

The EDCF Guide to ALTERNATIVE CONTENT in Digital Cinema

September 2008

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The EDCF Guide to Alternative Content in Cinema

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The European Digital Cinema Forum

Created in 2001, EDCF is the leading networking, information sharing and lobbying organisation for digital cinema in Europe. It has played a major role in assembling requirements, issues and concerns for collective consideration by public and commercial entities, and for 7 years has provided a vital link between Europe and Hollywood Studios. For more details visit *www.edcf.net*

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THE EDCF GUIDE TO ALTERNATIVE CONTENT in Digital Cinema has been created by the EDCF Technical Support Group, which is chaired by Peter Wilson. The aim of this guide is to provide a tutorial, preliminary information and guidelines to those who need to understand the techniques and processes involved in bringing a wide range of Alternative Content to cinemas, opening up new business opportunities. It is anticipated that future guides will deal with the related topics of gaming and 3D.

September 2008

The EDCF is extremely grateful to the following Member companies who have sponsored the publication of this *EDCF Guide to Alternative Content in Digital Cinema.*

1. Introduction to Alternative Content

Peter Wilson
Director of the
EDCF Technical Support Group and Board Member





One of the earliest Alternative Content events was in 2003 when a specially produced live performance by David Bowie was beamed live by satellite to cinemas around the globe, culminating in a real time question and answer session between Bowie and cinema audiences. The show was shot in digital widescreen with 5.1 DTS surround sound

Introduction

The Digital cinema networks in the US, Europe and the UK are now rolling out with gathering speed. Whilst the specifications and requirements for file based store and forward Digital Cinema delivery are extensively specified and are being standardised by SMPTE and ISO the situation for live delivery is quite unclear. There are now many events being relayed to the existing Digital Cinema locations, but the method and approach tends to be quite variable and case by case.

A new factor is the surprising speed at which 3D content is growing, first with feature movies and now by satellite, with live 3D Production techniques being rapidly developed. Although Odeon have not yet announced their Digital Cinema rollout plans they have signed a letter of intent for 500 RealD 3D systems in Europe.

There is an urgent need to specify the required methods to successfully broadcast live events to the rapidly increasing installed base of Digital Cinemas.

In addition to live events there are many other possibilities which may include the connection of rights paid DVDs, gaming machines, commercials and signage.

This first version of the Alternative Content delivery will concentrate on live events such as opera and sport.
Although each issue is covered in detail by relevant specialists, this introduction outlines the scope of the job.

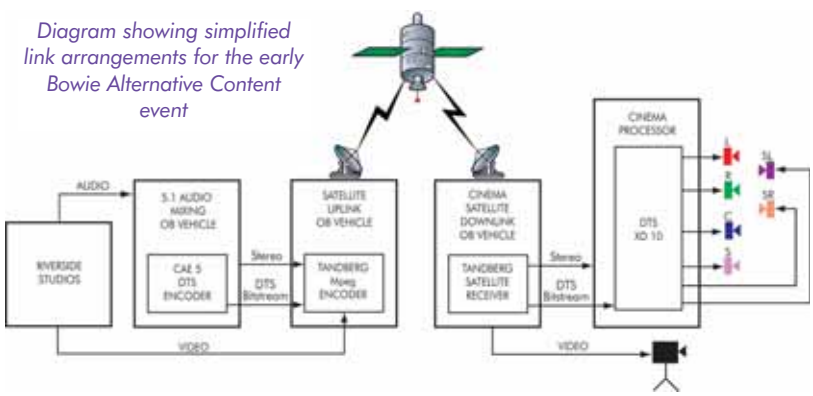
All electrical and electronic systems can be described by what's called a *block diagram*. Block diagrams can range from a single sheet with a top level overview of a particular system to a multi sheet set which can describe in simple pictures all aspects of the particular installation. Below the block diagrams sit the *circuit diagrams* which the designers and installers use when building the complex Digital Cinema picture, sound and automation Systems. It is vitally important to bear in mind the complete technical system from source to display when arranging Alternative Content events. Mismatches in signal levels or interconnection incompatibilities are often caused by poor system design. In the new digital world this often means no picture or sound at all.

Satellite links

There is a large choice of communications satellites across the world. These tend to have footprints chosen by a combination of commercial or political reasons. It may also be necessary to use more than one satellite to achieve the area of service required. These satellites may have differing operational frequency bands and differing power outputs, necessitating a selection of receiving dish sizes for reliable operation.

Though the programme distributor will contract with the teleport operators to deliver the signal, it is important that there is a certain minimum level of cooperation to ensure that the right dish sizes will be fitted and pointed in the right direction. Planning applications will also need to be made for the larger dish sizes which may be necessary for some satellites in some

Diagram showing simplified link arrangements for the early Bowie Alternative Content event





locations. A typical problem encountered in the UK is that of freehold ownership, where sometimes permissions for receiving dishes can be difficult to obtain as its not always clear who actually owns the building that the cinema is located in.

In Europe and many other parts of the world the satellite data delivery format follows as set of standards invented by the European Digital Video Broadcast group. The original standard was DVB-S but now DVB-S2 is coming on stream and receiving Equipment is coming on the market. DVB-S2 offers a higher Data Rate capability in the satellite Channel than was available before. DVB-S is used with MPEG2 compression and DVB-S2 is specified to work with either MPEG2 or MPEG4 (H264/AVC).

Digital cinema delivery uses JPEG2000 for compression of the picture, and since JPEG2000 has only a moderate compression Factor, as the highest possible picture quality is vital for digital cinema, it is not appropriate for live transmission of content to the movie theatre. Compression Factor means compression efficiency, and the DCI chose several encoding parameters more appropriate to JPEG2000 than to the more normal MPEG Standards.

MPEG2 is commonly used for Standard Definition services around the world and HDTV in the USA. With the advent of HDTV in Europe most services will move to MPEG4 (H264/AVC) though some care is needed when choosing the parameters.

Bit depth

Bit depth is now a serious consideration, Digital Cinema projectors now have seriously high contrast ratios, the DCI have specified 12 bits for the sampling depth of the picture information. Bit depth means the number of digital steps for each pixel as sampled. 12 bits is 2 to the power of 12 or 4096 steps between black and white, though black will not actually be at zero and white will not actually be at 4096. In reality the XYZ colour coding throws away one bit due to unused code values, giving approximately 2048 levels or 11 bits to represent each pixel or picture element. TV using MPEG 2 can have a maximum of 8 bits which is only 256 levels per pixel and MPEG4 (H264/AVC) can have a maximum of 10 bits or 1024 levels. Using these TV compression formats with limited Bit depths does not limit the projected contrast ratio but can display artefacts such as banding and contouring on computer generated images of flesh tones. This banding effect is common on Powerpoint backgrounds, as the computer industry did not do their home work when learning how to drive displays. Macs are popular in the pre-press and AV industries as they went part of the way to fixing this problem.

So an ideal receiver or decoder would have the possibility of receiving and decoding the chosen compression format with the chosen modulation standard. Ideally the bit depth should be 10 bit, as this matches well with Studio quality television equipment.
Warning: Locally inserted Ads shot on Pro-sumer HD equipment may look quite poor due to lack of bit depth and excess use of compression.

Audio, interconnections and interfaces

The audio system will most likely be stereo or Dolby AC3. Interconnections are vitally important for both picture and sound so the correct connectors are important. Professional Integrated receiver decoders have professional connectors whereas consumer set top boxes do not.

Digital Cinema projectors have two different interfaces, one interface is a pair of HDSDI BNC connectors which can be encrypted with local link encryption for connection with the Server / Media Block. On TI based projectors when using the internal scaler this limits the frame rate to 48Fps. The second interface is a DVI connector, this interface supports up to 60 Fps but any scaling has to happen in an external processor. The external processor also has to De-interlace any interlaced inputs as the Digital Cinema projectors are progressive scan only.

The audio from the decoder will need to be injected into the cinema sound system; Digital Cinema systems need a change over box to allow the digital cinema uncompressed sound tracks to be replayed through the separate channels. Alternative content may be stereo or compressed 5.1. Any processing delay through the picture must also be compensated to avoid lip sync problems. The sound from live events often sounds really bad on the cinema sound system, so care must be taken to ensure the sound mix will work on a system equalised for Hollywood movies. The Cinegrid network has successfully experimented with live remote mix down where a sound processor at the production site is remote controlled from a Cinema dubbing theatre.

Ideally any alternative sound and picture equipment should be remote controlled by the main Digital Cinema control system so the user control interfaces are minimised and the necessary interlocks can be achieved.

3D Live

There is now a lot of interest in live sporting events and live concerts being shot and produced in stereoscopic or 3D. Live events need to generate left and right streams which need to be transmitted in perfect synchronism, and the auditorium will need to be equipped with one or other of the proprietary 3D display systems with active or passive glasses.

Many new terms were used in the production of this guide so the EDCF glossary has been be updated to take account of this.

Peter Wilson
Director of the EDCF Technical Support Group
and Board Member

2. The Metropolitan Opera Live in HD



Mark Schubin
Engineer-in-charge of the media department of the Metropolitan Opera.

Introduction

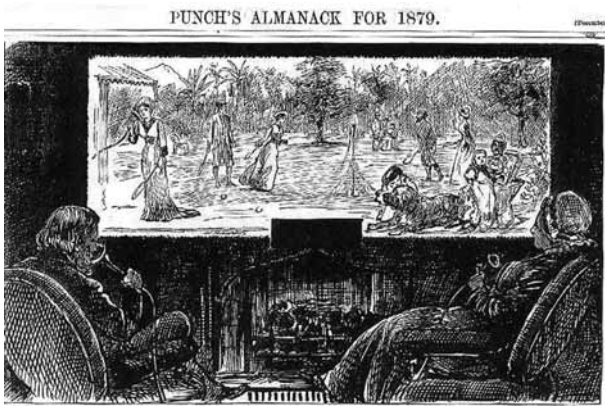
The Metropolitan Opera began an ongoing series of live high-definition transmissions to cinemas around the world in December 2006. Within a few months, a single live event achieved the equivalent of 15th-highest weekend U.S. cinema box-office gross revenue (measured in comparison to multiple showings of movies over the multi-day period). Outside the U.S., rankings have been even higher, and the series did even better as it progressed. Many factors have contributed to its success.

A Brief History of Cinema Television

A drawing of museum visitors floating in thin air while examining paintings would clearly be identified as a fantasy. Just such an image, drawn by George Du Maurier, appeared in late 1878 in the humor publication Punch's Almanack for 1879, labelled as "Edison's Anti-Gravitation Under-Clothing." Another drawing by the same artist in the same publication, however, this time labeled "Edison's Telephonoscope," (shown at the top of column 2) has been cited many times as a prediction of cinema television because it depicts a large, wide screen displaying live distant images.



William Edward Ayrton and John Perry, saying they were inspired by Du Maurier's drawing, demonstrated a crude television system to the London Physical Society in March 1881, and, in April 1882, William Lucas published in English Mechanic and World of Science a technical description of a proposed television system in which the images would be projected onto a screen. It wasn't until 1925 that the first video image of a recognizable human face would appear, but, even then, it wasn't clear whether television was best suited to the home or the cinema. In the U.S., Bell Telephone Laboratories demonstrated both theatrical (three-foot-high screen) and individual television displays in 1927. In the UK, John Logie Baird (who had achieved the 1925 image) also pursued both options, offering what he called "the world's first public performance of television in a theatre" at the London Coliseum in 1930.



The 1936 Berlin Olympic Games were reportedly seen by 150,000 (probably a cumulative audience figure) on large screens in 28 "public television rooms," effectively live cinemas. The same year, however, the first standardized "high-definition" (240 scanning lines or more) television broadcasting began, and it soon became clear that the medium would have its greatest impact in the home.

Meanwhile, movies were having their own economic impact. In the U.S., average weekly cinema attendance peaked in 1929 at 95 million. It dipped during the Great Depression but returned to 88 million in 1936 and never dipped below 80 million through the 1940s. In 1950, however, it dropped to just 60 million from 87.5 million in 1949, according to Reel Facts. There has never been a greater drop in absolute numerical terms or a greater percentage drop until 1967. Television was hurting the cinema; could it also help it?

Movie distributor Paramount Pictures invested in television developer DuMont Laboratories in 1938 with the specific purpose of furthering theatrical television. Ten years later, they publicly demonstrated, at the Paramount Theatre in New York, a version of an "intermediate-film" process shown by Fernseh AG at the 1933 Berlin Radio Exhibition. A continuous loop of film was coated with emulsion, exposed to a video signal, developed, projected, washed, and re-coated to start again. Picture quality was hailed as "nearly the equal of newsreels," according to "Shared Pleasures: A History of Movie Presentation in the United States," by Douglas Gomery and David Bordwell (University of Wisconsin Press, 1992). Paramount was not alone. Fox, RKO, and Warner also worked on theatrical-television systems, and equipment manufacturers made deals with exhibitors as well. U.S. News & World Report noted in 1949, "By 1952, most important theaters are expected to be equipped with television screens." Harry Brandt, president of the Independent Theatre Owners of America (and owner of 153 cinemas), predicted in 1950 that all cinemas would soon install coaxial-cable connections for live feeds, according to "Movies at Home: How Hollywood Came to Television," by Kerry Segrave (McFarland, 1999).

Also according to Segrave, however, only 16 U.S. cinemas had been equipped for theatrical television by late 1950, and, according to Gomery and Bordwell, by 1951 all cinemas in the Balaban & Katz chain had canceled plans to install theatrical-television facilities because revenues did not justify the cost. The concept of live newsreels was superseded by television news, and, according to Terra Media's Cinema-television chronology (www.terramedia.co.uk), by 1952 fewer than 100 U.S. cinemas were ever equipped for large-screen television, and Hollywood turned to such ideas as widescreen,

3-D, and stereophonic sound to counter the television problem. Distributor- and exhibitor-driven theatrical television, therefore, was replaced by event-driven theatrical television. Entrepreneurs could install equipment anywhere for events that justified the expense. Time magazine reported in December 1954 that a General Motors celebration of the production of their 50-millionth car the previous week was seen by 15,000 via "the most extensive closed-circuit TV network ever rigged." Venues included New York's Carnegie Hall but also conference rooms in 52 hotels.

That was the 75th event in five years carried by Theatre Network Television, which had also previously carried both boxing matches and opera to cinemas and would go on to carry sports to cinemas and sales and political events to other venues. Right up to the beginning of the Metropolitan Opera's Live in HD series in December 2006, there were still occasional live concert or sports events (and even business meetings) shown in cinemas, but their occasional nature gave exhibitors no incentive to prepare for the next one.

There were, however, some new-technology installations made by exhibitors. Some had become equipped for digital cinema; more had installed electronic projection systems for pre-show advertising. The facilities used to deliver advertising to cinema screens could also be used to deliver images and sounds of live events.

A Brief History of Opera and Sound & Picture Media

No later than 1726 (and perhaps as early as 1678), the Hamburg Opera used image projection on stage. The secretary of the Paris Opera said that motion-picture pioneer Louis Le Prince's 1886 patent was "for the projection of animated pictures in view of adaptation to operatic scenes." In 1896, footage of a bullfight was projected during the performance of the opera Carmen in Elizabeth, New Jersey.

Within two years of the 1876 introduction of the telephone, it was used to deliver opera remotely in Bellinzona, Switzerland. In 1881, stereo sound was delivered from the Paris Opera via multiple telephone transmitters and receivers, and, no later than 1925, the Berlin Opera broadcast stereo sound. The opening night of Massenet's opera Le Mage in 1891 was carried live from the Paris Opera to London via telephone lines. By 1896, an excerpt of the opera Il Trovatore was captured as a sound recording. By 1903, the complete opera Ernani was sold on 40 disks.

In 1899, a "silent" movie of Martha was projected at the Eden Musée in New York with singers providing the sound behind the screen. By 1900, synchronized-sound movies of operatic arias were shown at the Paris Exhibition (where the word television was coined), and by 1922 a 22-reel, synchronized-sound version of the opera Faust was shown in the UK.

An excerpt of the opera Pickwick was broadcast on BBC television in 1936. Full-length operas appeared on BBC television starting in 1937 (the first opera commissioned for television, Cinderella, was broadcast the following year), and, in Germany, the opera movie Der Schauspieldirektor was broadcast repeatedly on television in 1938. By 1947, opera was televised live from London's Cambridge Theatre. Helga Bertz-Dostal's multi-volume "Oper im Fernsehen" (Minor, 1971) offered a not-entirely-comprehensive list of 1646 different operas (not merely different productions) that had been broadcast on television by 1970.

In the U.S., the NBC commercial television network maintained its own opera company for 16 years, and competitors ABC and CBS also broadcast and commissioned operas for television. Public television in the U.S. also carried and commissioned operas, and in 1971 New York City Opera's Le Coq d'Or was carried live on a channel visible only to cable-television subscribers in Manhattan.

Basel Opera used an Eidophor projector to carry Lucia di Lammermoor to a crowd in the plaza adjacent to the opera house in 1986. New York City Opera used high-definition image magnification to show close-ups to the audience inside the opera house in 1991, a practice later taken up by Houston Grand Opera and the San Francisco Opera.

