a strategic priority. The cloud solution offers a competitive advantage by providing the unprecedented possibility of processing videos several hours long in the same time frame as those that run only a few minutes.

DISTRIBUTION CHALLENGES

Unlike TV signals, which are transmitted independently of the number of viewers, Internet media consumption is based on connectivity: Each user who wants to watch a video must open a separate connection. With unicast, the most popular distribution model, there is a separate connection for each user to the server responsible for content distribution. This limitation becomes increasingly evident when a variable volume of information must be processed to meet spikes in demand during, for example, popular sports competitions or public emergencies.

No matter how resourceful the entity distributing the contents is, there will be peak times with excessive demand and other times of idleness. Given that service providers can build applications with an elastic infrastructure and adjust effectively to demand variations, the cloud has all the characteristics needed to deal with this type of content.

In cases where there is a very large or seasonal demand, the use of public clouds for information processing and storage is emerging as an attractive alternative. The concept of hardware as a service (HaaS) relieves the necessity of making large infrastructure investments, while allowing on-the-fly resizing and adaptation to current needs.

With a public cloud, users can quickly gauge the resources required to perform a particular task and pay only for those effectively used. A successful example of this is the registration system for the *Big Brother Brasil* reality TV show.

The application process is open to any resident in the country, with contestants required to send a video of themselves in the format of their choice. Videos are encoded in the MPEG-2 standard to facilitate visualization by the jurors and spare them the hassle of dealing with a plethora of different codecs. The system is able to receive a very large number of videos during the three-month application process.

The system in particular leverages the power of cloud computing to deal with uncertain storage and processing requirements, allocate resources needed during the application and selection processes, and scale up to rare but extreme high-peak situations—for example, during the last weekend, when 60 percent of the total submissions with about 200,000 videos are expected.

Applications with seasonal but very large demand are not rare. The Internet transmission of sports events such as FIFA's World Cup and the Olympics, and of breaking news such as Michael Jackson's death, require a huge infrastructure for a very short time, making them killer cloud applications.

CONSUMER CHALLENGES

The new paradigm of video content consumption quickly became clear to major broadcasters, whose revenues had been falling consistently since 2005 and who had been forced to rethink their content distribution models. For example, NBC Universal partnered with News Corp. to launch Hulu.com in 2007, with Disney joining two years later. The popular website, which offers commercial-supported streaming video of TV shows and movies, aims to recover part of the lost revenue resulting from the decrease of traditional TV audiences.

During the recent high-definition format war between HD-DVD (supported by Microsoft and Toshiba) and Blu-ray (supported by Sony) technologies, videogames played an important role. Sony pushed Blu-ray adoption, using the technology as the underlying basis for its PlayStation 3, which doubles as a Blu-ray disc player. Although Microsoft's Xbox 360 console supported HD-DVD, a disc player sold as expansion hardware and was not required to play videogames. Shortly after Blu-ray emerged victorious in 2008 (http://news.bbc.co.uk/1/hi/business/7252172.stm), it become clear that Microsoft's strategy was not focused on the disc formats but rather on the rising market for online video.

In July 2008, less than six months after the end of the HD format wars, Microsoft announced its partnership with Netflix to stream movies and TV episodes using the XBox 360 console (www.microsoft.com/presspass/press/2008/jul08/07-14instantstreampr.mspx). This constituted a shift from the paradigm of media discs, enabling console owners to rent movies with the press of a button. Apple offered a similar initiative with Apple TV, enabling subscribers to download movies through its iTunes store.

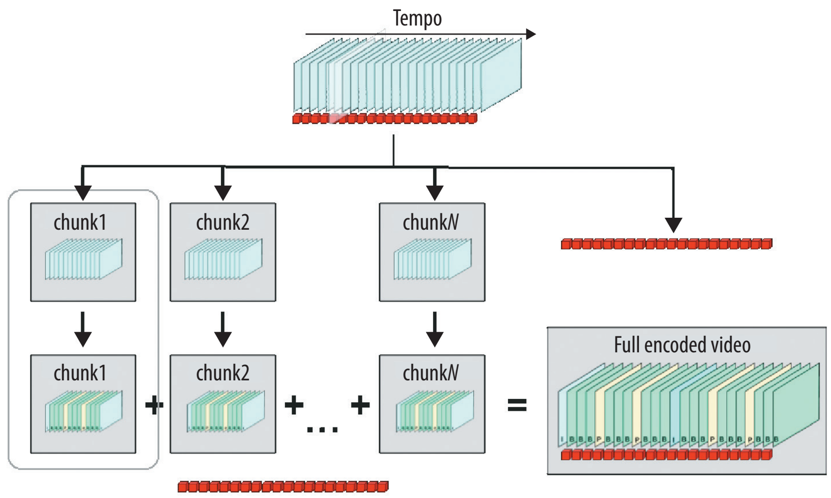


Figure 2. Split and Merge architecture. The system fragments every video received, processes the fragments in a distributed cloud environment, and merges partial results.

While the Internet offered new revenue possibilities, it also augmented the complexity of production and distribution business models. Hulu (www.fastcompany.com/magazine/140/the-unlikely-mogul.html), for example, preferred to follow a model similar to that used by TV, with commercial spots at intervals in the content. Even this simple model can be further refined, with Web technology easily identifying and addressing specific group campaigns such as gender, age, and location.

Cable TV networks are pursuing a similar approach to avoid losing ground to Internet-based TV providers. Many have launched their own video sites, which offer added services to justify their value. For example, Comcast recently launched Xfinity (blogs.wsj.com/digits/2009/12/15/comcast-opens-fancast-xfinity-tv), a service that lets users watch TV programming on the Internet anywhere.

The popularity of online videos has also raised the interesting possibility of the Internet serving as a large and collaborative content producer, with user-generated content complementing TV programming.

Video production and distribution are no longer restricted to large broadcasters. Users now have the power to make, distribute, mix, and match their own content. Cloud computing will play a decisive role in this extremely demanding scenario. The evolution of connectivity, coupled with the expected growth in bandwidth over the next decade, will indelibly change the face of TV.

Karin Breitman *is an assistant professor in the Departamento de Informática, PUC-Rio. Contact her at karin@inf.puc-rio.br.*

Markus Endler *is an associate professor in the Departamento de Informática, PUC-Rio. Contact him at endler@inf.puc-rio.br.*

Rafael Pereira *is a senior media engineer at Globo.com. Contact him at rafael.pereira@corp.globo.com.*

Marcello Azambuja *is a digital media manager at Globo.com. Contact him at azambuja@ieee.org.*

Editor: Mike Hinchey, Lero—The Irish Software Engineering Research Centre; mike.hinchey@lero.ie