

envivio®



MOBILE TV

Ensuring Quality of Experience

February 2008



Contents

1.	ABSTRACT.....	3
1.1	The Big Lesson.....	3
1.2	The Second Lesson.....	3
2.	QUALITY OF EXPERIENCE	4
2.1	Transporting High Quality Audio and Video.....	4
2.2	Client navigation and workflow.....	6
2.3	Content diversity and unified experience.....	7
2.4	Other QoE Considerations.....	10
3.	CONSIDERATIONS FOR SERVICE DEPLOYMENT	11
3.1	Multi-Profile.....	11
3.2	Qualified Ecosystem.....	12
3.3	Handset Client Application Compatibility & Optimization.....	14
3.4	Service Reliability.....	15
4.	CUSTOMER SUCCESS – ORANGE CASE.....	16
4.1	Orange.....	16
4.2	Orange Mobile TV service description.....	16
4.3	Orange Mobile HD TV.....	18
4.4	Statistics.....	19
4.5	Deploying High Quality Mobile Video Services.....	21
5.	CONCLUSIONS – KEY LESSON LEARNED.....	22

1. Abstract

Mobile TV has become a key, if not the key, application that mobile operators need to deploy to attract new subscribers, or simply retain their existing base. Even before the business models and killer applications for mobile video have been fully explored, mobile operators and broadcasters already face a wide variety of mobile video distribution standards, devices, and applications that deeply impact the way in which those services are deployed.

This presentation will focus on the knowledge gained from early deployments of MPEG-4 encoders for Mobile TV. Featured highlights include case studies on the Orange 3GPP deployment, with an overview of its technical challenges as well as current requirements for successful Mobile TV deployments.

1.1 The Big Lesson

As with most new consumer services, while Mobile TV services are enabled by advances in technology and video is still perceived to be a high value driver of premium service adoption, the technology itself is not what the user values. Instead operators deploying commercial Mobile TV services attribute their success to focusing on and optimizing the quality of experience, and delivering services that meet or exceed the customers' expectations at a price that is perceived to be acceptable.

1.2 The Second Lesson

Mobile TV deployments can only be considered a success if they contribute positively to an operator's business. Most operators are looking beyond user subscription fees as the sole revenue source for the service by adding revenue from targeted advertising and other paid content. Operators also see tangential benefits of improved subscriber adoption, increased penetration of premium services and handsets, and greater overall brand visibility.

Operators who optimize their video headends and TV portals on the device to improve the end user Quality of Experience see better user adoption, higher revenue potential and more positive brand awareness. While debates continue around the potential future for Mobile TV, it is clear that operators who have created attractive video services were able to generate substantial revenues and establish brand leadership.

This paper details the encoder and client specific technologies and features that can greatly enhance a Mobile TV service by improving the consumers' Quality of Experience.

2. Quality of Experience

Except perhaps for early adopters, most users are unaware of the technology that enables the services they consume. Each user judges how well a service enhances their lifestyle in comparison with its cost or potential inconvenience. Service providers need to fully understand and exploit these lifestyle benefits, which are predominantly information and entertainment delivery to improve personal productivity and alleviate boredom.

While there is a measure of prestige associated with the early adoption of premium video services, subscribers will ultimately weigh any benefits derived from using a Mobile TV service against its cost and any negative user experiences. During quality surveys¹, when asked about the characteristics that would determine the overall quality of experiences, users have answered:

1. Video quality
2. Audio quality
3. Time to access the main TV portal
4. Channel tuning speed

2.1 Transporting High Quality Audio and Video

Given the relatively low bit rates available to deliver Mobile TV services, bandwidth constraints and compression quality are key parameters to take into account.

The recent explosion of successful user-generated video services for PCs has proven that consumers will watch video that is less than traditional broadcast quality. However, it is also true that in a direct comparison between providers offering similar content, users do value improved video quality. In the case of Mobile TV where many operators are simply rebroadcasting commercial television channels, user expectations for quality are higher than for user-generated content.