A Brief History of Television at the Metropolitan Opera

Like opera, itself, the Metropolitan Opera (the Met) has had a long media history. Sound recordings were made of Met opera performances by 1901. In 1910, radio pioneer Lee de Forest transmitted a series of opera radio broadcasts from the Met. Regularly scheduled weekly live Met radio broadcasts began in 1931 and continue to this day, with the opera company creating and operating its own global network (stereo since 1973). The Met also has its own full-time channel on Sirius Satellite Radio. The Met's first television broadcast was in 1940, and the first from its stage was in 1948. Martin Mayer, author of the book "About Television" (Harper & Row, 1972) recalled watching Met opening-night performances, carried on a commercial network, on a television set in a bar.

The "new" Metropolitan Opera House, opened in 1966, was wired for television when it was built (unfortunately with obsolete camera cables possibly never used). The 14-hour, two-part, one-day Met Centennial Gala in 1983 was carried live on television networks around the world. The Met's first opera shot in modern HDTV was Semiramide in 1990, and their first large-screen projection to the plaza in front of the opera house was in 2001. In 2006, the opening-night performance was shown on the gigantic advertising screens in Times Square, with sound added and a street closed and filled with seats for viewers.

The Met's media department has dealt with live and pre-recorded television broadcasts and an odd hybrid of the two, broadcasts in which the last act is transmitted live but the prior acts are delayed to eliminate intermissions. In the era before high-capacity disk drives, those delays were accomplished with six videotape recorders, a backed-up pair each recording, playing, and cueing/synchronizing at any given moment. The Met has also dealt with home-video media, starting with VHS and LaserDisc and even such obscure formats as Japan's VHD, and also offers both streams and downloads of live and archived audio and video.

Since the opening of the 1966 opera house, in-house television has also been used to serve latecomers (now with HDTV projection and plasma displays). It shows images of the conductor to singers no matter where they are facing, it is used for stage operations, and it even created an on-stage ghostly image for the most-recent production of Macbeth.

The First Metropolitan Opera Cinema-Television Transmissions

In 1952, Theatre Network Television carried the Met's Carmen to 31 cinemas in 27 U.S. cities via coaxial cable. The 1954 opening-night gala was sent to an even larger network. Unlike the current live cinema transmissions, those in the

1950s were low-definition, analog, monochrome instead of today's digital HD color. Despite a contemporary account in The Los Angeles Times that one cinema in that city was being equipped with stereophonic sound for the Met's 1952 transmission, that transmission (and its 1954 successor) had only monaural, limited-frequency-response, limited-dynamic-range sound as opposed to the current 5.1-channel digital surround sound.

The use of coaxial transmission circuits had to be negotiated with television stations in the 1950s, and sometimes an inadvertent switch would send network television programming instead of the opera into a cinema. The current cinema transmissions are largely via multiple satellite channels.

There are other differences: The 1950s events used four cameras, three in fixed positions for the opera and one for the intermissions; the current cinemacasts use as many as 16 cameras, as many as 15 of them for the opera (many moving) and as many as four for the intermissions, with some working on both opera and intermissions. The audience walk-in period was 90 minutes in the 1950s and is half as long today.

There are many more cinemas today but not as great an increase in audience because today's cinemas are much smaller. It's common for cinemas to be filled to capacity for the current transmissions; in the 1950s, an inability to sell out completely a movie palace having more seats than the 3800 at the Metropolitan Opera House was deemed by some to be a failure. Other than that difference in the business outlook for live operas in cinemas, the reactions of viewers and the press were remarkably similar. While sometimes acknowledging that the pictures and sound were "not perfect," Albert Goldberg, reporting in The Los Angeles Times after the 1952 cinema opera transmission, nevertheless called the event "little less than breath-taking." Viewers at a cinema that had been temporarily switched to the wrong signal in 1952 nevertheless rated the event positively. In 2007, after fire caused evacuation of a cinema, much of that audience waited until emergency workers left and then asked to watch what remained of the opera transmission. Applause is common in U.S. cinemas, even though the performers cannot hear the remote audiences. The applause is probably indicative of a sense of community among the audiences, and that same community sense might explain some of the positive ratings even for the interrupted, low-resolution, monochrome, monaural transmissions of the 1950s. Another possible explanation for the similar ratings 55 years apart is audience training. Henri de Parville wrote of the Lumière brothers' 1895 screening of L'arrivée d'un train en gare de La Ciotat, "One of my neighbors was so much captivated that she sprung to her feet... and waited until the car disappeared before she sat down again." That was the effect of a silent, monochrome image of a train not headed anywhere near the viewers. Similarly, when Thomas Edison compared the sound of a live opera singer to that of a phonograph recording in 1919, the Pittsburgh Post reported, "It did not seem difficult to determine in the dark when the singer sang and when she did not. The writer himself was pretty sure about it until the lights were turned on again and it was discovered that [the singer] was not on the stage at all and that the new Edison alone had been heard." Although human beings are physiologically capable of distinguishing the sound of a live singer from that of a mechanical phonograph record and the image of a real locomotive from that of a monochrome movie, it has taken some training to make those differences obvious. Today's viewers are becoming accustomed to high-definition pictures and high-fidelity surround sound, which is why that is what is currently transmitted by the Met. A third possible explanation for high viewer ratings for the cinema transmissions was offered by Alfred Goldsmith, in a 1947 paper, "Theater Television - a general analysis," presented at a conference of the Society of Motion-Picture Engineers on the subject. "Television pictures in theaters," he wrote, will, initially, at least, have the strong appeal of novelty." The audiences for the Met cinema transmissions, however, have increased over the course of two seasons, so novelty doesn't seem to have been a major factor driving the current series.

Challenges of the Met Cinema Transmissions

All Met television productions have had to deal with tight schedules, live audiences in the opera house, low light levels, high contrast ratios, and sound pickup on a stage more than 100 feet deep. Furthermore, little can remain in place from day to day. Twelve operas are performed on the main Met stage each week. On weekdays, after an evening's performance, the opera set is removed by the overnight crew and replaced by that of the opera being rehearsed. After the rehearsal, the rehearsal set is removed and replaced by that of the opera being performed that evening. On Saturdays, there are matinee and evening performances of different operas. At one point in the television schedule, the crew dealt with the sets of five different operas over the course of two days. Similarly, although a few seating positions might be blocked by a camera (and, therefore, not sold to patrons) for a live transmission, those seats cannot be blocked for operas performed between a television rehearsal and a live transmission. All cameras and cables, therefore, must be removed between television activity periods.

Metropolitan Opera live screen cinema transmission in 1952





Audience for Carmen - note large screen projector



The cinema transmissions presented new challenges. How could images be optimized for viewing on a cinema screen and sound for reproduction in a cinema auditorium? How should intermission intervals between acts be handled? How could live multi-language subtitling be handled? How could different cinema reception and projection standards be accommodated? How could later home video and television broadcasts be made from the same performances if the acquisition was optimized for cinema? How should radio-network and cinema-television programming be coordinated?

That last challenge arose because of the global nature of the Met cinema transmissions. Evening performances at the Met would begin after midnight in Europe. Only the Saturday matinee performances could be distributed live from the west coast of North America to the Middle East. The Saturday matinee performances, however, were already scheduled for global radio broadcasts, with commercial advertising breaks for some U.S. stations, other material for U.S. and global non-commercial broadcasters, and intermission material for radio listeners.

Sometimes the radio announcer is heard in the cinemas. Sometimes television interviews are carried on radio. At other times, the transmissions diverge, but they must come together again for the next common element.

Practical technical aspects

Dealing with screen size and position relative to the audience has been difficult. It might seem that the issue is simply one of retinal angle, but psychophysical experimentation has shown that people have a sense of image size and distance separate from subtended angle. Unfortunately, it is impossible to rig a cinema-sized screen inside a television production truck. Directors, therefore, see home-sized images but must bear in mind cinema-screen sizes, affecting framing, cutting, and even camera angles.

An interesting example of the last is a rail camera used in many of the Met cinema transmissions. Originally proposed by video-photographer Hank Geving for director Gary Halvorson, the camera rides a rail over the edge of the orchestra pit, below the lip of the stage. Shots from that angle have been rated highly by cinema audiences, but they pose a quandary in the opera house. If the camera is too high, it will be objectionable to the audience as it moves across the stage; if it is too low, it will be unable to get shots. If it is a prism-based camera with 2/3-inch format imaging chips, it will be large; if it uses a smaller format or a single chip, image quality will suffer. If the camera moves slowly, it will not offer great perspective changes; if it moves quickly, the image might be unstable, and the dolly might make excessive noise.



Shooting credit at the 1954 live Metropolitan Opera opening-night cinema transmission on Theatre Network Television

Currently, a 2/3-inch prism-based camera's optical block is separated from its electronics to create a smaller profile, although the lens extends the size considerably. Optical image stabilization has been used (and required acoustic treatment so that sound from the orchestra pit did not activate the stabilization sensor).

Another psychophysical phenomenon affecting audience perceptions involves lip sync. It is impossible to provide zero-offset audio-video synchronization in a large cinema auditorium due to the speed of sound, roughly 1130 feet per second in dry air at room temperature. It is possible to compensate for microphone-pickup locations, audio and video processing, encoding and decoding, and display delays, but it is impossible to speed the sound leaving a speaker behind the screen and reaching an audience member in a cinema's first row so that it reaches an audience member in the last row at the same moment. If the distance between the two audience members is 113 feet, then, under the conditions noted above, there would be a 100 millisecond difference in when the two hear the sound, roughly three U.S.-standard frames. Fortunately, as noted previously, people have an appropriate sense of screen distance and accept audio lag when they are far from a screen. Cutting between wide shots and close-ups of singers, however, seems to affect that sensation in some viewers, leading to reports of changing audio-video synchronization.

As for the sound mix, there are major differences between cinema sound and home television sound. Consider just the location of surround-sound speakers. In a cinema, the left, center, and right speakers are normally invisible behind the screen. All visible speakers are surround-channel speakers. Most audience members, therefore, have at least some of the surround sound coming from the front. In a home-theater surround-sound setup, the surround speakers, appropriately or not, are typically located behind viewers. Furthermore, the center speaker, instead of being behind the screen, is above or below it. The Met's audio producer, therefore, selects cinema-sound parameters in a cinema and checks them periodically in other cinemas (during test transmissions of pre-recorded material).

Given the differences between cinema and home television, the Met captures multiple, isolated camera recordings and all microphones on individual tracks. Broadcast and home-video versions of the performance are created in post production, with choices optimized, in those cases, for the home.

The live intermissions are somewhat trickier. Even if operas were not exceptionally lengthy programming, it would be difficult for the director and associate director dealing with the opera to prepare the intermission material at the same time. Backstage and dressing-room lighting must often be set up during the opera performance, and cameras might reposition from one location to another, needing a director to approve the new shot and look. The Met sets up a second control room, therefore, in the production truck, where an intermission director and intermission associate director can work with the intermission lighting, audio, and camera crews and the intermission stage managers as the opera is being performed. Two of the live intermission features were actually shot in the main control room, partially emptied after an act to allow the crews room to work. Another involved a rapid 600-foot Steadicam move from a dressing room to the stage,



Production and transmission vehicles at the Metropolitan Opera occupy every legal parking space on three city blocks

with seven stagehands hurriedly coiling cable out of sight. A long portion of any of the intermissions is always a wide shot of the opera-house auditorium with a countdown clock. Cinema audiences need longer breaks between programming than do home audiences.

International Considerations

Televising an opera is expensive, so the larger the audience the better. From the start, therefore, the Met sent the modern transmissions to cinemas outside the United States. That has posed two major issues: standards and subtitling.

Due to available equipment and broadcasting agreements with U.S. public broadcasters, the Met's operas are acquired at the U.S. standard of 59.94 images per second. Unfortunately, some of the receivers used by cinemas outside North America do not support that rate. Rather than change all of the receivers, the Met uses motion-compensating HD frame-rate conversion.

The first live television subtitles appeared on the Live from Lincoln Center broadcast of New York City Opera's Barber of Seville in 1976. All Met television shows have been subtitled since 1977, and a system of individual displays with restricted-angle filtering allows each audience member in the opera house to opt to see titles or not. The first cinema transmissions were sent with English-language subtitles to cinemas in the U.S., Canada, and the UK and with no subtitles to Japan, where Japanese-language subtitles were added prior to projection. In the middle of the first season of Met cinema transmissions, German-language subtitles were added on short notice.



A second character generator, with a second operator (bilingual in German and English) was added, along with a second subtitlist, a second video keyer, a second motion-compensating HD frame-rate converter, another encoder, and more transmission paths, including another across the Atlantic Ocean. When more languages were required, it was clear that a different system would be needed. The Met has



worked with Screen Subtitling on the development of a live, multi-language, high-definition DVB Subtitle system. The system allows last-moment changes in all languages, multi-language proofreading, title skipping, direct video keying for the English-language North American feed, and more, including the ability simultaneously to send test subtitles with language identifications to the cinemas, rehearse subtitles with the director, and proofread and correlate the multiple languages. It is still being optimized as this is being written to improve its capabilities. Until HD DVB Subtitle receivers are generally available (and have been installed in all cinemas taking the DVB Subtitle signals), the Met inserts the subtitles into the pictures within the compressed domain to avoid additional decode-encode stages with associated image degradation. ASI signals are distributed to each language's subtitle inserter.

Individual Cinema Considerations

The Met cinema transmissions are seen in hundreds of cinemas and arts centers and even on 19 cruise ships in international waters. Different reception, projection, and sound systems are used. More significantly, there are different settings.

For pre-show advertising, for example, auditorium lighting is usually on, so projector brightness might be boosted to compensate. Sound, conversely, might be reduced in level. Those settings need to be changed for the operas. Before each opera, therefore, the Met transmits extensive test material including lip-sync identification, portions of different operas with both bright and dark scenes, and subtitles identifying languages. The test transmissions allow projectionists to verify reception and settings before the start of the opera "walk-in" period (the sights and sounds of the opera house filling up as the cinema auditorium fills up).

Mark Schubin

SMPTE Fellow and multiple-Emmy-award winner Mark Schubin first worked on cinema television in 1967 and is engineer-in-charge of the media department of the Metropolitan Opera.

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3. The Hurdles in programming Alternative Content



Frank de Neeve
Technical Manager
Mustsee Delft cinema
The Netherlands

I'm a projectionist and technical manager, working at Mustsee Delft and I've specifically been hired for my knowledge of digital cinema. That's because in my second job, as a journalist writing about the cinema industry, I've been following the rise of digital cinema since 2001. I've also organized a number of digital cinema events and I have recently launched the premier Dutch website on D-cinema, *www.cineserver.nl*

I've entitled this piece 'The hurdles in programming alternative content', because I think that when cinemas start exploring this topic they come across technical, financial and even mental matters that could hinder their advance in this field or even make it come to a grinding halt. This article isn't particularly technical, but I hope that it will help you to appreciate some hands on experiences of starting out in the field of Alternative Content.

First let me explain about the digital cinema situation in The Netherlands. We have about 30 2K screens in this country, with all chains having 1 or 2 cinemas with a few pilot installations. Up to now we have seen no roll out of any significance, though this might change in the coming months.

When the Mustsee cinema in Delft was opened 2 years ago, we were the first cinema in the Mustsee group with digital projectors: one in the main auditorium and one in a medium sized screen. The only cinema that I was aware of having any experience with alternative content was the Luxor Hoogeveen, an associated cinema in the north of the country. Talking to them didn't make us very happy. They had for instance been offered the European Championship soccer 4 years ago for 25,000 Euros, which they'd kindly declined. And they had played a pre-recorded concert of Marilyn Manson to no more than two paying customers.

So for a while we didn't do too much with the projectors, apart from getting acquainted with them and trying to get to grips with all the faults and bugs that were still in the projectors and servers. We hardly played any movies on them, as there simply weren't any digital movies available in this territory.

First steps into AC

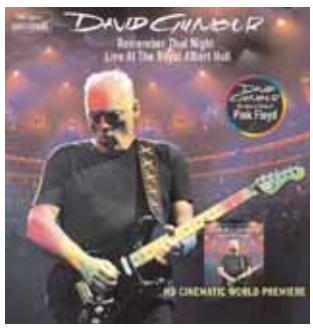
With our booker concentrating on features, I was allowed to venture into the wonderful world of alternative content or Other Digital Stuff. Apart from Euro1080, the first European HD channel that also does broadcasts to cinemas, I wasn't aware of any company offering this kind of content. This is true for most exhibitors: I sometimes say that we in exhibition have only one address book and it only contains the names of the film distributors. This is the reason why in the near future they will also start offering alternative content; to them it's only another kind of content for which to broker the rights.



Mustsee cinema in Delft. *Photo credit: Roloff de Jeu*

Learning lessons

So what to do? You could take a look around D-cinematoday, but in my experience it's also good to regularly check the websites of International exhibitors. So one day on the website of the British exhibitor Vue I came across the announcement of Dave Gilmour live by satellite. We didn't have a satellite connection back then, but I also decided that this Dave Gilmour wasn't for us. I mean some guy from the seventies that we hadn't heard from for ages? The show did play at Pathé Tuschinski and Cinemec Ede and sold out, in Cinemec even on 2 screens. I've since learned that old rockers are big business, especially since their fans are generally somewhat older and don't mind spending some money, which is nice for us exhibitors. Another lesson is that we in exhibition know a lot about movies, but that's about it. So when working with alternative content, but also with gaming, it's good to have a partner organization with knowledge in that field. So now when I get offered rock concerts, I visit my local record store and ask the owner how well this act sells. I then also phone a friend who is a rock promoter to enquire about the act, and with both their inputs I can save myself disasters like with Dave Gilmour.



