

# Engineering Progress in the Field of Digital Cinema

By Michael Sterling, Technicolor Digital Cinema

Since its formation in 1999, Technicolor Digital Cinema has worked side-by-side with core digital cinema stakeholders as both a technology enabler and service provider. The division is now utilizing its industry knowledge and expertise to develop engineering-based solutions for technologies and promote standards that will ultimately enable digital cinema commercialization on a global basis.

Technicolor Digital Cinema signed digital cinema equipment usage agreements in November 2005 with DreamWorks SKG, Sony Pictures Entertainment, Twentieth Century Fox, Universal Pictures, and Warner Bros., to accelerate its plans for the distribution of digital cinema content and systems throughout North America. In January 2006, the company reached a strategic understanding with Century Theatres, Inc., one of America's largest national theater circuits, to install Digital Cinema systems in Century-owned and operated screens. These installations are part of Technicolor Digital Cinema's beta test deployment, which began in June of this year.

Following the successful completion of its beta test, Technicolor Digital Cinema plans an initial deployment of complete digital projection systems in up to 5,000 screens over the next 3 to 4 years. It is the strategic intent of the company to introduce systems into at least 15,000 digitally equipped screens in the United States and Canada over the next 10 years through the preliminary rollout and additional phases.

### **Digital Cinema Engineering Advancements: The Technicolor Digital Cinema Test Center**

Prior to the commencement of its North American equipment deployment, Technicolor Digital Cinema recognized the critical need for a qualified team of engineers to conduct ongoing and in-depth analysis and evaluation of currently available digital cinema hardware, middleware, and software. To that end, in December 2005, Technicolor Digital Cinema established the world's largest digital cinema test and research facility in Burbank, CA. This state-of-the-art facility, operated by four dedicated digital cinema engineers, also includes two auditoriums designed to reproduce real-world commercial cinema environments. The large auditorium is a

162-seat house with a 35-ft screen, while the smaller theater accommodates 50 individuals and has a 22-ft screen. The projection booth, which services both auditoriums, provides a 61-ft throw and is capable of supporting up to nine digital cinema projectors for image comparison testing.

The formation of a digital cinema test center is necessary to rigorously measure the reliability, performance, and DCI compatibility of digital cinema projectors and servers from major hardware manufacturers; identify the existence and cause of related interoperability issues among products; and subsequently develop a comprehensive solution for digital cinema—all within a controlled laboratory environment. Technicolor Digital Cinema believes that the analysis of equipment in such an environment is absolutely imperative to the general success and viability of digital cinema and to ensure that DCI-based systems are ready and available for deployment and continued support as required in a commercial environment.

To ensure the integrity and transparency of its research methodology, Technicolor Digital Cinema first actively solicited the participation of major hardware developers via an open request for information (RFI) process, followed by the issuance of formal requests for proposals (RFP) based on OEM interest and the scope of equipment details provided to the company. The company then accepted projectors and servers into its facility for evaluation, based on the quality of RFP submissions, and the willingness of manufacturer representatives to work closely with staff engineers on test implementations and their corresponding findings.

For the subsequent hardware analysis conducted in the laboratory, Technicolor Digital Cinema devised an extensive battery of 144 individual tests, principally based on the DCI Digital Cinema System Specification v. 1.0. In addition, the comprehensive assessment sequence was also based on specific requirements set forth by Technicolor Digital Cinema during the RFP process. Unique test materials, including projector test patterns, server test patterns, network and disk-based content sources, were required to fully measure the capabilities of the equipment. Technicolor engineers also developed test patterns to provide highly-specialized

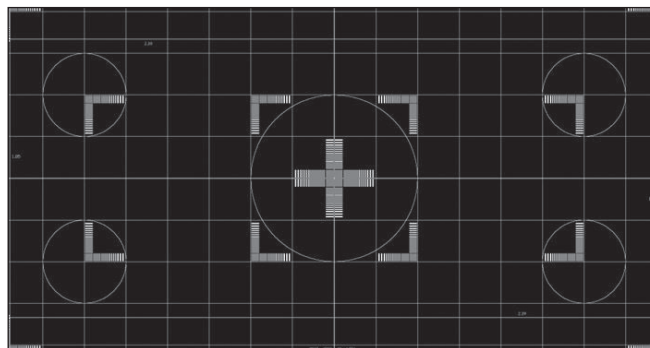
information. One such test pattern was designed to expose chroma subsampling within a server.

During equipment evaluation and analysis, Technicolor Digital Cinema engineers examine each device's ability to efficiently handle such core digital cinema operations as subtitle display, simultaneous playout and movement, inter-server movement, automation, 2k and 4k interoperability, alternative content playback, remote management, 3-D capabilities, and on-screen advertising integration. Furthermore, the company also tests each unit's ease of use and back-of-house systems integration, since projectors and servers are required by the DCI specification to work seamlessly with each other, and with different distribution and theater management systems (TMS).

Over the course of its first seven months of operation, Technicolor Digital Cinema has utilized its test center findings to specifically determine which digital projection equipment configurations will be deployed during the first phase of the company's beta test rollout, which is already under way.