- **Audio and Video quality**

Although network delivery and decoder performance play a part, the video and audio encoder is the single most important component determining the audio and picture quality experienced by the user. For an encoder to provide optimum video quality it needs to combine the following features:

- Highest quality signal interfaces for broadcast content ingest
- Optimized audio and video prefiltering and resampling
- Best audio and video codecs (MPEG-4 AAC, HE-AAC, H.264 and MPEG-4 Simple Profile)
- Efficient codec with pre-analysis, look-ahead, advanced toolsets and rate controls

¹ Results from Orange user satisfaction surveys

- Continuous improvements

Devices, networks and standards used for MobileTV are evolving at a fast pace. Screen resolutions, processing capacities, and network interfaces are changing constantly. In order to satisfy user appetite for TV services, the capacity of the encoder must evolve constantly in order to provide:

- better quality
- larger picture
- higher bandwidth
- new codecs

An encoder based on a software compression core addresses the Mobile TV requirements perfectly by providing:

- flexibility (choice of codecs)
- constant quality improvements over time
- additional formats and resolutions

By comparison, hardware compression cores do not provide anything like the same level of flexibility and functionality and are simply not the right technology choice for this type of service.

- Audio and Video synchronization

Lip synchronization, or audio/video synchronization, is a common problem seen in mobile streaming. The large variety of audio sampling and video frame rates makes the perfect input synchronization of the two media difficult to achieve. Tight output synchronization is achieved using IETF protocols (RTP and RTCP) which are poorly supported in most of entry-level encoders. A high quality Mobile TV encoder should sample audio and video with high precision time-stamps and make efficient use of RTCP.

- Transport

Another highly important aspect determining the user Quality of Experience is the efficiency of the transport layer. As mobile networks are extremely sensitive to bandwidth variations or jitter, poor bit rate regulation of the encoded streams has an immediate effect on packet loss levels resulting in a very visible degradation of the service.

In order to improve the Audio/Video transport, Envivio has added a *network-aware rate control* algorithm to its Mobile encoders, which provides the following functionalities:

- packet overhead minimization
- optimally-sized packets maximizing bandwidth occupancy without overflow

This unique rate control algorithm allows more bits are to be allocated to the audio and video payload and fewer to signaling. This offers two significant benefits: higher quality video and fluent video transmission without packet loss.

2.2 Client navigation and workflow

The portal through which the end user selects and watches the video is an important contributor to the overall customer experience. Making sure that this user interface is easy to use and does not interfere with the viewing habits of users will significantly improve the consumer's perception of the video service. The portal can also be used to influence viewing behavior towards more profitable content and services.

The embedded client targets the following objectives:

- ease of use, including intuitive navigation,
- high-end video quality,
- robustness,
- reactivity,
- completeness to the extent it does not impact ease of use.

We may note that the high-end video quality is a criteria which is fully part of the definition of the interface since it all ends with a trade-off between the extensive list of animations, features offered to the user and preserving the best in class video experience.



Figure 1 Example of Mobile TV Client interface from Bluestreak

Several means enable to maximize the user experience with smooth interactions, and non disruptive actions while watching the video program:

- transparencies and use of overlay on top of the video stream,
- touch and especially finger touch interactions,
- full screen video playback.

A last point worth noting is the Electronic Program Guide. While watching a channel, viewing the name of the programs running on other channels let the user decide before changing.



Figure 2 Example of program guide from Bluestreak

2.3 Content diversity and unified experience

By their very nature, mobile terminals are both personal and mobile. What may seem like an obvious observation is actually key to understanding the potential for multimedia content consumption on these devices. Unlike movie theatres or television screens, where the media is usually targeting the largest audience with a limited choice of high quality material, personal mobile video devices give access to a much wider choice of local or even user-specific content. This ability to deliver specific interest channels or personal content such as videos shared among friends and family is key to the future of Mobile TV. This new model of media consumption is commonly called the “content long tail” (see

Figure 3): whereas a few years ago technology and network limitations meant that only the most popular media (the content “head”) could be delivered, now users also have access to a wide variety of niche content (the “long tail”)