Later on, also on the Vue website, I came across Take That live from the O_2 in London. I could see the commercial potential of this event and rang my contact at Vue to express my interest in this project. At first he seemed willing and told me the conditions, but later on it became clear that Pathé, the major exhibitor in The Netherlands, was also talking to him. Pathé wanted to bring the Take That event exclusively to their site in The Hague. I argued that Take That are big enough an act to bring to two sites in a country of 16 million people, but that didn't work.

So that was another lesson: while the distributor of Harry Potter wants to carpet bomb every territory with his film, alternative content doesn't work like that. Exhibitors sometimes want to claim exclusivity, in an attempt to distinguish themselves from the rest. Of course this is an emerging market, and conditions and arrangements still need to be tried out.

I did in the end buy a ticket for Take That at Pathé Buitenhof and - not being a fan myself - it was good to see the fans standing up from their seats during the show and singing and dancing along. The best thing however and one of my cinema experiences of last year was before the actual show started, to see the wave go through the O_2 venue in London and continuing in the cinema in The Hague.

Revenue implications

Let me at this point say something about the general expectations of how alternative content can add to our revenue. The example above with two exhibitors fighting for Take That is in my vue exceptional, basically because the focus of exhibitors will remain on screening movies. Expectations are that alternative content will not add more than 10% to the box office. Having attended Cinema Expo and other trade shows since the year 2000, I know how manufacturers have stressed again and again how much more money exhibitors can earn with digital projectors, using them for seminars and the like in the dark hours in the morning. Well, I can tell you that the Mustsee Delft cinema is certainly not full in the morning, it's just the cleaning ladies at work.

To illustrate this point, let me tell you about a recent project. I got a phone call from a UK company offering a live rock concert by satellite. In order to be able to bring the event to The Netherlands, they needed to convince the record company of the band that there was sufficient interest in this project with Dutch exhibitors. Thing was that they didn't know all the digital cinemas in this country, so there I was phoning our competitors enquiring if they were interested in screening this event. It turned out that some of the early adopters, that had been the very first to install the equipment more than two years ago, had never been offered alternative content at all, and had not ventured into this field themselves either. This astounded me.

There is more to AC than money

Later on, when these cinemas had their satellite equipment installed, they wrote me an e-mail enquiring where they could get certain alternative content. They'd made some calculations with costs, ticket price and number of admissions, which covered my whole computer screen. My reply to them was that starting out in alternative content should be a commitment more or less regardless of money. This period should be utilized in gaining experience with the equipment, with finding an audience for this content, getting your ticket price right etc. Any money you lose, should be regarded as the cost of gaining experience in this field. To say it another way, you should turn a mental button about wanting to venture into this field.

In some strange way when talking about alternative content people always end up talking about opera. We at Mustsee were always a bit hesitant when opera came up. We thought we know how to reach movie lovers, but how will we reach opera lovers and convince them to come and see opera in the cinema? Last year we were offered The New York Metropolitan, but had to commit to 8 transmissions right from the start. Having at that time no experience whatsoever with alternative content, we decided to let it slip. How wrong could we be...

When we were offered live opera by the Italian company DDCinema late last year we decided to give it a go, as the only group in The Netherlands. We have up to now done four live operas from various locations like Venice and Madrid and especially in Mustsee Delft it has been a great success: our highest number of admissions is 270 people, proving that exhibitors tend to be more conservative than their customers. However, to make this kind of content a success takes a lot of work. In exhibition we're used to open our doors when we have the new Disney movie and people will just turn up to come and see it. Alternative content really is something else. Especially in mainstream cinemas, marketing is regarded as something that is done by the distributor, and a cinema marketing manager is seen as something of a luxury. For alternative content to work, this attitude needs to change.

Live Sport

We have had some interesting experiences with live sports here. Let me start by telling you why we decided not to screen the Euro2008 soccer tournament. I visited Euro1080 in Belgium together with our CEO a few months before the tournament, where we discussed this. They offered us a good price and we expressed an interest in screening it. However, as time went on and they were finalizing their agreement with UEFA, hesitation grew. It appeared that matches would be broadcast with English commentary - so not in Dutch. Also, when it was finally offered to us, it was already just a few weeks before the start of the tournament so there was hardly any time to prepare. And thirdly: here in the Netherlands, every bar has big football matches on TV or a big screen for free, so it would be hard to compete with them. In our view alternative content that is live should be exclusive; otherwise it's better to leave it.

Formula 1 is something that we often talked about, but never thought we'd be able to show. Word had it that Bernie Ecclestone, the boss of Formula 1 had objections to it being shown in cinemas. Much to my surprise at the end of last Formula 1 season, I suddenly saw it featured on the website of Odeon Cinemas in the UK. It wasn't easy to get in touch with the company that brokered the rights to the races, calling it 'F1 in Cinema' and when we did, their conditions were not like what we're used to in exhibition. They asked a contribution towards satellite costs of 1000 Euros per race which therefore acted as a minimum guarantee plus a 50/50 ticket revenue split on top of that. This is something that I've noticed with companies that offer alternative content: their financial demands can be quite out of



Formula 1 screenshot in cinema

this world. I already mentioned the 25,000 Euros that was demanded for the European soccer and as another instance we were offered live opera at a flat fee of 1500 Euros per screen. Another company argued that there were so many players involved in a certain project to legitimize the quite exceptional revenue split that they demanded.

The first Formula 1 race that we screened was the race in Spain, the first European race of the current season. The deal came about only 10 days or so beforehand because of long negotiations, but also because of the contract that was sent to us. It was so lengthy that we had it checked by our solicitor: again, something that we are not used to in this business. A little over 100 people turned up at the Mustsee cinema for this first race, which was a number that we could live with, but we'd had higher expectations of Formula 1. Problem was that 'F1 in Cinema' didn't provide us with any promotional items like regular distributors do. We'd advertised in the local newspaper and on some Formula 1 websites, but apart from that we hadn't been able to produce any promotional items like flyers, as `F1 in Cinema' had to okay them all...and they didn't. Also we weren't allowed to use the name Formula 1, but had to call it F1. Thereby we had to use the 'F1 in Cinema' logo on all our announcements. We could buy the official Formula One photos but everything that Mustsee produced at our own costs got rejected. This matter dragged on for weeks and weeks, to the point that we started to think `hey, it's also in your interest that we promote this thing and make some money'. Some people have said that we should have made a joint promotion with broadcaster RTL. For one, I think this has only any chance of being accepted when you have a good spread of cinemas showing the content. With our four digital Mustsee cinemas showing Formula 1, I think our chances would have been very low. On the other hand, this is hardly a tried and tested concept in exhibition; cross media promotions coming from cinemas themselves are few and far between.
Looking at the survey that we did with the Formula 1 audience, it turned out that they missed a decent preshow looking ahead at the race and that they missed the Dutch commentary by Olav Mol, who works for broadcaster RTL, F1 in Cinema only providing English commentary. Subsequently for the next race from Turkey, we had a smaller audience, also with a small number of returning visitors, which bothered us. So what could be the reasons for this. The audience might not have liked what they saw: I can tell you that Formula 1 on the 17 meter screen in Mustsee Delft's main auditorium, with 5.1 sound is quite something. It is however only 720p and not 1080i like the operas that we showed. The reason for this is that for fast movement you need progressive pictures, interlaced would look bad. And apparently 1080p is not currently possible over a satellite link. However, when one of my colleagues used his videoscaler to produce a split screen with the regular broadcast signal from RTL, he was amazed to discover that there was hardly any difference in the image quality.

Getting the price right

Secondly the price might have been an issue. We charge 15 Euros admission, which is almost double the price of a regular movie ticket and some might consider this expensive. However, they don't realize that we got offered this content at 1000 Euros satellite cost per race. On the other hand it should be said that we're having a hard time getting our admission price right. In cinema we're used to charging 8-9 Euros, but opera lovers are used to spending much more. After much internal discussion we



Formula 1 promotion outside cinema with car decorated by 'Miss Drenthe'. Photo courtesy Luxor Theater Hoogeveen

now charge 21.50 Euros for live opera, but for instance Pathé charge 32.50 Euros. And if people are willing to pay...

Technical difficulties

The second race turned into a major disaster as during the race our signal deteriorated, up to a point that we had to cancel the show and refund all the tickets. It turned out that our satellite guy had mixed up 2 satellites and that our dish was pointed a fraction off target. This time it was our fault, but to cinema people live events are very scary. We're used to having the film, our equipment and the knowledge of how to use it all in house and if something goes wrong, we can generally fix it ourselves. With satellite, you have to say a little prayer as it's all in other people's hands. If some guy in Italy or wherever pulls the wrong plug, it's over and out. Getting to grips with satellite equipment, video scalers and external sound signals is also an art in itself. In Mustsee Delft we're now up to our third upgrade of the satellite installation: after having started with just a fixed installation, we had a motor added, then a back-up dish and now we're looking at an upgrade of the whole system, with a new receiver and cables. Knowing nothing of satellite whatsoever, it's a strange feeling venturing into the world of LNBs, different kinds of receivers and the likes. Starting out in alternative content, an exhibitor has no idea where to get his equipment and what to buy. Once you have a dish installed, it quickly emerges that your demands change, for instance if you're screening from multiple satellites and you have to upgrade the equipment. But if you have a problem with the equipment, it's hard to find out who to believe in getting the matter resolved. Some will for instance say that a small dish is good enough for good reception, while others will claim that there is a huge difference between a 1.1 and a 1.2 meter satellite dish. And then we haven't even started to discuss the wonderful world of video signals and video scalers, but that's worth a whole article in itself.

I hope that I've been able to give you an inside look into to the pitfalls and hurdles to take when cinemas enter the arena of alternative content. To some, they seem so huge that they never even start screening it, but when they do decide to give it a go and the hurdles are taken successfully, screening alternative content can be quite rewarding.

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This article is based on a presentation at the ICTA technical seminar June 22nd 2008 in Mustsee Delft. ICTA, the International Cinema Technology Association, is an organization of hardware manufacturers for the cinema industry, designing equipment that gets used day in day out by projectionists in cinemas.



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4. Satellite Delivery for Alternative Content: The Future for Digital cinema



Scott Mumford
Datasat Communications

Introduction

The delivery of cinema content via satellite is a strong proposition for the future of digital cinema and will see the market move away from the traditional method in which content is delivered via hard drive or reels of celluloid. Satellite is currently the predominant method used for delivering alternative content to cinemas with different levels of service available. The quality of the service received is mainly a question of how much bandwidth a provider wants to use for delivering alternative content and how good is the system design. With many instances of signal drop-outs in the past, it is important for the cinema industry to ensure that it is able to send and receive content, without alienating the audience to ensure that alternative content is a success.

In this article we discuss the various aspects that can affect the quality of service that satellite can offer, and the cost implications and reliability of the transmission path. Datasat Communications has been working with DTS Digital Cinema to develop an advanced system for managing the delivery of content to cinemas, and both companies are actively involved in the European 2020 3D Media project to further this objective.

Applications for satellite delivery

Currently there are two principle applications for delivery of alternative content via satellite. The first application is the broadcast of live material, involving the process of streaming live content through a broadcast satellite channel; and the second application is delivering content for later playback involving a process of file delivery over a managed satellite communications service. In the satellite world, both processes happen very differently.

Segmentation - optimising cost effectiveness

In order to maximise the benefits of a satellite channel and minimise costs, content can be optimised by segmentation into smaller packages for transmission rather than being sent as a constant stream. By delaying the file transmission



process and sending the content in segments, use of spare capacity on a satellite can be optimised (e.g. overnight transmission so that the programming is ready to playback in the morning) and thus minimising the cost for the content distributor.

Live Content

The concept of delivering live content is a very different challenge. There are a number of ways to deliver such content and a number of different pricing tariffs which accompany each level of service. Through satellite delivery of live alternative content there is a quality, cost and availability/reliability equation which must be taken into account. The consequences of loss of signal need to be understood, and if intermittent interruptions are not acceptable, steps can be taken in the design to improve system availability, performance margins, fault tolerant transmission protocols and system redundancy.

There are additional techniques (e.g. lossy or lossless compression schemes) that can be invoked to create more space for self-correcting error detection systems. There are also varying degrees of redundancy which can be put into a system. Redundancy makes for a more resilient service but there is a higher capital cost associated with such an approach. By utilising robust equipment and well-architected system designs, content distributors can reduce the risk of failure or the separation of signal parts. Domestic equipment can be used at a lower cost, but this comes with lower reliability and reduced flexibility. Satellite technology has demonstrated that not only does it have longevity but that it is stable and reliable.

Practical experiences

There have been cases of loss of signal and dropouts with live broadcast to cinema. Some cinemas have had to refund tickets due to an extended loss of signal. To avoid this undesirable scenario, appropriate solutions must be implemented in order to achieve a positive impact on the quality of service and ensure consistency throughout. If satellite is used to transmit the content, failures should not occur as long as the service provider has specified and installed the equipment correctly. As a medium, satellite requires a suitably rigorous

link budget calculation to be completed. Such a calculation will ensure that the signal being received into the antennae is within specification under all realistic operating conditions. As with any technology, however, nothing is infallible and system failures occasionally occur - which is why redundancy is included in the first place.

Satellite reliability considerations

The myth that a satellite itself is not reliable needs to be dispelled as it is a very robust and widely used delivery system. Satellites are expensive systems and are designed to operate for a number of years without maintenance.

Internet Protocol solutions

IP-based solutions for delivery of alternative content are beginning to be used, but the problem with these solutions is the available throughput that can be obtained from existing broadband links. When using IP-based systems across shared ADSL networks, video quality often suffers, (usually due to the non-deterministic characteristics of packet-based terrestrial networks giving variable path parameters and also to user contention ratios) and services are usually provided on an "available bandwidth" basis rather than guaranteed bandwidth. This is not the case with dedicated media channels such as satellite or point-to-point fibre. Of course, there is a cost implication with securing 100% reliability through satellite channels, but to elicit the benefits that showing alternative content can provide, it is worth the investment to ensure that customers are happy with the service they receive. This will increase their loyalty and ensure that they keep coming back for future programming.

Satellite delivery to cinemas - it is the way forward

Alternative content looks set to play an integral role in the future of digital cinema as exhibitors look for ways to maximise their profit through the programming they show. This content will include live broadcast as well as pre-recorded material, both of which can be distributed highly successfully through satellite channels. Broadcasting live content means that the quality of the service depends on the amount invested in ensuring reliability. It is likely that the digital cinema industry will embrace the delivery of content via satellite which is why companies such as Datasat Communications and DTS Digital Cinema are working together to ensure reliable distribution becomes part of the norm.

Scott Mumford
Datasat Communications
www.datasat.com

5. Satellite Distribution - Achieving Cost-reduction through consumer electronics.



Bob Hannent
Chief Technologist, Humax Electronics Co. Ltd

Introduction

The usefulness of satellites in distributing content over a wide geographic area and particularly into remote or non-metropolitan areas has now been demonstrated to be indisputable. The satellite signal is broadcast from an 'earth station' to the satellite and the satellite with just some frequency transposing and amplification rebroadcasts that signal back to earth. The returned signal has a 'footprint' which is designed in to cover a particular geographical market and can either broadcast with a tight focus, with the associated focus of energy, or to a much wider area with still good performance. Typically broadcasters and network operators take advantage of this to distribute content either for 'one to many' contributions of events (such as sports and concerts) or for the core of their business 'direct to home' (DTH) broadcasting.

Comparatively the cost multiples of delivery over fibre or ADSL are not as advantageous as simply broadcasting when making use of existing satellite broadcast systems (rather than having a dedicated transmit infrastructure). The focus of this



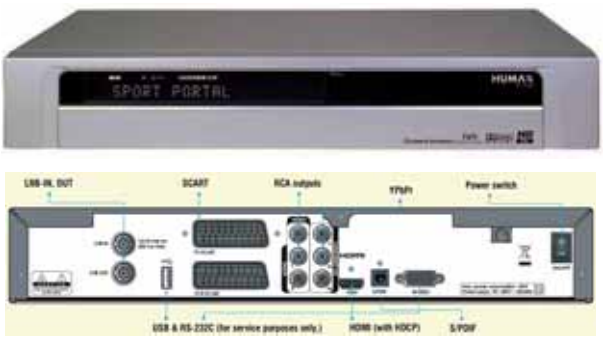


Typical satellite uplink station, and
Footprint of the North beam of Astra 2A
Images courtesy SES-Astra.

contribution is to indicate how the changing market of consumer electronics is beginning to produce products of such high production standard, with such powerful processing and with statistically significant volumes as to provide a low cost alternative to traditional delivery hardware. In addition the lessons learnt by consumer electronics manufacturers means that some options are available now that were perhaps costly with traditional broadcast hardware.