In addition to this primary purpose, the company also set forth a number of other important objectives, outlined below, to be achieved by the Technicolor Digital Cinema Test Center:

1. Determine the viability of 4k technology as a differentiator from other rollouts.
2. Continue to test components and systems throughout the beta test to monitor interoperability, DCI feature implementation, and DCI compliance.
3. Analyze and accept equipment, based on RFP responses.
4. Devise comprehensive tests based on the DCI specification, MXF interoperability test plan, and specific RFP requirements.
5. Work closely with studios, industry experts, and standards bodies.
6. Select and perform preliminary tests for projectors and servers to measure feature set, performance, and compliance criteria.
7. Measure capabilities and shortfalls of equipment performance, based on objective test criteria.
8. Create proprietary test materials (e.g., projector test patterns and server killer patterns) to fully exercise the operations of various equipment.
9. Establish a controlled theater environment for testing.
10. Execute equipment testing on an aggressive evaluation schedule.



*This is the test pattern as described in the article.*

11. Complete the 144 tests defined to date.

### **Technicolor Digital Cinema Test Center: Engineering Accomplishments To Date**

In just seven months, Technicolor Digital Cinema engineers, technicians, and project managers have made significant progress on the aforementioned objectives. First and foremost, the test center was designed from the ground up, and then transformed into a fully-operational, sophisticated laboratory, as described, to fully evaluate the reliability, performance, and DCI compatibility of digital cinema projectors and servers from major hardware manufacturers. After just two months of analyses, test center engineers had already obtained preliminary results to serve as input for equipment vendors, and then used those, and subsequent, findings to determine the equipment configurations which will be deployed in the first phase of the company's beta test. As of this writing, the company has successfully completed more than half of the 144 equipment tests defined to date, and it continues to conduct ongoing evaluations of 2k and 4k projectors, servers, and interface equipment.

Test center engineers are currently working on the execution of the following remaining test cases as part of its test center objective set:

- Subtitles
- Simultaneous playout and movement of content
- Inter-server movement
- Automation
- 2k/4k Interoperability
- Alternative content

Furthermore, test center engineers must still identify and execute additional test cases for the equipment under evaluation. These additional test cases include the analysis of such important capabilities as security; remote management, including Technicolor Digital Cinema's proprietary TMS interface; 3-D capabilities;

alternative content and on-screen advertising integration. Additionally, distribution and back-of-house systems integration and the interoperability of servers and projectors with various distribution and TMS systems will require evaluation.

Obviously, there is still much work to be done to complete a thorough performance evaluation of currently-available digital cinema hardware and software. The Technicolor Digital Cinema Test Center has accomplished a great deal in a short amount of time, and has invested significant time, energy, and resources to determine the most viable equipment for commercial environments.

### **Technicolor Digital Cinema Beta Test Program Status**

As a previously mentioned, Technicolor Digital Cinema firmly believes that the controlled testing of hardware and systems is crucial to the success of digital cinema. That being said, the test center is proceeding with further detailed tests of fully integrated systems incorporating the latest developments and upgrades to hardware and software.

In addition to its equipment testing initiative, the company is currently deploying a number of beta systems into select commercial cinema locations. This is intended to provide real-world data to complement the work being done in the test center. The beta test deployment program consists of 180 to 240 screens at approximately 20 sites throughout the United States and Canada, agreements with multiple exhibitors in various markets, and definitive plans to equip sufficient screens per site to allow traditional workflows supporting “move-overs” and “play-offs.”

Technicolor Digital Cinema is currently in development and testing of the following services, which it plans to deploy during the beta test and its broader rollout, scheduled to begin in early 2007:

- Theater management system.
- Ingest server and related equipment.
- Back-end systems (key management, monitoring, reporting).
  - Audio and automation interfaces.
  - Digital distribution services.

### **Other Important Technologies Related to Digital Cinema**

Technicolor Digital Cinema, using the substantial engineering resources available within its parent company,

Thomson, is continuously in development of new anti-piracy technologies relating to the area of digital cinema. For example, Thomson has developed a complete image and audio watermarking solution that is currently in use by various digital cinema server manufacturers to safeguard electronic content. In addition, the company is creating a complete forensic detection platform to facilitate the reading and decoding of the embedded watermark. This technology enables digital cinema engineers to precisely pinpoint the date, time, and location of the theft of the content, and then electronically trace how and where the content was replicated, distributed, and/or used to identify the perpetrator.

Finally, Thomson has invented, and is in the process of refining, an anti-camcording solution, which was first demonstrated at the 2005 Cannes Film Festival. This particular technology is specifically designed to thwart the piracy of major motion pictures during digital cinema projections by using consumer camcorders at the individual screen level. The solution is enabled by the insertion of a watermark, which remains invisible to moviegoers, into the digital content. The watermark may be deployed during the film’s post-production, the preparation of the digital cinema digital master (DCDM) file, or the digital projection of the film itself. The technology is very flexible and uses text messages and semi-transparent visual effects, such as water waves or flickering shapes, to disrupt the illegal recording of the film. When the content is replayed on a camcorder or monitor, the content is rendered completely unwatchable. Technicolor Digital Cinema believes that this technology will be ready for deployment in conjunction with the broad digital cinema rollout beginning in 2007.

### **Conclusion**

Technicolor Digital Cinema views the future of digital cinema engineering and technology research as a very bright one. However, in addition to the ongoing, groundbreaking research in its test center, and the further refinement of content security solutions for digital cinema, there is still much to be accomplished in the field relative to the actual performance of digital cinema hardware and software. As a result, it is critical to maintain a focused approach on engineering and research and development activities to ensure that digital cinema is successful, here in North America, and worldwide. Technicolor Digital Cinema is committed to contributing to this success, at both an engineering level and from an operational perspective.