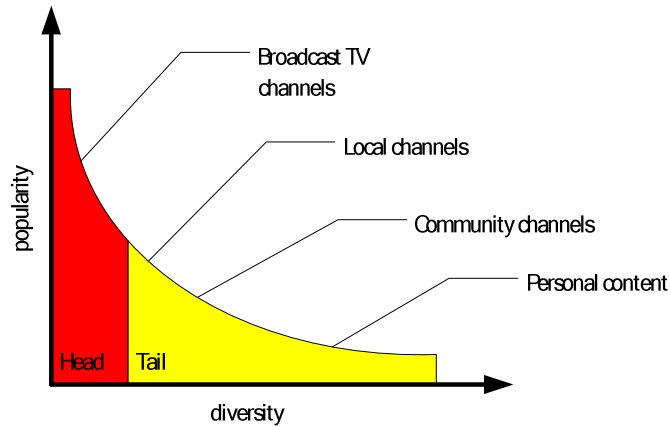


Figure 3. The content long tail

If Mobile TV can deliver this long tail model and provide the choice and individuality that traditional mediums lack it stands to become a much more than just TV on your mobile phone.

Two main elements are necessary to make Mobile TV a commercial success.

The first is a combination of delivery networks and technologies that allow each content model to be delivered cost effectively:

- Mobile Broadcast for the most popular TV channels addressing the largest audience
- 3GPP/WiFi Mobile Streaming for more targeted users and a higher number of channels addressing a smaller audience
- MMS or Video messengers for personal content

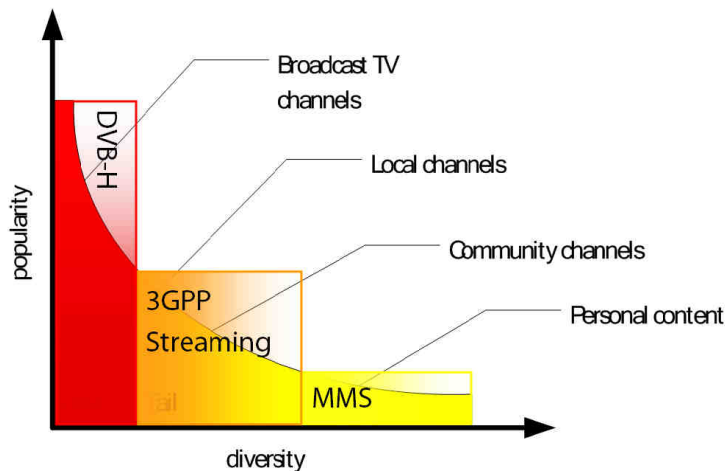


Figure 4. Distribution of the content long tail

The second element is an integrated client which masks all of the various technologies used, behind a single, intuitive and unified user interface such as the one represented below.



Figure 5. Unified client interface from Bluestreak

The embedded client is in charge of gathering all the video source, aggregating pieces of information from various sources and bring them to the user in a consistent way, still intuitive and easy to use. The reference model remains the home television itself: switching from one channel to another is driven by the programs and the content.

2.4 Other QoE Considerations

In addition to the delivery of high quality audio and video, and the ease-of-use and appeal of the client interface discussed above, operators should consider the valuable lessons learned from successful existing deployments.

- **Attractive Content**

Most fast growing Telco video services can attribute their success to securing the rights to unique and valuable content. Whether it is an exclusive library of movies or premium sporting channels, if an operator can promote content that users find appealing then they will be more likely to adopt Mobile TV services. This premium content should be mixed with attractive services, targeting specific group of users in a unique way.

- **Suitable Pricing**

Although users have shown they are keen to consume Mobile TV content, they perceive its value to be lower than premium broadcast TV. Pricing models offered by service providers should reflect this. There are numerous examples of ingenious and flexible pricing schemes in the market, some of which are similar to the tiered packages offered by cable TV operators, and some of which are “all you can eat”. What has proven universally unsuccessful is to price video as an extension of existing data plans where the high bandwidth video content is quickly seen as unaffordable.

3. Considerations for Service Deployment

3.1 Multi-Profile

Content for mobile streaming needs to be encoded in to a variety of different formats at the same time. The wide range of mobile devices deployed in a network will have different decoding capabilities. Different areas in the network will support different data delivery protocols including:

- GPRS
- EDGE
- UMTS
- HSDPA

By encoding each video channel multiple times, with various codecs, resolutions and bit rates, the operator can ensure that each user receives the best experience possible for their phone and their location. A deployment of mobile video services based on a hybrid approach allows operators to extend their service coverage, especially in the first phase of deployment. They might offer:

- DVB-H in large network areas
- 3G / HSDPA in more rural environments
- Wireless networks at home