The Advantage

Typically 'contribution' has involved the use of expensive specialised broadcast equipment to receive the signals; the 'integrated receiver decoder' (IRD) is a highly specified satellite receiver which is able to handle a variety of video, audio and transmission formats that might be thrown at it. The cost of these devices is dictated by their low volume of sales, this is because these devices are often built from general purpose processing components such as FPGAs and DSPs which do not have the cost of a high volume custom ASIC. *[Field Programmable Gate Array: A programmable logic device. Digital Signal Processor: A specialized microprocessor designed specifically for digital signal processing in real-time. Application Specific Integrated Circuit: An integrated circuit custom designed to a specific task.]*



Humax HDCI 2000 satellite receiver and its various connections. Although designed for domestic use it has many features that could render it suitable for use with alternative content presentations for digital cinema

The typical 'domestic' receiver in use today contains simply a self-contained tuner chip which is very effective at its task and an ASIC processor which has all the required processing elements on-board. The processor has dedicated video decoders, audio decoders, video processors (with 2D graphics rendering and compositing) and often even video scalers to handle various video formats that might be thrown at it (although the scalers are by no means comparable to dedicated devices). The devices have a range of connectivity options both analogue and digital, including: HDMI, S/PDIF, component analogue and ITU Rec. 656. The ITU Rec. 656 output has to date rarely been used in products and is not available as an output from domestic products, but does exist as a chip output if required.

Previously these products had not been suitable for use by the cinema community because they were early generation domestic devices which perhaps either did not have optimal performance, or had features which prevented their use in a professional environment. One of the issues has perhaps been security - digital cinema distribution is a sensitive issue because the content being delivered is of the highest quality and its distribution needs to be tightly controlled. However it is worth noting that set-top-box (STB) manufacturers have been supplying high security devices to pay-TV operators for many years and these lessons learnt are now being applied to mass-market devices. Most notably the extension to the 'common interface' (CI) standard called 'CI+' is enabling better control of content to and from the STB including secure connection to a display device via HDMI.

Another advantage of delivery to these devices is that consumer electronics has given us the 'digital television recorder' (DTR or PVR) and this is a receiver with a built-in hard disk. It is easy to achieve a good level of time-shift, push content and repeatability with these devices for public presentation. The devices have a large capacity (typically 320GB to 500GB), can have external storage attached and can replay the content consistently even while receiving/recording further transmissions. It is also worth noting that although the video formats used in broadcasting production and distribution are rather limited these devices are actually capable of handling much more than they typically receive, including 1080/24p.

Challenges

It is worth noting that up to this point consumer electronics companies have not been encouraged to develop for the cinema market. It is only now that the technologies are beginning to become feasible for the desired standard of delivery. Further effort is required to meet the needs of the digital cinema market, but the technologies are here to be implemented. The challenges that need to be met are:

1. **OSD**: The on screen displays presented to the consumer are very useful for controlling the device; however this it not desirable in public presentation. With some little effort either the OSD could be eliminated and the device controlled via another means, or a separation of the OSD could be arranged, so it appears on the SD output and not the HD output in a typical monitoring arrangement.
2. **CI+**: As yet it is not implemented in any consumer devices although a range of other security options already exist as well. Newer HD receivers have the potential to support the new CI+ standard.
3. **Development**: If the hardware can be a standard production model then the cost multiples are achieved in hardware. However the modification of software to meet the demands of the cinema industry should be confined to the minimum and then developed quickly so as not to impact larger business opportunities.

Once these needs are met a product could be sold with off the shelf hardware which could cost as little as €200 to €600, a price which is affordable to almost any size of cinema presentation operation including rural and low income areas.

Bob Hannent

HUMAX entered the digital set-top box market in 1997 and now exports them to over 90 countries worldwide, a truly global brand. The convergence of technologies is providing Humax with new challenges and fresh opportunities in the marketplace, and the company aims to become a provider of a wide range of Digital Home Multimedia Products including home media servers.

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Bath Road, West Drayton, Middlesex UB7 0DB, UK Contact: Tom Cotton tom.cotton@thomson.net

6. Satellite Distribution - The best solution for Alternative Content



George Eyles
Head of Digital Media Networks, Arqiva

Satellite remains the most viable, flexible and cost effective platform for broadcasting live events to a cinema audience and utilising satellite technology need not be as complicated as you may imagine. The service is supplied using tried and tested technology similar to that used for satellite distribution of direct-to-home broadcasting. However there are some important differences, especially regarding flexibility and operational efficiency, which raise the service from a domestic to a professional level. What follows is a guide to the technology involved and the key factors to consider when digitally enabling a cinema for satellite distribution of alternative content. Naturally the key to an optimum install is using a single reputable and established satellite service provider with a good understanding and experience of Digital Cinema. They will be able to guide you on the specifics of a particular project and will deal with the technical complexities on your behalf.

It is worth remembering that the broadcast of live events and pre-recorded material differs fundamentally in the way that the data is transmitted. Pre-recorded material is segmented and encoded as lots and lots of individually labelled data packets which can be stored on a hard drive and 'unpacked' for viewing in non-real time. Alternative Content, whether it is a live broadcast or a recording broadcast 'as live', encodes the data as a continuous stream in real time – delivering the picture data straight to the projection equipment. This naturally requires the associated hardware and software to work much faster and more efficiently than for pre-recorded material.

Which Satellites?

Satellites enable signals to be sent from point-to-multipoint (or indeed point-to-point). A key advantage of satellite distribution is its fundamental flexibility. Distribution is unfettered by the constraints of available terrestrial connectivity – especially between multiple and geographically diverse sites. This allows the satellite signal to originate from one location and be received within wide geographical footprints across the world – regardless of its terrestrial infrastructure.

The relative ease, speed and cost effectiveness of installing satellite hardware (with installation timescales measured in weeks rather than months) makes it a much more viable option when compared to terrestrial solutions. Being relatively quick and easy to install, satellite technology provides a fast start solution to Alternative Content distribution. Furthermore satellite's inherent scalability makes it simple to expand and grow your digital cinema network as required.

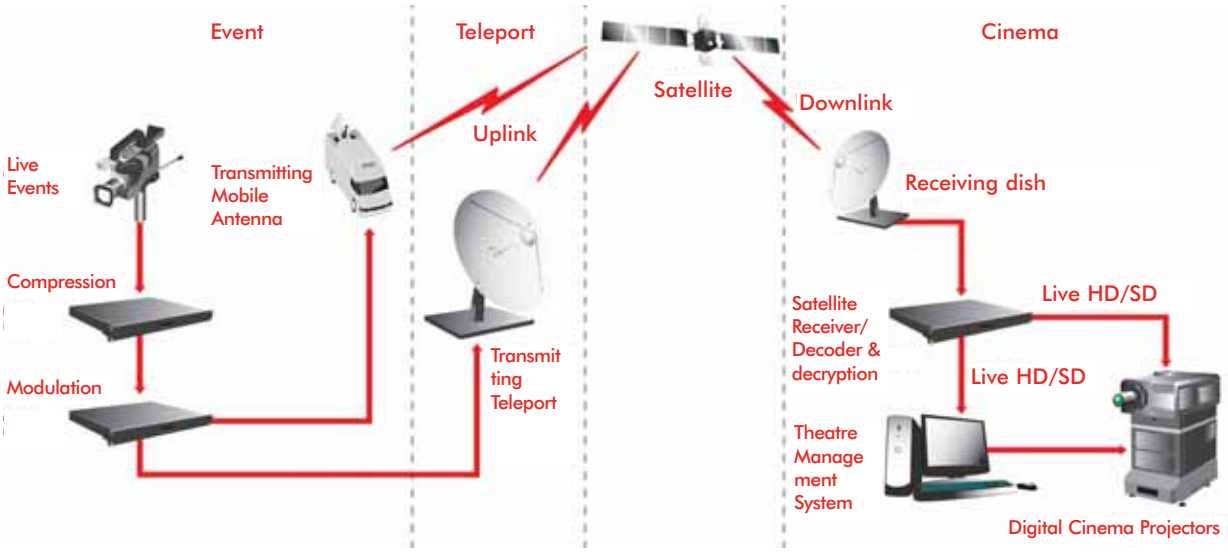
A further crucial advantage of satellite is that it is a guaranteed broadcast medium. Satellite delivers the highest levels of reliability and service with rapid resolution of any issues. This high level of guaranteed availability makes satellite a confident choice for the Digital Cinema distributor.

The complete Digital Cinema chain

The Digital Cinema satellite chain (diagram below) consists of a transmitting earth station (the antenna or dish which sends the signal), the distributing satellite which relays the signal and the receiving dish which receives the signal. The transmitting earth station is located at a teleport which contains all the technology and expertise needed to uplink a signal to a satellite. For live events an antenna can be deployed in the form of a mobile satellite truck or flyaway unit. These allow the live signal to be transmitted from the event's location, via satellite, to a suitable teleport for on-pass to the distributing satellite. In some circumstances the mobile antenna can uplink the live signal direct to the distributing satellite. An established and reputable teleport operator will act as a single-source technical service provider, managing all the elements of the satellite supply chain through a 24/7 help desk.



There are several hundred commercial satellites operating in a geostationary orbit 36000km above the equator. Placed in this geostationary arc, the satellite appears stationary when viewed from the earth allowing the earth station antenna to point in a fixed direction.





The Master Control Room at an Arqiva teleport monitors the uplink and downlink of live satellite signals



Each satellite has its own footprint – this is the area of the earth's surface that its signal can be received in. The satellite is designed to provide particular frequencies and power levels within this geographical area.

Your satellite service provider will select an appropriate satellite footprint based on the geographical area you want to distribute to. A single geostationary satellite can cover as much as one third of the earth's surface - for example Europe. For particularly broad geographic distribution, such as across multiple continents, it may take two or three satellites to reach all of your markets.

When the signal reaches the satellite it passes through a transponder which receives, amplifies and re-transmits the signal. Commercial satellites usually carry between 24 and 36 transponders, some capable of handling a throughput of up to 155 Megabits of data per second. High Definition broadcasting demands a relatively high level of data throughput, requiring a larger number of Megabits per second and therefore more satellite transponder capacity.

As satellite operators tend to sell only full transponders, each typically costing several million Euros per annum, it is advisable to buy the exact capacity you need through an established satellite service provider. They sell portions of the transponder, a defined number of Megabits over a contracted period of time, appropriate to the requirements of individual customers. Your satellite service provider will select a satellite with suitable transponder availability for your Alternative Content occasional use requirements both now and in the future. This is important to avoid having to switch satellites which would involve costly re-pointing of your receiving dish.

The cost of satellite transponder capacity depends on a number of key factors including the satellite footprint, power and popularity. It is also worth noting that a specialist satellite service provider may be able to leverage access to heavily or even over-subscribed satellites on your behalf.

Different satellites have different power outputs measured in decibel watts or dBW. Furthermore the power output of the satellite beam will vary within its footprint, generally reducing towards the periphery. The greater the power output of the satellite the smaller the size of the receiving dish that is required - but you may have to pay more for your satellite transponder capacity. The combination of power and coverage (satellite footprint) is a major consideration in working out the design of your satellite network.

Satellites transmit their signal as a radio frequency beam in either C-band, Ku-band or Ka-band – each an assigned portion of the radio spectrum. For Alternative Content Digital Cinema broadcasting Ku-band is the best choice. C-band utilisation is restricted in certain areas and it is susceptible to interference from microwave beams in the metropolitan areas where many digital cinemas are located. Ka-band is still very much in its infancy with technology still being refined and equipment still expensive.

The differing operational frequency bands and power outputs that make up the satellite's transmitting beam will determine the size of the receiving dish required to ensure a reliable signal. Ideally Digital Cinemas will want to deploy smaller dishes that are less expensive and take up minimal space in an urban environment. This requirement for a small receive dish demands the use of a high power beam. It further precludes C-band which requires a larger dish to capture the longer wavelength and lower power beam. While Ka-band utilizes suitably smaller dishes its advantages are not yet easily exploited as noted above. This leaves the very acceptable Ku-band as the optimum choice for the Digital Cinema industry.

While the programme distributor will normally contract with the teleport operator to deliver the signal it is important that the right dish sizes are installed – and pointed in the right direction - to pick up the satellite beam. The complex and technical process of balancing crucial factors such as footprint, throughput, frequency band and power output is best entrusted to a single experienced service provider.

The size of your receiving dish is also important when you consider the need for planning consent. Planning regulations vary around the world and even regionally within a single country. However early consultation with local authorities will resolve these issues and, as a rule of thumb, the smaller the size of dish the easier it is to get approved.

To receive a signal the receiving dish must have a clear line of sight to the transmitting satellite situated directly above the equator. The further north or south you move from the equator, and the further east or west from your chosen satellite, the lower the necessary look angle of the receiving dish. The higher the look angle the less of an issue buildings surrounding the dish become. For European distribution satellites with an orbital position between 25 degrees East and 25 degrees West will provide suitable look angles in most locations and circumstances.

Therefore your choice of satellite will be determined by the location of your cinemas, size of dish you can install, possible elevation of the dish in relation to surrounding structures, availability and cost of satellite capacity, and the bandwidth and available power of the satellite. These considerations will all be computed by the satellite service provider who will ensure the most effective solution for individual and multiple sites.

Which compression scheme?

Compression is an essential part of the transmission process because it is not cost effective to transmit uncompressed video. A typical uncompressed High Definition signal, destined for the big screen, requires an uncompressed data transfer rate of around 1.2Gb every second. This would require around 20 transponders – over half of the transponder capacity available

on a modern satellite. Compression reduces the size of the required bandwidth by a factor of around 80 – so that 1.2Gb/s becomes 15 Mb/s – a much more manageable size requiring only 5-15MHz of satellite transponder capacity (depending on your modulation choice).

You may already be familiar with JPEG 2000 compression as the standard used for the file based distribution of feature film content. However for Alternative Content distribution to the Digital Cinema market two principle forms of compression are available - MPEG2 and MPEG4.

MPEG2 is currently used for most TV transmissions, including High Definition TV. MPEG2 has a proven track record as a safe, solid and stable compression scheme. Its wide availability, relatively low outlay costs and well understood technology make it relatively simple to deploy and still a viable option against more advanced technologies. However it is not the most efficient form of compression and anyone looking to maximize their compression should utilise its more advanced version – MPEG4.

MPEG4 is already an industry standard for Direct-to-Home HD TV broadcasting, having originated from streaming video on the internet. Its enhanced compression rates are driving its popularity on other broadcast platforms – including Alternative Content for Digital Cinema. MPEG4 achieves its higher compression rates through highly complex and powerful processing of the image. This delivers significantly greater transponder efficiency, reducing the required satellite transponder capacity. This cost saving is offset against a higher initial outlay for more expensive receivers – but as prices steadily come down MPEG4 is superseding MPEG2 as the industry standard.

Early compatibility and standardisation issues have been resolved though expert advice is recommended to ensure reliable operations. It is also worth noting that the high level of complex processing used by MPEG4 can lead to a short time delay. This only really effects time specific interactions between the event and the audience, and ever improving processing speeds are steadily reducing its impact.

It is briefly worth mentioning JPEG2000 compression, the Digital Cinema industry's standard for the non-real time delivery of digital movies as data files. While it can achieve very near lossless compression, its very modest compression efficiency and far greater decompression time makes it unsuitable for Alternative Content transmissions. Digital Cinema screens are LAN, server or/and file based systems generally operating on GigE networks. So live streaming, particularly when coincident with movie playout, would congest the network and could cause significant problems. Therefore this cannot be used to deliver Alternative Content and a separate video distribution network may be required within the cinema complex. Therefore your choice of compression scheme is a trade off between the slightly cheaper initial install of MPEG2 technology and the significant transponder capacity savings of MPEG4. In most circumstances, the advantages of the more efficient MPEG4 compression scheme now outweigh those of MPEG2.

Which Modulation Scheme?

Modulation is the process by which the film or video is transformed into a radio frequency which can be sent via satellite from the transmitting earth station to the receiving dish. In essence it turns the digital video and audio you wish to distribute into a transmittable radio frequency. These modulation schemes are well established in satellite direct-to-home services. Some forms of modulation are more efficient than others and maximising the efficiency of modulation brings cost savings on the amount of satellite transponder capacity required.

DVB-S (Digital Video Broadcast - Satellite) is the current industry standard designed for and generally used with MPEG-2 compression, although it also works with other compression formats. The technology behind DVB-S is tried and tested with mass produced and relatively low cost receivers being readily available and consistent across the world. However DVB-S is not the most efficient form of modulation which means you need to lease a larger amount of satellite transponder space. It is primarily this inefficiency, rather than questions of quality, performance or reliability, that is seeing it replaced by DVB-S2.

DVB-S2 provides up to a 30% saving on transponder capacity compared to its forerunner. Steadily becoming more available, the hardware investment is more expensive but costs are converging and this is seeing DVB-S2 become the industry standard. DVB-S2 modulation can carry both MPEG4 and MPEG2 compression, giving greater flexibility, choice and ultimately greater potential efficiencies and savings. While DVB-S delivers the same end-result in terms of quality, at the moment the additional initial outlay on a DVB-S2 scheme must be offset against the reduced costs of satellite transponder capacity it delivers. However, as outlay costs continue to converge, DVB-S2 is becoming the de facto standard.