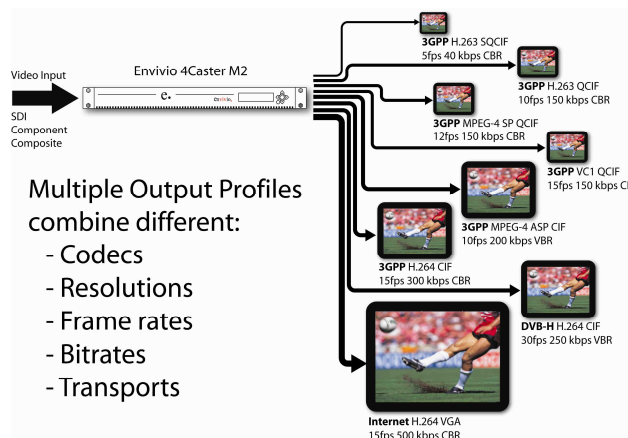


Figure 6: Multi format output for Envivio 4Caster M2

3.2 Qualified Ecosystem

Most of the technologies used in Mobile Video distribution are based on open standards. While this approach fosters innovation and competition, the interoperability between various vendors is often a challenge. Cooperation between vendors of servers, CAS, software players and terminals is essential to ensure that the whole ecosystem works well.

- **Headend for Mobile Streaming**

A typical head-end is composed of:

- A receiving headend, composed of decoders or gateways (such as *Envivio 4Stream*) getting the signal from satellite or other sources,
- Signal routers (either baseband signals such as analog or SDI video or IP signals such as MPEG video over IP)
- Encoders or transcoder, such as *Envivio 4Caster Mobile*, with optional encryption
- 3GPP streaming servers, acting as unicast relay to the terminal

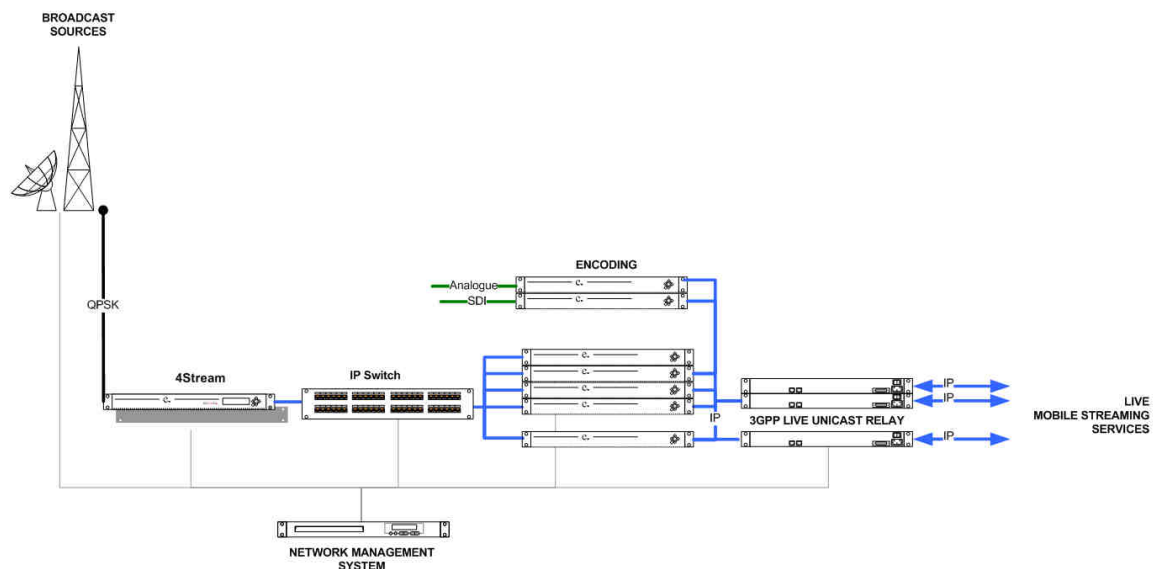


Figure 7. Typical Mobile Streaming Headend

- **Servers**

3G networks are not multicast enabled. While most other large distribution mediums rely on a one-to-many mechanism for live broadcast (TV Broadcast, IP Multicast), 3G networks require one to one communication between the content source and the final user.

Mobile streaming servers are providing the necessary unicast link between the terminals and the source content (video encoder). Although for large scale deployment and for the most popular channels a broadcast/multicast approach is going to be more suitable, the unicast approach has some benefits:

- access to a larger variety of sources
 - player identification, allowing functionalities like conditional access, targeted content or advertisement,
 - direct control on the source (PVR, VOD functionalities, etc.)
- **Conditional Access and DRM**

Encryption is an essential component for mobile broadcast that may well be extended to mobile streaming, so another important ecosystem partner to integrate is the content protection infrastructure. This includes authentication systems, rights management systems, key generators, stream encryption and client decryption.

In an effort to simplify the headend components, some encoders for Mobile TV now offer integrated stream encryption. This has the advantage of providing additional content security by ensuring that content is protected when it leaves the encoder.

These third party components interoperate using the SimulCrypt standard.

The operator must be aware that any encryption system deployed in the head end must be supported by the mobile handsets. This usually requires device support for OMA SmartCard profile, which is becoming the predominant standard for mobile content encryption.

- Middleware

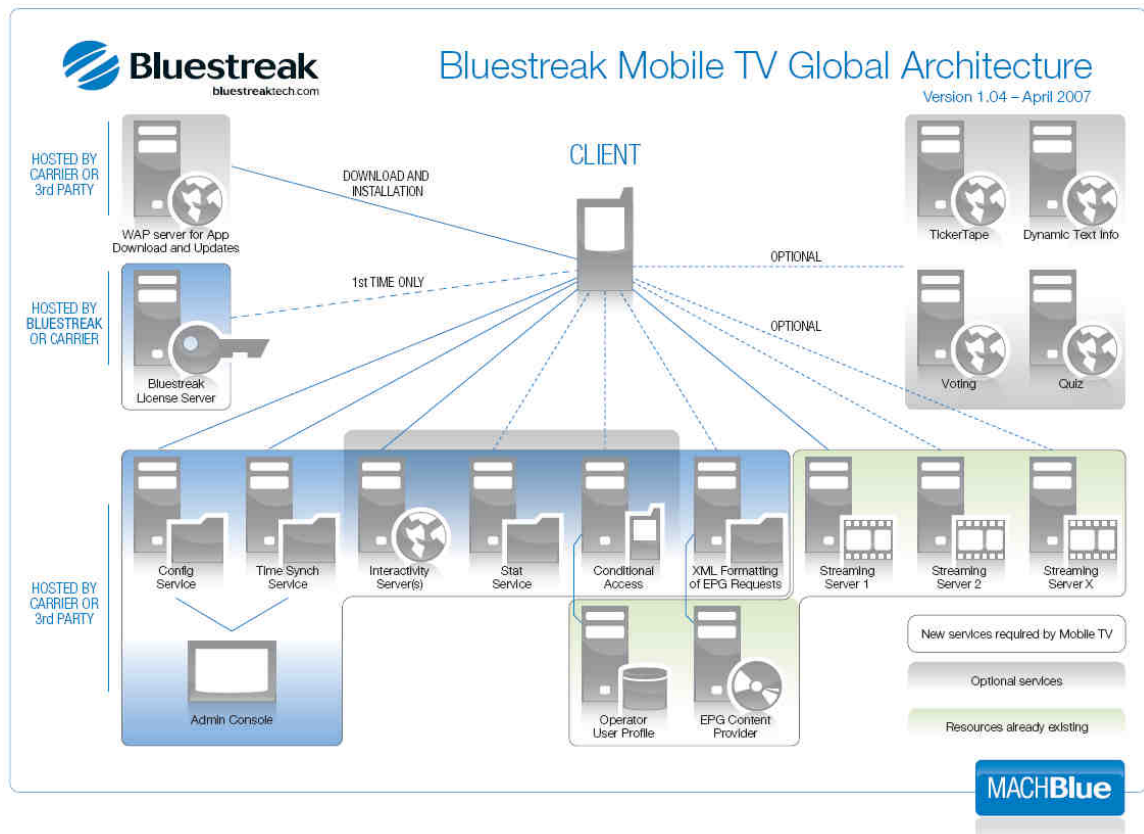


Figure 8 Overview of Bluestreak client technology and related middleware

3.3 Handset Client Application Compatibility & Optimization

Advanced interoperability with mobile video players is a critical success factor for large scale deployments. Vendor participation in industry interoperability events (such as the ones organized by IMTC, ISMA, BMCO Forum) is a good method to improve end-to-end solutions.