Satellite Receiver / Decoder

The satellite receiver decoder sits at the digital cinema end of the chain. The receiver element demodulates the radio frequency signal received from the satellite and reconstitutes the bit rates of the original signal converting it into a base band digital stream. The decoder element further decompresses the signal back into a High Definition picture. It's worth noting that early attempts to use domestic satellite receiver decoders in digital cinemas have failed - often embarrassingly. Only professional satellite receiver decoder equipment should be deployed to ensure the requirements for reliable alternative content delivery are met.

Digitally enabled cinemas need to be able to receive two different and distinct types of signal: real time broadcasting used for Alternative Content and non-real time file transfer used for digital content and film distribution. The Digital Cinema Initiative (DCI) sets the standard for the transmission of digital cinema files. Most digitally distributed movies are sent as data, compressed using JPEG2000 and with a DCI overlay providing conditional access and security encryption. However, Alternative Content is transmitted using the faster MPEG2 or MPEG4 compression. Increasingly it is possible for a single satellite receiver decoder to handle both kinds of signal and switch easily and seamlessly between the two. There are a range of professional satellite receiver decoders available off the shelf, however equipment like the IDC satellite receiver decoder has been specifically developed for Digital Cinema distribution and has a proven track record in the United States.

Security and Encryption

Encryption of the satellite signal is fundamental to the security of Digital Cinema content. To ensure that the signal can only be accessed by authorised receivers the signal is encoded and encrypted at source – whether this is in a studio or at the live event. Studio material, such as recorded movies, uses a DCI

encryption as standard, designed with JPEG2000 compression in mind. Alternative Content is frequently encoded using BISS-E, the industry standard for live outside broadcast events. Both encryption systems have a proven track record for their particular purpose, but it is important to ensure that the satellite receiver decoder installed can decode both.

Therefore the most essential factor in choosing your satellite receiver decoder is to ensure that it can handle all the relevant forms of compression and encryption that are required. Once again, taking expert advice from an established service provider will ensure that the technology you install is fit for purpose.

A note on stereoscopic (3D) broadcast of Alternative Content

The ability to broadcast Alternative Content in 3D offers very exciting possibilities to event organisers and exhibitors. 3D Alternative Content is increasingly seen to offer a truly engaging audience experience and therefore the ability to handle stereoscopic transmissions is becoming increasingly important to digitally enabled cinemas. To ensure as life like an effect as possible 3D motion requires pixel accurate synchronisation of two camera signals – each slightly physically offset from the other. These two signals must be modulated, compressed, transmitted and decoded whilst maintaining their synchronisation. Simplified solutions to this complex process are still being developed but there are two essential schools of thought at the moment.

One solution offers pixel accurate dual transmission of the signals. Here the cinema-end reception equipment employs buffering to allow the two signals to be received and the two receivers are synchronised to allow their outputs to be fully timed. Another solution is to pre-mix the signals prior to transmission. This enables the signal to travel within the same bandwidth envelope and be unpacked at the cinema-end while maintaining their synchronisation. The advantage of this is that it is a little more efficient on bandwidth and therefore could offer a slight cost saving on satellite transponder capacity.



Both systems have their pros and cons; however satellite has the inherent advantage of being able to transmit either option without problem. As this is still very much an emerging technology the standards have yet to be set. Therefore it is again highly advisable to seek up-to-date advice from a reputable service provider when considering installing 3D technology.

George Eyles

Some notable Alternative Content events

2007
Ross Noble Live
Danny Boyle, Sunshine, Live Q and A
Joe Wright, Atonement
Ken Loach, It's a free world
Quentin Tarantino, Deathproof
Shekhar Kapur, Golden Age
NY Met Opera, five live transmissions
Glyndebourne, three recorded events
Genesis Live from Dusseldorf
Bob Marley Anniversary Programme
Stax 50th anniversary DVD releases
David Gilmore - Live and the Royal Albert Hall
Pearl Jam -Imagine in Cornice
Queen Rock Concert
The Who
Kylie White Diamond
Ramones: Its Alive
Take That
Formula 1 Live, three Grand Prix events
Rugby World Cup x 34
Pam Ayres, Mothers Day Special
Warner Bros. Movies that Matter festival
Mike Leigh, Happy go Lucky plus interview



The Rolling Stones in 'Shine a Light'. Copyright Twentieth Century Fox. Courtesy PAPicselect

2008
John Wayberry, Edge of Love plus interview
La Scala, six events
NY Met Opera, eight transmissions
Muse Live at Wembley 2008
Fall Out Boy, Live in Phoenix
Foo Fighters
Rolling Stones, Red carpet and Shine a light
Girls Aloud
Formula One, three races
Royal Opera House, five events

Thanks to screendigest

7. The Multiplex of the Future - New Experiences on Screen



Olivier Rey, EU EDCine project

Introduction

What can we expect from a fully networked cinema? It is quite a difficult question to answer. This is rather like how it was difficult to predict the evolution of the internet in its early years. Even though current technology already allows alternative content to hit the screens, the creators and the marketers still need to fully get their heads around this new concept. The future of the Alternative Content idea is still unknown, and still to be developed, for many reasons.

First there is no complete cinema network at the moment, so Alternative Content cannot reach all the potential clients. Also, this new concept of using a film theater for Alternative Content may be against the interests of some movie distributors. So far this new experience has in general been kept away from cinema audiences.

Looking to the future

Let us imagine a day in the life of a family in a place called "Alteplex" in the year 2012.

'It was a 4th of July in my small town somewhere in the northern hemisphere. As usual at this time of the year, the weather was awful, it had been raining continuously for some days, with depressions crossing our sky one after the other. The kids were already on their school holidays and my wife Nathalie and I couldn't wait to have a break after this never ending year, so we decided to try out the freshly opened **Alteplex** in our city, a completely new complex. The concept was of a totally new genre, mixing audiovisual experiences, interactivity and entertainment.

The principle was very attractive. In a place that we could compare to an old cinema multiplex, we could watch concerts, operas, sports, play games, and take part in debates from remote locations, etc. Nathalie, Maëlle and Loïc, respectively my daughter (17) and son (15), were very excited to experience it. We had some friends from London who had already told us how much they liked the concept. To them, it had already become their way of spending a rainy Sunday together in a great atmosphere. Their Alteplex had opened a year ago and its success was immediate.

Making the Plan

We had spent some time on the internet the previous week in compiling our agenda of activities. After a good meal, we sat altogether in front of our screen in the living room and started to discuss and plan our day at the Alteplex. It was already quite a struggle to make a plan that would allow us to fit in all the different shows and events proposed by family members. The complex was divided in sectors; each one was especially dedicated, one for sports, one for documentaries and debates, one for video games, one for music, one for old movies, and even one called "the church". You could choose between different formulas. It was very clever, and you could shop and mix different themes for a fairly reasonable package price. As you can imagine, we ended up with 4 different programs. From the start, we decided that we would all finish our day by watching the football game together in the "Event Theater" as they called it. This was the largest room of the complex that could take 2000 people - there weren't any seats, but this crowd gathered in front of a huge screen, 20 metres wide by 11 metres high, equipped with 3D.
I have provided a copy of our agenda below, to give you an idea of our day at the Alteplex.

<table>
<tr><th></th><th>Nathalie & Olivier</th><th>Maëlle</th><th>Loïc</th></tr>
<tr><td>10h - 11h</td><td rowspan="2">Tea Road</td><td rowspan="2">My name is Nobody</td><td rowspan="2">PS3 Soccer 2012</td></tr>
<tr><td>11h - 12h</td></tr>
<tr><td>13h - 14h</td><td>Diner at 'L'Ecaillier'</td><td rowspan="2">Sauna and Hammam</td><td rowspan="2">Rocky IV</td></tr>
<tr><td>14h - 15h</td><td>Quatuor Danel from the Bozar June 2012</td></tr>
<tr><td>15h - 16h</td><td rowspan="2">Wimbledon Men's Final</td><td rowspan="2">Live from Secret Story's house</td><td rowspan="2">PS4 Formula One Championships</td></tr>
<tr><td>17h - 18h</td></tr>
<tr><td>18h - 19h</td><td rowspan="2">Jaws in 3D</td><td rowspan="3" colspan="2">Radiohead from Wechter in 3D</td></tr>
<tr><td>19h - 20h</td></tr>
<tr><td>20h - 21h</td><td>Transmission of a typical 4th of July in New-York</td></tr>
<tr><td>21h - 22h</td><td rowspan="2" colspan="3">European Cup Final 2012</td></tr>
<tr><td>22h - 23h</td></tr>
</table>

As you can see from the table, the day was going to be quite active. Everyone had chosen their own activities, and it was quite impressive to be able to switch between all these activities in only one place. I was very curious to see how everything would turn out.

How it all worked out

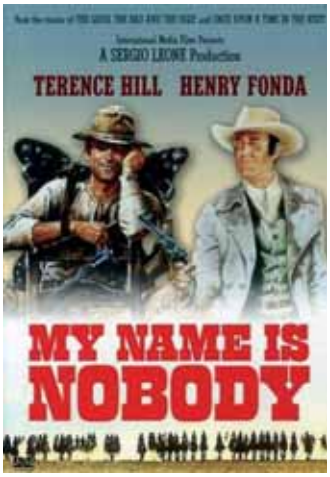
The next Sunday, we arrived as scheduled for our first meeting. The entrance looked like a cross between a Cineplex, an attraction park and a shopping mall. We had to scan our PDA through a terminal that printed us out our schedule for the day. The complex was composed of a dozen theatres colour coded to indicate the function of the activity programmed; green for sports, blue for music, red for entertainment etc. Some venues were big and others tinier. There were staff on hand to help us to find our way in the building. In the middle were restaurants, shops, place to relax and, cream of the crop for us, a swimming pool with spa capabilities.

I was also interested to see that, being a Sunday, one of the sections had been designated as a Church, and various religions were holding services there during the day, making good use of the audio and video facilities.

Documentary

Our personal program started with a documentary on the Tea Road in China. It was actually a old documentary re-mastered in HD format. The room was set with a hundred comfortable seats. The picture and sound quality was remarkable. Even at home, with our brand new equipment, we couldn't reach the quality of what we got to watch on the screen. During the show, we could answer with our PDA an interactive questionnaire. The winner was offered a full box of the finest tea. It was already a great experience and we didn't regret to wake up early that Sunday morning.

Classic Movie



Maëlle was anxious to see the old western of his father's time. "My name is Nobody" had also been re-mastered. I have to admit that I could have gone with her if it wasn't for wanting to see Tea Road because of the trip my wife and I have planned to China next fall.

Computer Gaming

In another room, Loïc and his friends were competing against another team they had met through the net on soccer gaming. It was for them such an experience to test themselves out on the big screen, and he had been train himself for the event all week. Concentration was at its peak. I went in their room get a hint of what was happening. I must admit that I found the game, shown on a 10 metre wide screen with surround sound and each of his friends playing one guy on the field, to be somewhat unrealistic, but I can appreciate that the gaming experience must have been extraordinary for someone who's into it.

Classical Music

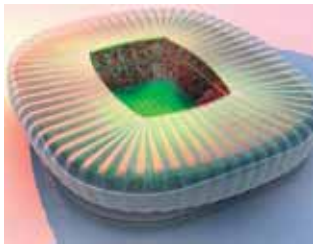
After dinner, we had the concert of the quatuor Danel (The Danel String Quartet). The musicians had been recorded in the Bozar in Brussels. Once again, we were entering a room where you could feel that the emphasis had been pointed towards the quality of reproduction of image and sound. The acoustic was totally respected and the sound volume was set as if you were in the concert hall. I was as also impressed to see that the room was full, not only with musicians but also with people who probably had never gone to a real concert before. I became more and more enthusiastic about the day we were having. All these different genres were actually mixing together very well. The public was responding to the shows.

Sport

After this interlude, the cultural part of our day was over, and we now entered the green part of the Alteplex where sport was the king. It was quite exciting, as the Wimbledon men's finals were finishing and the European Football final was to follow. In this section, the rooms were bigger and could admit 500 people each. Here, we could gain a hint of what was actually financing this great place. Each sport room had been sponsored by key brands of the game shown. For Tennis, a racket's brand was showing its new models and had decorated the room. In between games, commercials especially designed for the Alteplex complex were shown. The match was shot in 3D and the commentaries were done by a member of Alteplex. It was quite impressive to feel the game as if we were part of it. I could not believe how much progress the technology had made over the last years. I surprised myself by shouting and supporting the players on match points with the rest of the room.

The final was played in three sets, though, before the European Cup final actually started, we shared a quiet moment exchanging with the kids. As for us, they too had experienced a full and enjoyable day, and a unique experiment. Between the screening of blockbuster movies from ancient times, the interactive gaming and the concert, they had trouble decide which they had found to be the most exciting.

The European Cup final saw England playing against Italy in Warsaw. The "Event room" had just finished showing Radiohead live from Werchter's rock festival. The fans had left the place as from any other rock concert hall, sweating, screaming and looking as if they were coming out of the real concert.



Warsaw Stadium 2012
www.poland2012.net

The Alteplex staff changed the decor of the room within minutes. When they allowed us in, everything was settled for a great experience, the walls were covered with flags, shops for food and drinks were ready and the screen was already showing the stadium filling up with fans in Warsaw. I was thrilled to be there, we could feel the atmosphere as if we had actually travelled to Poland. We experienced the game like never before. My son, who is used to going to football stadiums as a fan and as football player himself, made the comment: "Dad; it's like in the stadium but with the replays."

On our way back, we had many things to share all together about our experiences. Within one day, we had encountered so many different styles of events that our heads were spinning. However, we all agreed on two key elements, the quality of the audiovisual experience was better by far than we had seen anywhere, and sharing the experiences with others added a great deal to our entertainment.

The very next day, we booked tickets for the opening ceremony of the summer Olympics in London on July 26th.

The Future

Is Alteplex a total utopia or will we have one next door in a near future? Rights management, satellite communications, bandwidth allocations, sound re-enforcement, etc. still need to evolve. All these questions are still to be solved. Entertainment is certainly a business where marketing and technology are working closely together, and the future of what we now call Alternative Content perhaps depends on this more than other sectors.

Olivier Rey

Olivier Rey is working with the EDCine project www.edcine.org, which is focusing on the optimisation, enhancement and interoperability issues of JPEG 2000 based Digital Cinema. EDCine will optimise, improve and validate the DCI specifications in quality, robustness to transmission errors, content security, stereoscopic imaging, live events and transcoding for digital archiving and interactive access on various devices.

8. Audio for Alternative Content



Dr John Emmett
Director, Broadcast Project Research, BPR, and Chair of the EBU Audio Advisory Group

Introduction

By 1937 the London television schedules were looking remarkably like those we see today. Television had already found its "Alternative Content" place based around live State Events and Sports, along with studio based Music, Light Entertainment, News and Current Affairs. The Sound production was based heavily on Radio techniques, with the additional tool of silence, which was (and still is) anathema to Radio production. Interestingly, the quality of television Sound on VHF AM was then better than Radio until FM arrived years later, and this was a serious selling point for the first televisions. It was however the introduction of NICAM stereo to television during the late 1980s that really sold new television sets on the strength of sound alone.

Stereo television production practice had evolved into a distinct and unique art by 1995, but within a few years, the widespread home adoption of DVD players with 5.1 sound delivery set yet another expectation in the minds of the public.

From then on, television sound was no longer a simple entity, some of the viewers (listeners?) demanding "5.1 cinema-quality" sound from every programme (however appropriate), whilst others, possibly elderly or hard-of-hearing, just wanted the dialogue to be clearly reproduced from a tiny portable television or from IP delivery. Of course digital delivery allows all these variations to be employed, even simultaneously, but the economics of viewer demographics will in the end govern which Sound format dominates, as different mixes are unavoidable in most of these cases.

Setting the foundations for Television Surround Sound

EBU Tech Doc 3276 (freely available from *www.ebu.ch*) recommends the baseline requirements for Broadcast listening conditions, and so effectively sets much of the "Sound" of broadcasting today. The basic document was developed from an initiative to standardise mono and stereo listening conditions for Radio programmes, and Supplement 1 took this recommendation into the 5.1 listening domain, based on the worldwide ITU Standard BS 775. The listening levels in all these documents are essentially aligned with those in the SMPTE Recommended Practice RP200.



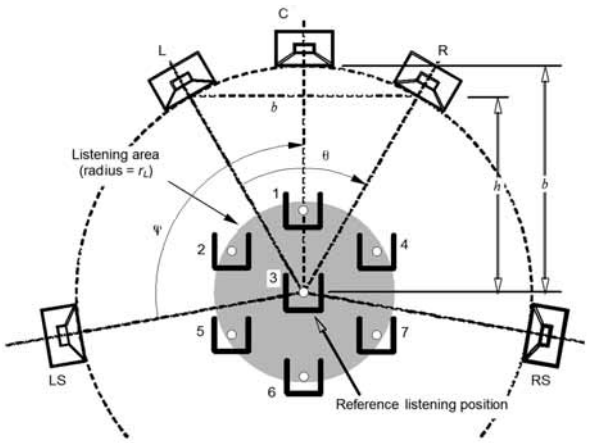
The principal differences between Broadcast practice and Cinema practice come from the smaller listening area, as well as the lower dynamic range and a listening level inherited from Radio. The smaller listening area allows for a degree of two-channel compatibility, including phase based imaging, rather than the first wavefront based stereo imaging (Haas effect) that predominates in the Cinema and larger sized environments.

Listening levels

The level produced by each of the five main channels separately is listed as 96 dB SPL, referenced to digital FSD signal level. The LFE (Low Frequency Effects) channel is reproduced 10dB higher, as for Cinema Practice. So an Alignment Level at -18dBFS will give an SPL of 78dB per main channel. Thus the recommended listening sound pressure levels for television are some 8dB lower than those recommended for Cinema, although the television mix will normally have the dialogue higher by nearly this amount. Under cinema playback conditions, therefore, the most obvious differences to theatrical material will firstly be reduced dynamic range, followed by a possible LFE prominence resulting from the non-linearity of this channel when mixed under lower listening levels.

The listening arrangement

Originally the listening "sweet spot" encompassed just three seats (a Man, his Wife and his Mistress was suggested!) and thereby hangs an awkward generalisation, that as more channels become involved, the smaller the sweet spot area will be for optimum phase based "virtual" imaging.



b = 2 - 4 m
h ≈ 0.9 b
θ ≈ 60°
φ = 110 – 120°
r_L ≤ 0.8 m

And In Practice...

At the time of writing, and in one word: **experimentation**.
Quite an innovative area for television multichannel audio development so far has been live Sports. In the NICAM era this was also a popular genre, and this has resulted in viewer expectations of a wide commentary field, encompassing all three of the front channels. This might work under cinema listening conditions with material such as live Motor Racing commentary, or the front image might need reducing in width.

Signal and Loudness Levels

In the digital home, television dialogue levels come out some 3 to 6dB higher than from DVD mixes, that is to say around -21 to -24dB LKFS, with a lower statutory "Permitted

Maximum Level" inherited from analogue transmission of around -9dBFS.

Any loudness level in the digital home however will ultimately have to compete with other "Alternative Content"; Pre-recorded music, Internet sources and Radio channels exhibit peak levels close to FSD and ITU loudness levels above -8dBLKFS*, that is to say some 18dB louder than typical DVD dialogue tracks.

*dBLKFS = dBs Loudness, K-weighted, below Full-Scale (the new ITU1770 loudness scale). For television use around a 4 second integration time with gating is normally applied to this.

The Surround Channels

The smaller picture and higher background lighting of television compared to the Cinema tends to lead to reduced surround usage. Setting an "atmosphere" seems to be the most effective programme tool, and this has indirectly revived the use of Soundfield microphone techniques, especially as the four B format channels lend themselves well to downstream (re)mixing for stereo and mono feeds.

Simultaneous translation is an interesting new use for the rear channels too, featuring a whispered translation in your ear of the Front channel dialogue.
Another type of very active surround channel use is in pure Radio, where the (sound) pictures can be bigger, and 4.0 sound mixing and other formats can yield stunning results.

Programme Exchange

This is a very active area for the EBU and the EHDF at present, and a look at recently published recommendations will give the reader an idea of the latest thinking about Broadcast File exchange, Tape exchange and Metadata. Suffice it to say the Eurovision live links are all capable of the widest range of sound delivery, as you would expect in an area of the world where we nearly share a time zone but certainly not a language.

Dr John Emmett

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EDCF



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SES



9. Audio Interfacing - Bringing Together Two Worlds

Julian Pinn and Jason Power, with case notes from Richard Stockdale - Dolby Laboratories Inc.



Introduction

"Two worlds"? Well, yes! The evolution of the technologies, standards and art of cinema audio preparation, delivery, and reproduction has followed a very separate path to the evolution of the same for audio intended for the consumer listening environment. Interfacing non-cinema audio into the cinema not only concerns finding solutions for hooking together equipment that is not normally interfaced, it is very much also to do with the less tangible aspects of avoiding the many potential problems and exploiting the opportunities available from a highly standardised and immersive environment.

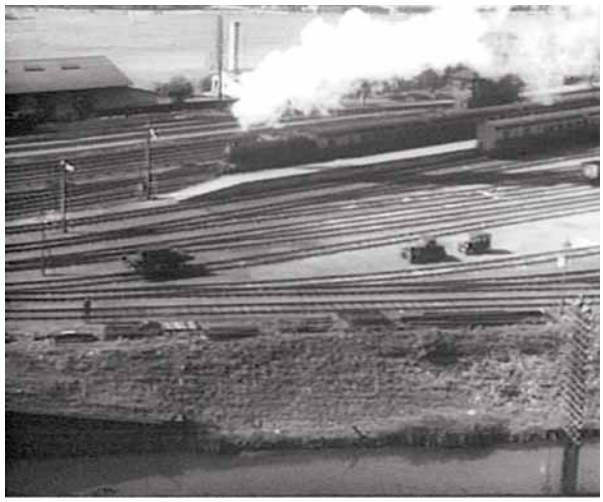
This paper aims to compliment others in this publication on the audio for alternative content. It aims to provide a clear understanding of the cinema audio environment and its high level of standardisation and how and why it differs to other audio applications. It also aims to provide practical guidance on the aspects that one must consider when interfacing non-cinema sound into the cinema. And this is based on experience as much as theory; in particular through decades of providing audio consultancy work in the film and broadcast industries and also consultancy for the following alternative content broadcasts into cinemas:

- *Genesis live from Düsseldorf LTU Arena on 27th June, 2007.*
- *David Gilmour live and DVD play-out from Odeon Leicester Square on 6th September, 2007.*
- *David Gilmour DVD play-out from Brixton Ritzy on 15th September, 2007*
- *Take That live from the O_2 Arena on 7th December, 2007.*

The evolution and short history of cinema sound and its standardisation

Typical mono and stereo channel configurations

The very first two-channel stereo recording experiments were carried out by Alan Blumlein in the early 1930s when he recorded a train travelling from one side to the other side of the frame with a motion-picture camera and a pair of microphones. The two audio channels were recorded on two optical tracks of the film as no other record medium at that time could record two channels. Whilst his invention allowed for directional elements of the original sound-stage to be captured and reproduced, and he made use of film, the use of two-channel stereo in cinema was never considered suitable, even with the later introduction of multi-track magnetic coatings on film. This



is because a typical motion-picture theatre (cinema) has a large picture area and a large seating area with only a fraction of the audience placed on the centre line between the Left and Right loudspeakers. For cinema sound and picture to become a believable union, sound - especially the dialogue - must emanate from the picture itself. This is achieved by placing the loudspeaker(s) directly behind the screen and for the screen to be perforated to let the sound propagate through. With just Left and Right loudspeakers it is impossible to reproduce sound that appears to emanate from the centre of the screen, or even realistically anywhere between Left and Right, except for the minority of the audience who are sat centrally. For these reasons, Mono cinema sound from a Centre loudspeaker is actually a superior arrangement than Left-Right two-channel stereo; stereo cinema sound requires a minimum on three screen channels.

Apart from numerous optical experiments with stereo and Walt Disney's famous release of Fantasia in 1941, with stereo Fantasound shot optically on a separate piece of film, stereo cinema sound on a single inventory was not really viable optically due to the increased level of noise introduced by squeezing another track in the small area normally occupied by one. Viable stereo cinema sound on a single print was first achieved through the coating of magnetic stripes on the release print - an expensive process. 35 mm featured Cinemascope's 4-channel sound (3 screen channels and a mono surround) and 70 mm initially featured Todd A O's 6-channel sound (5 screen channels and a mono surround). With later developments, the following table indicates the key stereo channel configurations offered by magnetic release prints:



Photo from Bell Theatre Services of Empire Leicester Square

35 mm
Left - Centre - Right
Left - Centre - Right - Surround
70 mm
Left - Left Extra - Centre - Right Extra - Right - Surround
Left - LFE (Low Frequency Extension) - Centre - LFE - Right - Surround
Left - Centre - Right - Left Surround - Right Surround - LFE

Introduced by Dolby Laboratories Inc. for Superman in 1978 and Apocalypse Now in 1979 in such a way as to remain compatible with previous 70 mm track configurations, this was the birth of 5.1 as we know it today.



Due to the expense of magnetic prints and replay sound processors, the Academy Mono sound format was the commonest cinema sound format for many years up until the early 1970s with the introduction of Dolby Stereo. Noise reduction and other key improvements on the optical process introduced full range, lower noise and distortion, and viable stereo for the first time from optical replay. A number of improvements in channel separation, noise reduction, and low frequency reproduction have been introduced through the years, but the stereo channel configuration has remained
Left - Centre - Right - Surround

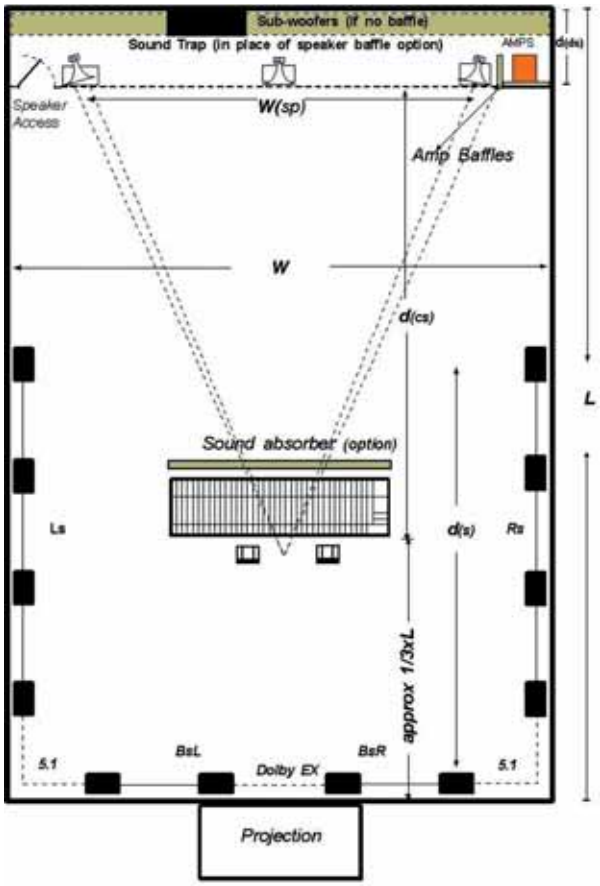
Over the last decade or so, digital sound systems have been introduced widely into cinemas. The majority of motion-pictures are now released with a digital soundtrack, in addition to the analogue track for backwards compatibility. Digital soundtrack systems enable the delivery of very high quality audio with a wide dynamic range; movies release with digital soundtracks have typically adopted the 5.1 channel configuration that was introduced on Superman (on 70 mm as above) to create a truly immersive audio-visual experience. Even the industry's gradual migration from 35 mm film to Digital Cinema has so far not changed the sound format configuration employed. The channel configuration of today's releases is as follows:

Analogue
Left - Centre - Right - Surround (matrixed via 2 optical tracks)
Digital
Left - Centre - Right - Left Surround - Right Surround - LFE

It is relatively commonplace to matrix-encode a Back Surround channel to Left Surround and Right Surround, but the number of tracks and thus the interconnection into the cinema is 5.1

Of all the numerous mono and stereo channel configurations, the Centre channel has been the most important channel of all. It plays an important role, helping to place dialogue and other on-screen sounds for listeners in all parts of the auditorium. Indeed, all the screen channels are reproduced with loudspeakers placed right behind the perforated screen.

Placement and type of loudspeakers and the cinematic environment.
The studio diagram above is also indicative of many preview



theatres and cinemas in loudspeaker setup. The diagram indicates two key differences to the loudspeaker arrangement found typically in multichannel setups for broadcast to consumer environments. The first, as mentioned above: the three screen channels are placed physically behind the perforated screen to enable sound and picture unification regardless of the seating position. Second: the surrounds are an array of loudspeakers rather than point sources; they are meant to support the ambiance of the motion-picture and are rarely used to create focused point-source sound elements. An array of loudspeakers helps distribute the ambient surround elements in a diffuse way throughout the wide audience listening area typical of the movie theatre. The action is on screen and the use of the surrounds must be carefully considered in respect of each other.

Cinemas are typically large in size and the audience typically sits in the reverberant field and off-centre. The acoustics of the cinema play a large part in the total experience of sound reproduced. Electro-acoustic standards (as below) take the loudspeakers and the acoustic environment into consideration in a good attempt to remove variances in performance from cinema to cinema. Due to the size, the placement of the loudspeakers behind the screen, and the lower power of amplification available until recent times, cinema loudspeakers have tended to be extremely efficient horn-loaded designs. Modern digital soundtracks demand greater peak-level performance at the same time that greater power amplification has become available and viable. The horn, with two-way and now three-way systems being the norm, has remained the typical approach to reproducing sound in cinemas of all sizes.

Global standardisation and interchange

Aside from the technology-offering, the vital ingredient of the Dolby film programme was the extensive research carried out in order to improve and to standardise many aspects of the audio process from the mixing stage through to reproduction within exhibition. Of relevance to this paper are the standards that specify precise electro-acoustic level and frequency response characteristics for each replay channel. These standards are published and maintained within the Society of Motion Picture and Television Engineers (SMPTE) and at the International Organisation for Standardization (ISO) and have been adopted, for all current cinema sound formats, by studios and cinemas globally.

This tight standardisation provides the director and post-production sound crew an audio system capable of high dynamic range, high unification to the picture, and high accuracy of tonal and level reproduction; and the capability for the crew to base their detailed creative decisions (over typically hundreds of sound elements) in an environment that matches what will be heard by the final audience. The whole family of cinema standards have enabled total interchange of cinematic materials around the world—and this is set to continue as the industry embraces and standardises Digital Cinema.



Members of the ISO TC36 Standards Committee at a meeting in Seoul. The author can be seen far right.

The standards of interest are ISO2969 (1), which provides frequency response characteristics, and ISO22234 (2), which provides reference sound pressure levels for each loudspeaker channel. The key element is that these standards describe reference pink noise stimulus and its measurement in the acoustic listening area of the studio or cinema itself. The target frequency response achieved from the reference pink noise stimulus is often referred to as the X-curve. The target sound pressure levels achieved from the reference pink noise stimulus is 85 dBC(slow) for the full-range screen channels and 82 dBC(slow) for each discrete surround channel array. The LFE / Sub-woofer is set +10 dB relative to the 85 dBC(slow) achieved by the screen channels and, due to its limited frequency response (20 – 125 Hz) is typically set with a Real Time Analyser for absolute precision regardless of absolute bandwidth.

Interfacing non-cinema audio

The art

As discussed in greater detail in John Emmett's paper in this publication, sound mixes prepared specifically for DVD or television broadcast, whilst potentially 5.1, are not generally prepared in an environment set to the electro-acoustical standards for cinema. Such mixes can give variable and often undesirable results if replayed directly in the cinema without any adjustment.

Typical problems to look out for include:

- *poor suitability of 2-ch stereo content;*
- *stereo width compatibility;*
- *the miss-use of phantom centre between Left and Right rather than the proper use of the Centre channel;*
- *loudness uncertainty;*
- *surround level differences (level and delay settings);*
- *intelligibility and tonal issues due to the large auditorium size, listening area, typical use of horn systems, and increased reverberation time / characteristics;*
- *audio-visual synchronisation; and*
- *channel routing issues.*

Key features to exploit include:

- *high dynamic range available;*
- *certainty of replay level calibration;*
- *loudspeakers situated behind the screen for good image unification;*
- *centre channel for vocals, dialogue, and other key sound elements;*
- *enveloping surround ambiance for crowd or audience emulation; and*
- *the presence of a discrete LFE channel with no risk of base management intervention.*

Transmission



Many projects utilise HDTV broadcast transmission encoding and receiving products, although a higher data rate may be used than for normal HD television services. Specifications for the digital transmission equipment widely used in Europe have been set by the DVB group; the standards document ETSI TS101 154 (3) outlines the various audio coding formats which are allowable. To date, HD DVB television services have widely utilised the AC3 audio format, also known as Dolby Digital, for multichannel broadcasts. The launch of new European HDTV services utilising MPEG4 video is also resulting in the introduction of new multichannel-capable audio codecs: both HE-AAC (also known as aacPlus) and E-AC-3 (Dolby Digital Plus) formats are expected to be used and may therefore also have application in alternative content broadcasts in the future.

Care should be taken in the implementation of the broadcast transmission system with regard to encoder reference synchronisation and latency management (lip-sync). Alternative content transmission projects to date have typically utilised separate video and audio hardware encoders. In this configuration, the audio encoder must be referenced to a correctly derived timing signal from the video encoder to avoid data errors resulting in the final transport stream. To maintain lip-sync, it is necessary to quantify and manage the video and audio delays introduced

throughout the production/transmission chain. To ease system implementation and trouble shooting, it is strongly recommended that video and audio are presented in sync when handed between key system stages. This means, for example, that the video delays introduced by digital cameras, VTRs and switching equipment should ideally be compensated for before handover of final video+audio programme to the transmission department. Similarly, the cinema receivers should ideally decode video and audio in sync, with any audio delay needed to compensate for different projector types etc to be added in the cinema equipment, as settings will vary from site to site. In some circumstances where similar equipment is used in all receiving sites, it may be possible to compensate for the average behaviour of receiver equipment by introducing compensating delays prior to transmission, but this approach must be applied carefully.