As player implementations often vary among vendors (some vendors implement multiple players), encoders need to support and cope with the specific requirements of each player. Operators can then create a set of profiles for encoding the same content to optimize the viewer experience on each device using a combination of:

- Maximum Screen Resolution
- Optimal Codec support
- Player/Hardware Compatibility
- Device/Network Protocol handshaking
- Network Bandwidth

In reality, many of these compatibility issues can only be resolved with field experience where the particularities of each device have been addressed.

3.4 Service Reliability

- Management

Operators need to deploy Mobile TV head ends which support advanced levels of failure detection and management. The management system should integrate error detection (I/O output loss, hardware platform issue), SNMP alarms, logs and redundant IP interfaces. Operations such as firmware upgrades should be easily scheduled and require only minimal intervention. The system should also provide automatic redundancy to minimize service downtime and on-going operational costs.

- High availability

The reliability of some solutions currently used for live streaming is extremely limited. This is particularly the case for software encoders installed on standard PC platforms fitted with video capture cards. Over time, this type of platform often shows unstable behavior resulting in frequent and long service interruptions. Units require manual intervention to reboot, take a long time to launch and the configuration might be lost or corrupted.

In comparison, dedicated compression appliances are highly reliable platforms. The units are designed for 24/7 broadcast operation with a high level of availability. Reboot times after power failure are minimal and the encoder will automatically return to its normal encoding state, using the configuration and parameters previously set.

To further improve service availability, management systems should support a range of redundancy schemes:

- N+1 (N encoders and one automatic backup)
- N+M (N encoders and M automatic backup)
- 1+1 (each encoder is backed up)

The various redundancy configurations offered as well as the use of dedicated appliances offer a cost-efficient platform for Mobile TV services.

4. Customer Success – Orange case

Envivio has successfully deployed more than 100 video headends with mobile operators delivering Mobile TV services. These include both 3GPP network deployments as well as Mobile broadcast services. In this section we will take a detailed look at Orange's European 3GPP deployment.

4.1 Orange

Orange is the leading integrated operator in Europe offering converged video services. Since 2006, Orange has been the France Telecom group's single brand for mobile, Internet and TV services. As of December 2006, the Group provided services to almost 160 million clients worldwide, of whom two thirds are under the Orange brand.

- Key dates
 - 2002 : Launch of VOD on PC: First in the French market
 - 2003 : Launch of TV/VOD via ADSL: First in the French market
 - 2004 : Launch of mobile TV: First in the European market
 - 2005 : Launch of the first digital recording service on ADSL
 - 2006 : Launch of high definition channels on ADSL: First worldwide
 - 2006 : Launch of high definition TV via mobile: First in the European market

In 2006, the first Bluestreak rich media client is launched on selected phones. In 2007, Globecast and Envivio replaced the existing mobile encoders with a complete mobile TV head-end.

Since then, the number of live video channels and profiles has augmented, more and more phones are introduced with Bluestreak client pre-installed.

4.2 Orange Mobile TV service description

- Rich and varied content: 60 TV channels, 3000 videos, exclusive sports coverage (football, rugby).
- The first operator to offer unlimited access.
- The only operator to offer high definition quality.

- Access

TV/Video on Orange mobiles is accessible by over 95% of the population in France. It is available from the Orange World portal, Video/TV section, or by downloading Orange World TV. The viewer just has to have a mobile device equipped with EDGE or 3G technology. Six million Orange customers are equipped with TV-compatible handsets. A high definition TV-compatible handset has been available on the French market since Christmas 2006 (Samsung Z560); 10 models are available today.