Behaviour of real world transmission and receiving equipment with regard to latency and errors can very depending on exact transmission setup, including image format (720p or 1080i), encoder setup and software version, receiver software, etc, so comprehensive broadcast transmission chain testing well in advance using the planned encoding, receiver, projector and audio decoder configurations is strongly advised.

Large projects should consider the use of redundant video and audio encoders as used for typical TV broadcast services.

Cinema playback equipment

Current cinemas are equipped with an audio processor, known as a Cinema Processor, which decodes the film digital or analogue soundtrack, handles source selection, speaker and redundancy switching, and performs level and EQ processing in order to satisfy ISO2969 and ISO22234. The Cinema Processor also interfaces to the show automation system to enable automated control of features including format selection and main fader level control. Many existing installations feature older cinema processors where the only external multichannel input is an analogue 6 channel input, which is usually used for connection of an external decoder for the digital film soundtrack. Interface units are available that enable this input to be shared between multichannel AES3 input sources and the conventional film decoder source (analogue input). More recent cinema processors, such as the CP650 range, typically allows for the injection of multichannel digital (AES3) inputs for direct connection of non-film types of audio, such as AC3 and PCM, for reproduction to normal cinema standards.

Whatever method is used, it is vital that the equipment used to interface non-cinema audio is designed for proper interfacing with regular cinema equipment. The key features this interfacing device must offer are:

- *audio delays in order that digital projectors' latencies can be accommodated so that lip-sync is preserved;*
- *correct level settings between digital and analogue levels;*
- *correct decoding of non-PCM sources respecting the inter-channel level architecture specific to the cinema and as per ISO 22234; and*
- *consideration for format switching and operational aspects of being part of a complex cinema system showing non-sync walk-in music, film, digital cinema, etc. etc.*

Practical guidance: case notes

Background

For the following events, combined support was provided from Dolby's Professional Audio (broadcast) and Production Services (motion-picture) divisions. The broadcast engineers provided support for the Dolby equipment, integrating it into the trucks and ensuring that the audio and video were correctly multiplexed and technically correct for satellite transmission. The motion-picture engineers provided consultation and mix truck setup ensuring the audio was suitably optimised for the cinema environment. The following case notes are included here to highlight the importance of consultation, pre-planning, and testing in maximising the success of such an event.



Genesis: live from Düsseldorf LTU Arena

"Before the show dates we had been liaising with Nick Davis who was doing the live mix for the satellite uplink. We discussed the difference in monitoring conditions for DVD mix and mixing for the cinema. We took at trip down to Portsmouth to meet Nick at a Vue cinema to play some of his previous Genesis DVD mixes. This then gave him an idea of what a DVD mix would sound like and how he would need to adjust it for the cinema environment. For the actual Genesis show we arrived at the LTU Arena in Düsseldorf the day before the event for a test transmission on the 26th. Genesis were playing a gig that night too so it gave everyone involved in the cinema uplink a chance to test the system and it gave Nick a chance to mix and receive feedback from the cinemas in the UK who were receiving the transmission.
Our involvement in Düsseldorf was to ensure that the monitoring conditions in the mix truck were correct. A set of 5.1 monitors were set up in the truck and calibrated the same as a cinema system. For the rest of the time on site we mainly had a consulting roll, talking with Nick Davis and Peter Brandt about cinema monitoring conditions, EQ curves and mix details. This event was transmitted to Vue cinemas in the UK."

David Gilmour: shows from Odeon Leicester Square and from Brixton Ritzy

"The main purpose of these shows was to promote the latest David Gilmour DVD, Remember That Night – Live At The Royal Albert Hall. At the Odeon Leicester Square David Gilmour was to play live on stage solo, which would lead into the DVD playback. After the DVD, there was a question-and-answer section and then David Gilmour and his band took to the stage again to play some more. This event was transmitted to Odeon cinemas across the UK. The Brixton Ritzy was a stripped-down version of the Odeon Leicester Square show. It comprised of David

Gilmour opening the show as in the Odeon Leicester Square, the DVD was played out and then a question and answer section. This event was broadcast to cinemas in the US.

Prior to the events we all travelled down to Bow Tie Television, who were providing all the trucks and broadcast support, in Kent. This trip allowed for the audio mixing section of the truck to be calibrated and to ensure that the Dolby broadcast equipment was correctly integrated into the trucks. It also gave us the opportunity to talk to Andy Jackson, who would be mixing the live events. Like the Genesis event, we discussed cinema monitoring, EQ curves and mix details.
For both of the live events the calibration on the monitors in the trucks was checked, along with the B-Chain of the cinemas and we were on hand during both events for consultation and support with the integration of the audio into the cinemas."

Take That: live from the O_2 Arena

"This event was very similar to the Genesis event. As with Genesis, Take That were performing the night before so this was used as a test of the whole system. We also recorded the event and in the morning before the live cinema transmission Toby Alington, who was mixing this event, and I took the mix from the test transmission and played it back in Dolby's screening room. This gave Toby the chance to hear exactly what the audience in the cinemas would be hearing."

Summary

The development of audio for cinema and the development of audio for non-cinema applications have taken quite separate paths. In particular:

- *cinema requires a Centre channel;*
- *stereo means Left - Centre - Right as a minimum placed behind the screen; and*
- *the listening environment between motion-picture studios and cinemas is highly standardised with wide adoption of 5.1: L - C - R - Ls - Rs - LFE.*

Whilst the cinema presents a number of challenges in achieving good quality sound reproduction, it also presents opportunities that, with understanding, can be exploited to achieve excellent quality sound reproduction.
There is a number of useful SD and HD broadcast standards that enable the transmission of multi-channel audio and can be used in the transmission of sound for insertion and reproduction into cinemas with the correct mix conditions, coding equipment, and cinema interfacing equipment.

Preparation: planning, testing, and consultation from broadcast and cinema specialists are paramount in obtaining the required results and making full use of the cinema sound system available and providing the audience with an alternative content experience as good as the being there.

References

1 ISO 2969 — Cinematography — B-chain electro-acoustic response of motion-picture control rooms and indoor theatres — Specifications and measurements
2 ISO 22234 — Cinematography — Relative and absolute sound pressure levels for motion-picture multi-channel sound systems — Measurement methods and levels applicable to analog photographic film audio, digital photographic film audio and D-cinema audio
3 ETSI TS 101 154, Digital Video Broadcasting (DVB); Implementation guidelines for the use of Video and Audio Coding in Broadcasting Applications based on the MPEG-2 Transport Stream



10. Displaying Alternative Content at Digital Cinema Resolutions



Tim Sinnaeve, Barco Sales Director EMEA Digital Cinema

Alternative Content is an exciting new opportunity thanks to Digital Cinema. Content can range from events such as live or recorded broadcasts of sports, rock concerts, and opera to movie classics or TV shows on DVD or Blu-ray discs up to corporate presentations, computer gaming and even “home movies” filmed with a high definition consumer camcorder. The sky is the limit. All of this can be brought to the big screen using a Digital Cinema projector, providing new revenue opportunities and more efficient usage of the cinema venue for the exhibitor.

The Technical Challenges

For an exhibitor to take advantage of the opportunity that Alternative Content offers, however, a number of technological challenges need to be met. A variety of recent and legacy video sources means a variety of image formats, coupled with a plethora of different connection types. Throw content protection into the mix, and it’s clear that showing alternative content is not as simple as hooking up your source to a Digital Cinema projector.

What is needed is a piece of technology that allows us to connect up this variety of sources with their different formats and connections. It needs to provide a high quality connection to a Digital Cinema projector to seamlessly bring the content to the big screen at digital cinema resolutions. This requires highly advanced image processing capabilities, including scaling (upconverting), controlling aspect ratio, converting analog signals into digital and de-interlacing (to obtain a progressive signal). Given the complexities involved, another key factor is user-friendliness. The technology ideally should also provide some measure of integration with the other components of a digital cinema system such as the projector. It needs to do all this while respecting the prevailing High-Bandwidth Digital Content Protection (HDCP) standard.



The Alternative Content Switcher

At Barco, we call it an Alternative Content Switcher. We designed the ACS-2048 specifically for the cinema industry, to provide the ideal complement to our Digital Cinema Projectors.

The ACS-2048 is an 8x1 switcher that meets the above challenges by accepting "universal" input formats, and outputting 12-bit twin link DVI at 2048 x 1080 — one of the digital cinema standards.

The “universal” inputs support HD-SDI, SD-SDI, DVI (support analog RGB inputs), Analog, Composite and S-Video formats. The 12-bit twin link DVI outputs upconvert all inputs to 2048 x 1080.

With a high-quality scaler at its core, upconverting any input format is as simple as auto-acquiring and selecting the input on the unit’s front panel. The system’s motion adaptive de-interlacer and advanced noise reduction circuits ensure superb image quality.

Control features

To maximize user-friendliness, the front panel of the ACS-2048 provides intuitive menu-driven local control, while the integration with a Barco Digital Cinema projector’s “Communicator” touchscreen provides seamless remote control. In terms of installation, the ACS-2048 can be rack-mounted directly in the projector’s pedestal, or easily moved anywhere within the cinema multiplex. The unit is equipped with a standard HDCP "decrypted input" and "encrypted output" path. This feature enables copy-protected content to be displayed at digital cinema resolutions, while maintaining the highest degree of security for the copyright holder.
As a highly cost-effective unit, with no need for optional cards, the ACS-2048 is backed by Barco’s longstanding experience in image processing, with the capability of opening up new revenue streams for your digital cinema facility.

Tim Sinnaeve

11. Control and Interfacing of Video Sources



Ed Mauger, Freelance cinema engineer who has worked on the BFI digital cinema installations at The National Film Theatre.



Introduction

Automation and control systems are a well-established part of 35mm motion picture presentation, and have reached the point where they are highly reliable and dependable. Now that the industry is slowly beginning to move towards digital cinema technology, automation has been incorporated into the operating system of the servers themselves. These servers can be interfaced with existing cinema automation systems with relative ease, and this has been done very successfully, for example with the UK Film Council digital roll-out.

However, the control and interfacing of all other sources (some people call it "alternative content") has had much less priority. For the majority of cinemas, videos, satellite broadcasts and PC presentations are invariably screened as one-off "special" shows, or private hires. This requires very little in the way of control and interfacing. The source (eg. DVD player, PC) can be temporarily connected to the projector's video scalar, the picture sized to the correct size and ratio using a remote control, and the sound plugged into the cinema processor.

Requirements for Alternative Content at the NFT

This method is quite satisfactory for one-off shows, but can be a challenge when screening a programme of short films or extracts, all in different formats, in quick succession. Such is the requirement in a venue such as the National Film Theatre, London, and I will describe the system installed there.



The current video switching system was installed in 2001, with a Christie Roadster X4 DLP video projector. An article by Jerry Gilbert was written in Cinema Technology in December 2001, which includes the following quote: "The feedback we have had has been exceptional. When people see the X4 alongside the old CRT projector in NFT2, they understand why we are moving forward. It certainly produces a picture quality that is first class ….". It is interesting to note that the Roadster X4 projector described is still in use in NFT2, but due for upgrading very soon. Such is the speed of progress with digital imaging technology that just seven years on, the picture quality from what was considered to be a state-of-the-art video projector is now perceived to be poor compared to the current range of digital projectors. But the control system installed in 2001 has changed very little, and the RS-232 control codes for a new Christie Cine-IPM 2k have remained more or less identical for years. The NFT has 4 screens, 2 with Christie CP2000 projectors (soon to be 3), and one with a Barco DP100. All screens are equipped with Christie Cine-IPM 2k video scalers.

Interfacing

The main challenge with interfacing video sources with a Christie Cine-IPM 2k is the vast array of standards. Professional studio video seems to be converging into one standard; the video interface is invariably standard or high-definition digital, which simply connects to the digital input using one cable. Unfortunately much of the video material







shown in a commercial cinema is interfaced from sources designed for the domestic market. Interfaces include Composite Video, S-Video, Component Video, RGBHV or DVI-D for PCs, SCART, DVI, HDMI, and so on. Also there is a popular misconception that a digital signal must be better than an analogue one. This is not necessarily the case. In comparison tests between DVI-D and analogue component, running HD material, there was no noticeable difference in quality between the two, and an analogue signal is generally more stable over long cable distances.

For these reasons the NFT does not use the domestic digital interface standards, but sticks with analogue component when using domestic sources. This makes switching and patching of signals much easier and more reliable. Professional HD sources, such as Sony's HDCam and Panasonic's HDD5 can sometimes be connected directly to the projector head, but on other occasions need to be routed through a video scaler, depending on various factors. Interfacing professional HD material as an HD signal, rather

than as analogue component has advantages, both for picture quality and for ease of use. For this reason, all the NFT's Cine-IPMs include the optional dual-HD/SD-SDI input modules.

Control

Each signal type (eg. composite, component, RGBHV, SD-SDI, HD-SDI) requires a separate configuration, or channel, in a Cine-IPM. Each signal also needs a set of aspect ratios, eg. 4x3, 16x9 widescreen, 16x9 anamorphic. With most video sources, there are two main frame rates, or frequencies: 50Hz for Europe and 59.94Hz for the USA. So, multiplying these out, to serve all these parameters, the Cine-IPM requires around 30 unique channels. Thankfully the Cine-IPM can accommodate up to 99 channels (or just 50 if you believe the manual).



Switching between these can be done using the supplied remote control, but the buttons are getting so small that this method is not always reliable. To help with this, the NFT has installed a Crestron CNMSXAV control processor, with a 6" LCD touchscreen. The next channel to be used can be keyed in to a numerical keypad, then when actually required, the "Go" button sends the appropriate channel command to the IPM via RS-232 communication. Links can be made between the channel and video switchers, so now highly-reliable switching and projector channel selection can be made between various formats and signal types, with the push of one button.







Horses for courses

These control systems can be highly advantageous in these circumstances, and can aid smooth presentation enormously if programmed well and used correctly. But I am not trying to portray these systems as a "must have" accessory. For the average cinema which mainly plays one-off videos, this solution would be highly expensive and a bit like using a sledgehammer to crack a nut.

Ed Mauger

Ed is an experienced projectionist and engineer. He worked as a projectionist at the NFT for 5 years, and for the last 7 years has been a freelance Cinema Engineer working in independent and specialist cinemas, responsible for the technical design, installation and maintenance of cinemas, film, video, digital and sound systems. *Ed@mauger.freeserve.co.uk*

12. EDCF Guide to Alternative Content - Where we are - Summary



Peter Wilson

Many thanks to all the companies and authors who have contributed to this guide, which provides both 'state of the art' information and fascinating glimpses into the future.

Mark Schubin's fantastically comprehensive history of live alternative content in movie theatres provides an excellent start and proves that although there is nothing new in the world nothing is necessarily easy, and many of the articles make it plain that the complexity and care required to generate the content deserve a cinema delivery system which does it justice.

Important themes which come out in the text include:

- Cost performance when choosing satellite compression systems
- Audio is very important, audio made for TV may need significant re-processing to make it suitable for large auditoriums. Prime events like for example the Proms may need a special mix for the cinema feed made in a cinema dubbing theatre.
- Should you buy consumer equipment with limited features and consumer connectors or should you buy professional products? After all, the rest of the equipment is professional. Using consumer receiving equipment for the New York Met has meant a possible quality degradation for all, as the Met then has to standards convert for those cinemas which can only receive at 25 Frames per second.
- Professional satellite operators can and will advise on a range of service levels according to budget.
- All the systems mentioned are covered by International Standards but in fact there is no universal "Schematic" or Recommended Practice which outlines the best way to proceed and importantly to calibrate the various parts of the system.
- Stereoscopic live events are the talk of the town but Production Grammar and Production Techniques are far from being standard practice. Currently the stereo events are enabled by proprietary non standard technology or random ways to join together existing mono gear. This is not an acceptable situation so all sides need to work together on a standardised delivery method. All other parts of the system are covered by SMPTE, DVB or ITU standards, so 3D must be too.

One thing that this Guide makes clear, is that we can certainly look forward to an exiting future.

13. EDCF Glossary of Digital Cinema Terms



Angelo D'Alessio,
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The Beautiful Chaos of Digital Cinema terminology.
The use of digital technology and digital processes through the "film" chain is modifying the workflow and changing the terminology used by professionals. After a century of celluloid, the whole business model and the Art of "film" features is now changing.
Digital projection has already shown the benefits of digital techniques and the whole digital film business is moving forward. To understand the potential of digital cinema, this glossary includes terminology about the Mastering, Distribution and Exhibition of D-Cinema supply chain. Digital cinema can offer viable benefits if everyone involved in the supply chain understands and has a basic knowledge of both sections.

The key purpose of this EDCF Glossary is to facilitate and help new professionals entering into the "Beautiful Chaos" of digital Cinema!