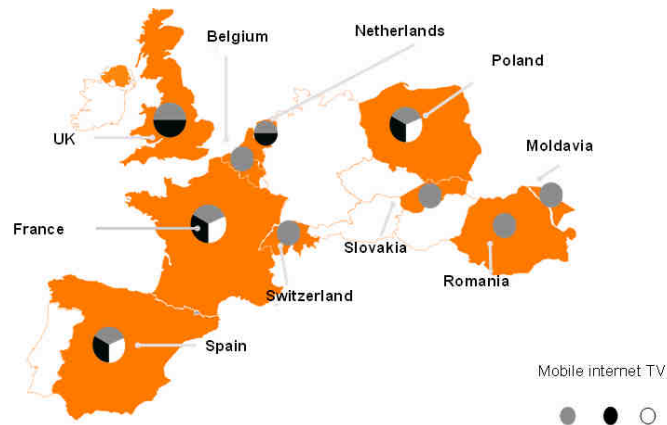


Figure 9 Presence of Orange Video Services (source: Orange)

- Content

Orange is both a producer and a distributor of the TV/video mobile content broadcast on the Orange World Portal. Three formats are available: classic streaming, TV on demand, or "mobile loop" (e.g. LCI mobile)

- 60 live TV channels
- 3,000 videos
- 8 themed TV categories: General, News, Sport, Entertainment, Music, Youth, Lifestyle, Discovery
- 9 themed video categories: News, Sport, Cinema, Music, Humor, Cartoons, TV/series, Live Cam, and Adult
- New types of content, created specially for mobile broadcasting: LCI Mobile, "mobisodes" and summaries of the "Plus Belle La Vie" series, Johnny Halliday videos, and "Arthur and the Minimoys" mini-episodes
- Exclusive programs with the Sport option includes access to all sports news via continuous programming, sports news and sports TV channels (Info Sport, TV foot, etc.), videos, commentary and text alerts.

- Pricing options

The viewer just needs a TV compatible mobile handset to access the 60 channels and the 3,000 video programs. Two pricing models are available²:

- For occasional use, Pay As You Go: 50c per 20 minutes of TV
- For regular use, Unlimited : unlimited access to various bouquets, with price ranging from €6/month to €10/month and options such Mobile HD (higher quality) Sports or Music channels.

4.3 Orange Mobile HD TV

At the end of 2006, Orange launched the “High Definition for Mobile”, providing a higher quality of experience. The Mobile HD service relies on:

- qualified phones, certified with a “Mobile HD ready” logo
- higher quality formats, providing a better user experience
- an embedded client from Bluestreak for the navigation

- Formats

The parameters used for Mobile HDTV are closed to those of the ones used in Mobile Broadcast standards such as DVB-H. Therefore, the expected quality is almost identical. The formats used for Mobile TV are compared below:

	EDGE TV	3G TV	Mobile HDTV
Bandwith per channel	56 Kbps	100 Kbps	250 Kbps
Resolution	QCIF (176*144)	QCIF (176*144)	QVGA (320*240)
Video Codec	H263	MPEG4	MPEG4 / H264
Audio Codec	AMR	AMR or AAC	AMR or AAC
Images / sec	5 - 7	6,5 - 15	> 15
Diffusion	Streaming	Streaming	Streaming

Figure 10 Comparison of the various formats with Mobile HD TV (source : Orange France)

² Tarifs available on www.orange.fr "L'offre"

- Embedded client

Most of the Orange Mobile HDTV certified phones come with Bluestreak embedded client to make content navigation easier. Some examples of screen are indicated below:



4.4 Statistics

6 Million terminals are compatible with MobileTV - 30% of the existing handset base.

55 million videos/TV programs were watched from January to September 2007 (33% increase compared to 2006)

- Average use of 36 minutes per month and up to 2 hours per month on unlimited offers
- Predominantly indoor usage, notably at home (40%) and between 20% and 30% in public transport or in public places (restaurants, cafés)
- TV channels are watched for 2'30 on average

- Mobile HD TV

The results for the Mobile HDTV service are particularly interesting:

- 400,000 clients of Mobile HDTV at the end of 2007 (one year after service launch)
- Sharp increase in service consumption: +17% in number of viewings, +31% in average duration, +85% in volume.

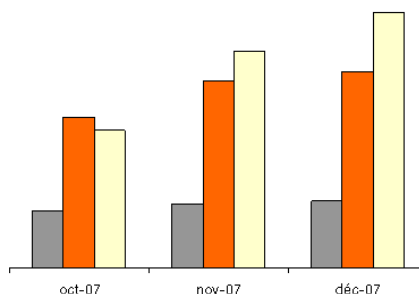


Figure 11 Mobile HD TV service consumption from October to December 2007 (source: Orange France)
 (Grey: average number of viewings per user; Orange : average duration of viewings per user;
 White: average volume of viewings per user.)