EDCF DIGITAL CINEMA GLOSSARY

Active picture
The area of video frame which carries image information.
Adaptive white
A color that an observer, adapted to a set of viewing conditions, would judge to be white.
Alternative Content
Content available through a digital cinema system that would typically occur on a "one-off" basis or "off-peak hours" run basis. Sometimes referred as "non-traditional content".
Alternative Content Fee (ACF)
This is a fee that is paid when alternative content is played.
Answer print
A print made from the cut original (camera) negative with proposed final color timing and soundtracks, furnished by the printing lab to the producer for acceptance of image and sound before screenings and manufacturing begin. The check print is similar, but is made from the internegative. A black track answer print has no soundtracks.
Asset
Audio and video material complete with rights of ownership or for publication. Material without rights has no commercial value. The following figure represents the Media Asset and its components.
Artefact
Particular visible effects which are a direct result of some technical limitation.
Bit Depth
The total number of bits available to represent each pixel or color sample in a digital imaging system, or the bits available to represent each sample in a digital audio system. Using linear binary coding, the total number of resolution steps available is equal to 2 raised to the power of the bit depth.
Brightness
The property of a surface emitting or reflecting light. In lighting, it is our impression of the amount of light received from a surface. It is measured in candelas per square metre and is called luminosity in the USA.
Cataloguing
Adding meaningful metadata to a stored asset to ensure that it will be easy to find in future with any relevant searches. This involves adding cross-references as the asset may be important to a number of separate subjects and generally creating the metadata needed to allow maximum us of the asset.
Calibration
The process by which a device or system is brought into the condition whereby a defined input produces a defined output.
Checkerboard contrast
The intra-frame contrast in which the black and white patches in an image are arranged in alternating pattern. In this case, the white luminance is measured as the sum of the white luminance of each white patch and the black luminance is measured as the sum of the black luminance of each black patch as long as the number of white and black patches is the same.
Chromaticity diagram
A plot of the x and y chromaticity coordinates in which the x coordinate is plotted on the abscissa and the y coordinate is plotted on the ordinate. There is a similar u', v' chromaticity diagram, but it is not used in this guideline.
CIE
Commission Internationale de l'Eclairage, an international organization responsible for photometry and colorimetry.
CIE Standard Colorimetric Observer
An observer with spectral sensitivities that exactly match the CIE 1931 color matching functions.
CIE tristimulus values
The X, Y, and Z values determined by the data and equations defined in 1931 by the CIE for the Standard Colorimetric Observer.
Colour appearance
What a colour looks like to an observer. Colour appearance depends in many factors including absolute luminance, surround luminance, adaptation of the observer, etc. Colour appearance differs from colour measurements in that the same measured colour will change its appearance as the environment in which the colour is observed changes.
Colour decoding
The definition of a relationship between colour information and numbers. Decoding is the conversion of the numbers, also called code values, into colour information.
Colour encoding
The definition of a relationship between color information and numbers. Encoding is the conversion of the colour information into the numbers, also called the code values.
Colour gamut
The limits of the colours that can be displayed by a system. Also the limits of the colours that belong to a set of colours that are mathematically defined.
Contouring
An image artefact in which there is the appearance of steps or bands where only a continuous or smooth gradient is expected.
Central Storage
A central location where the packaged Digital Cinema content is stored for a multiple
screen installation.
Composition
A motion picture, trailer, advertisement, etc. Composition consist of Metadata Composition Play List along with the Essence and other Metadata track files that define the work.
Conform

Making the final frame or image sequence according to a prepared scheme or EDL.

Chromaticity
The color aspect of light which includes hue and saturation, but not brightness.

Chrominance
The part of the video signal which conveys color hue and saturation information as distinct from luminance. Also called chroma.

Color correction
Changing the color balance or other characteristics of an image to improve the subjective image quality.

Color gamut
The range of colors allowed in a specific system, as defined within a triangular area located on the CIE color locus diagram whose corners are the three primaries of the system.

Conditional access
An entitlement control system that permits access to information only when specific cryptographically enforced conditions are met.

Cryptosystem
The entirely of methods and equipment used to protect content by cryptographic means, including scrambling and encryption, conditional access, key management, physical security of equipment (but not premises), and watermarking. It may also refer to all associated plaintexts and ciphertexts.

CineFence®
Video forensic marking technology developed by Philips.

CineLink(TM)2
The technology that encrypts the link between the media player and the projector. This technology supports the DCI specifications for strong link encryption.

CPL – Composition Playlist
A Composition Playlist consists of all of the essence and metadata required for a single presentation of a feature, trailer, advertisement, or logo. A single CPL contains all of the information on how the files are to be played, at the time of a presentation. There is a separate CPL for each version of a motion picture/feature (composition).

Digital image
An image defined by code values.

DCP – Digital Cinema Package
The DCP is the set of files that result from the encoding, encryption and packaging processes. A DCP may contain multiple CPLs.

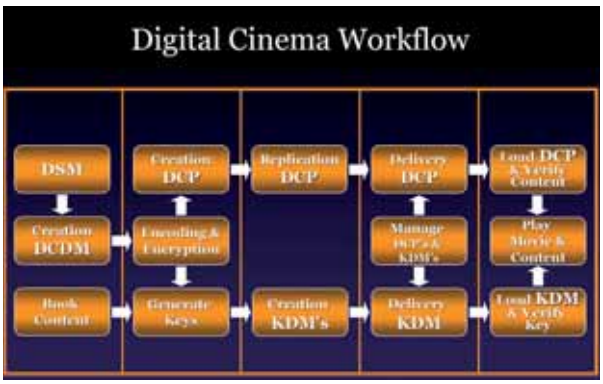
D-Cinema
A contraction of digital cinema. In the classic model the entire production chain from scene to screen is a digital process, with images first captured and processed digitally before then being compressed, encrypted and transmitted via satellite, broadband or disc to cinema theater for digital projection. Standard work is addressed by SMPTE DC28 Task Force on Digital Cinema

DC28
A standards committee composed of members from the Society of Motion Pictures and Television Engineers (SMPTE). The 28 refers to the number of groups required to oversee the various components of the digital cinema transition.

DCDM - Digital Cinema Distribution Master
A master set of files that have not been compressed, encrypted, or packaged for Digital Cinema distribution. The DCDM contains all of the elements required to provide a Digital Cinema presentation.

DCP - Digital Cinema Package. The set of files that are the result of the encoding, encryption and packaging process.

Definition
A description of sharpness or clarity of a picture. High definition pictures portray a lot of detail, while low definition pictures look soft and less clear. See also resolution.



Digital image
An image defined by code values.

Digital Cinema Projector
A Digital Cinema Projector is one that conforms to the DCI specifications. The available options in the marketplace today are those equipped with Texas Instrument's DLP Cinema® chip or Sony's SXRD® technology.

Distribution Package
The collection of files delivered by the distributor to the exhibitor. A distribution package may contain pieces of a composition, a complete composition, replacement/update files, etc.

DSM – Digital Source Master
The Digital Source Master is created in Post-Production and can be used to convert into a DCDM (Digital Cinema Distribution Master). The DSM can also be used to convert to a film duplication master, a home video master, and/or a master for archival purposes.

DLP
Texas Instrument's Digital Light Processing digital projectors, which use arrays of tiny mirrors mounted on DMDs (Digital Micromirror Devices) to project the image. Currently over one million DLP-Based systems have been sold worldwide (though very few of this number to date have been cinema projectors).

DPX
SMPTE file format for digital film images (extension .dpx) – ANSI/SMPTE 268M-1994. This uses the same raster formats as Cineon and only differs in its file header.

Encode (Compression)
In order for the digital cinema file to be a manageable size, it is compressed. A typical uncompressed feature can be approximately 2 Terabytes (TB) in size. After the compression process, those files may range between 150-250 Gigabytes (GB). This size file, while still large, is more easily delivered.

Encryption
Encryption can be considered as putting a lock on the content. The content is transformed by applying the encryption algorithm in conjunction with the encryption key. During the encoding process files must be encrypted to allow for secure transport of feature content. DCI adopted the AES (Advanced Encryption Standard) 128 bit encryption. AES 128 is the standard approved for U.S. government information classified to the SECRET level. Encryption is thus Hollywood's primary concern (fear) when it comes to digital cinema.

End-to-end Security
The consistent application of security measures across an entire process or system (the cryptosystem) such that the most vulnerable elements are sufficiently strong to maintain the desired level of security overall.

Essence
That part of the program data representing the image, audio or text that is directly presented to the audience.

Event Play List
A play list of compositions, describing an assembly of compo-

sitions in sequence. An event play list is typically created by content distributor and transferred to exhibition.

Expert viewing test
An assessment session based on the opinions of expert assessors, in which judgements are provided on visual quality and/or impairment visibility.

File
A structured collection of data characterized by a metadata header and a single body of data payload.

Frame rate
The number of pictures presented or recorded each second. It is measured in frames per second.

Gamut mapping
A process by which one color, which a device cannot produce, is replaced by another color, which the device can produce.

Gray scale
The series of achromatic colors from the lowest luminance to the highest luminance.

HVDLT
Human Vision Delta Luminance Threshold. This is the minimum change in luminance that a group of people can correctly identify 50% of the time. See also HVMT from which this is derived.

HVMT
Human Visual Modulation Threshold. This is the minimum modulation that a group of people can correctly identify 50% of the time.

Image State Diagram
A diagram showing the various states in which an encoded image can exist. There are three states, the Scene Referred State, the Output Referred State, and the Input Referred State. An image can be transformed between any two states.

Integration
Making one system, application or set of data work very closely with others. Ideally, the distinctions and boundaries and barriers between the separate parts should disappear as the integrated system or information works seamlessly - as one. This is a very 'deep' form of interfacing and goes a great deal further than simply interchanging information with a third party. The use of industry-wide standards is essential if extensive integration is to be achieved.

Interface
A means of passing on information from one application to another. Interfaces can either be proprietary, in which case only one or a chosen few applications can use it, or open with the interface details publicly available and, best of all, complying with the appropriate international standards.

Interoperability
The ability of systems to interoperate – to understand and work with information passed from one to another. Applied to television this means video, audio and metadata from one system can be used directly by another. Digital signals may be originated in various formats and subjected to different types of compression so care is needed to maintain interoperability.

Intra-frame contrast
The ratio of the luminance of the white divided by the luminance of the black, normalized to a denominator of 1,when the white and black that are measured are projected onto the screen in the same image. This is usually expressed as number:1, for example 2000:1. See also checkerboard contrast.

ISDCF Voluntary Naming Convention
The most significant information about the DCP is contained in the first 40 characters of the CPL text fields due to limited display space of certain DC servers. Additional information is included for servers that can display more than 40 characters.

JPEG 2000
A wavelet-based image compression standard. It was created by the Joint Photographic Expert Group (JPEG) committee with the intention of superseding their original discrete cosine transform-based JPEG standard. It is the compression method specified by DCI for digital cinema picturetracks.

KDM – Key Delivery Message
The KDM provides the method for securely delivering content and key elements. A KDM contains the 'keys' to unlock the elements of a CPL for a specific device. If a DCP contains multiple CPLs, a unique KDM is required for each different CPL, and can only be generated for devices on the Trusted Device List (TDL).

Kell Factor
The vertical definition of a scanned image is only around 70% (the Kell Factor) of the line count due to a scan's inability to show detail occurring between the lines. Note that, for interlaced scans, vertical definition is further reduced by the Interlace Factor to 50% or less overall during most vertical image movement.

Legacy
Something that is influenced by or a part of the past. As much as new applications and technologies spring up, most times even these bright new ideas are steeped in legacy - they are not a clean break from the past.

Library Management Server® (LMS)
A group of servers and networking components that are integrated and tested to create a powerful central hub for all communication needs in the multiplex. It allows central storage of all movies, alternative content, trailers, advertising and more. This component networks the theatre, increasing the value of the individual components on each screen.

Local Storage
A storage device that is associated with the individual playout device.

LSDI
Large Screen Digital Imagery. Is a family of digital imagery systems applicable to programs such as dramas, plays, sporting events, concerts, cultural events, etc, from capture to large screen presentation in high resolution quality in appropriately equipped theaters, halls and other venues.

Luminance
A measure of the energy being reflected or emitted by a surface and in which the energy is weighted by the CIE Vλ, also called the CIE y-bar color matching function. Luminance is an approximate correlate of brightness. The Y value in the set of CIE XYZ tristimulus values is the luminance.

Luminance factor
The ratio of the luminance of a sample divided by the luminance of a perfectly reflecting or transmitting object when both are illuminated identically.

Mastering
Mastering indicates the set of those technical activities that lead to the finished edited master of a program, which normally materializes the creative intent of its authors.

Media Server
Each digital cinema projector requires a media player to decompress and decrypt Digital Cinema Packages (DCP), allowing the content to be played on the associated projector. There is one media server for every projector in a multiplex.

Metadata
Data about data. For programme material this might include the title, duration, time and date, copyright details, location or type of programme. Metadata has become a vital part of storing digital content, image and audio, in large archives to enable it to be found again easily. Information that is considered ancillary to or otherwise directly complementary to Essence. Any information that a content provider considers



useful or of value when associated with the Essence being provided.

MXF
The Material Exchange Format is aimed at the exchange of program material between file servers and is a format for tape streamers and digital archives. It usually contains one complete sequence but this may comprise a sequence of clips and program segments. MXF bridges file and streaming transfers, helping to move material between AAF file-based post production and streaming program reply using standard networks. The MXF body carries the content that can include MPEG, DV and uncompressed video and contains an interleaved sequence of picture frames, each with audio and data essence plus frame-based metadata.

NexGuard®
Video forensic marking technology developed by Thomson.

Redundancy
In order to offer 24/7 uptime, there has to be protection against equipment failure. A good way to provide this is to provide redundancy that avoids any single point which could cause an unrecoverable system failure. As many may be relying on the continuous running of a server, the extra cost of redundancy is often justified.

Primary
A color from which other colors are made by addition or subtraction. The Reference Projector primaries are red, green, and blue and all other colors are made by addition of light from each of these primaries. The DCDM encoding primaries are X, Y, and Z, which are imaginary primaries, and by which all other colors are defined.

Rights
Material can only become a valuable asset if it has rights to its use. Such information which defines the allowable circumstances of its use needs to be associated with the material as a part of its linked metadata. For example, rights may be granted for broadcast on a certain channel at a particular time. At the same Rights Protection prevents the use of the asset where it is not licensed.

Review room
A theatre in which decisions are made about images projected onto a screen.

RPGB
Reference Projector Gamut Boundary, the limits of the colors that can be displayed by the Reference Projector.

Saturation
The colorfulness of an area judged in proportion to its brightness. On a chromaticity diagram, the saturation of a color increases as its distance from the white point on the diagram increases. Also, on a chromaticity diagram, the points that plot at the same xy coordinates, but have different Y values, form a series in colors that have the same saturation, but different brightness.

Sequential contrast
The ratio of the luminance of the white divided by the luminance of the black, normalized to a denominator of 1,when the white and black that are measured are projected onto the screen as full frame images. This is usually expressed as number:1, for example 2000:1.

Show Play List - SPL
A Play List of Compositions, Play lists and Event Play lists, describing a sequence that occurs at a particular screen. A Show Play List is typically created by exhibition using theatre management software to transfer screen ads, trailers, features to the equipment controlling a particular screen..

StEM
Standard Evaluation Material. Also called the ASC/DCI Standard Evaluation Material or the DCI-ASC Mini-Movie. Motion content that was shot on film, scanned, and used for D-Cinema and image quality testing. The material is available from SMPTE as of the writing of this guideline.

Transfer function
The equation that shows luminance as a function of the DCDM Y' code value, Y = f(Y'), Equation 6-5.

TDL – Trusted Device List
The TDL is list comprised of digital equipment installed in theatres for which studios or other rights owners have given their approval to these 'trusted' devices to play their content. KDMs are only created for devices on the list. This adds another level of security to the DC process.

Transport and Delivery
Digital Cinema Packages (DCPs) and Key Delivery Messages (KDMs) are transported either physically on media (such as hard drives) or electronically via satellite. When the DCP arrives at the theater and is loaded, it is unpackaged, decrypted and decompressed for play out by the projection equipment.

Watermark
Watermarking refers to the type of technology used to embed information, including content usage rules, securely into a video or audio signal. Watermarks are designed to be imperceptible by the audience, and they travel with the content even over analog interfaces. Watermarks are directly embedded into the actual content itself and therefore are difficult to remove. Furthermore, watermarks survive and "travel with" content as it is converted from digital to analog form or is re-digitized from analog back into digital. While watermark technology permits content protection rules to "stay with" content, watermarks do not, in and of themselves, protect the content. Watermarking is simply a technology for signaling information and usage rights to devices that may receive the content.

Wrapper
A digital container that contains program Content and also defines and describes the structure of the Content.

Visually Lossless
An image is considered visually lossless when the processed image is indistinguishable from the unprocessed image under normal theatrical viewing conditions.

XYZ
A shorthand notation for the CIE tristimulus values.

X'Y'Z'
A shorthand notation for the DCDM encoded code values. Notably, the DCDM encoded code values are normalized to a maximum code value of 4095 and have a non-linear transfer function of 1/2.6.

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