- User satisfaction

Question asked in September 2007 to 100 people with 3G services: "According to you, what should be improved in the mobile TV service?" (As a reminder 3G services at 100kbps)

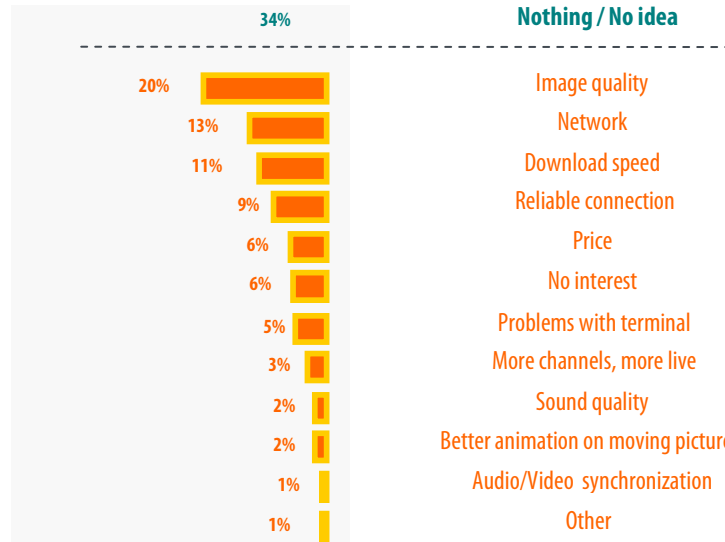


Figure 12 September 2007 User Survey for 3G services – Mobile HD not included (source: Orange France)

From this survey and the service consumption of Mobile HD, we can observe that:

- Users seem comfortable with paying for MobileTV services with a simple pricing model based on usage
- Video quality is cited as the first parameter for the acceptance of Mobile TV services
- The video quality available on Mobile HDTV services is a key driving factor for subscribers and volume consumption growth.
- Video quality perception is good to excellent for 3G and 3G+ services

4.5 Deploying High Quality Mobile Video Services

For operators launching commercial offers based on HSDPA capacity, proposing high-end MobileTV services equivalent to Orange Mobile HDTV has many benefits:

- the service itself has very good take-up
- it drives consumers towards the purchase of high-end cell phones and related high speed services plan
- because the quality of experience on HSDPA is quite close to the one delivered by mobile broadcast standards such as DVB-H, operators can deploy high quality services on their existing 3G network without waiting for the deployment of a broadcast network. Launching High Quality Mobile TV services ahead of time represents a significant competitive advantage: not only operators can capture a good chunk of the future MobileTV users, but they also have more control over the timing and topography of the broadcast network to roll out.

5. Conclusions – Key lesson learned

Many operators like Orange have now deployed successful Mobile TV services. These operators have learned how to manage the broad range of technical and commercial challenges that must be overcome in order to deliver, manage and scale an attractive video service.

The key objective when planning a successful Mobile TV deployment is to optimize the overall client interaction and maximize the value users perceive from using the service. This is known as the users' Quality of Experience and is defined by more than just picture quality.

While there are several business and workflow decisions that contribute to the Quality of Experience, the operator should select technology vendors that deliver not only compression optimization, but which also address issues of reliability and interoperability so that the perceived user value of their Mobile TV service is maximized.

If users see value in the video services then the operator will be able to generate direct commensurate revenues and indirect benefits for the operator's brand. Only if the service provider can recognize these direct and/or indirect benefits can a Mobile TV service be considered a success.

- **Beyond Mobile TV**

Both mobile and fixed network operators are looking to expand the coverage of their video services to allow their subscribers to consume content on a variety of devices – TVs, PCs and mobile phones – over a variety of networks. This move to the Three Screens of consumer video is seen as the logical way to leverage premium services to new customers or to offer additional premium services to existing customers.

In attempting to migrate video services to all client platforms, operators are looking for vendors that can bring simplified video head end and middleware architectures able to address Mobile TV, Internet TV and IPTV simultaneously. As experts in multi-platform advanced video compression and interactive middleware, Envivio and Bluestreak see this demand for a "convergence head end and middleware" as the next essential requirement for operators looking to provide ubiquitous video services.

Acknowledgements

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