New WorldWide (DCS) Digital Cinema Solution
From a relationship between Cisco Systems Italy
and Cinemeccanica spa

Cinemeccanica spa is an Italian Company specialized in manufacturing and distributing Cinema equipments, from projectors to the screens. It has launched an innovative solution related to the movie playback inside Cinema theatres based on a centralized server architecture able to stream audio and video contents to the Digital Cinema projectors installed in the projection booths.
Together with Italian system developers (ART srl) and an Italian specialized system integrator (In.I.T srl.), Cisco Systems is able to supply a robust and flexible network solution that allows some significant saving in ownership and maintenance costs for Cinema exhibitors, also introducing a more efficient control and troubleshooting for all the Digital Cinema Equipments.
As consequence Cinemeccanica spa, leveraging its strong expertise in field, is able to face the Digital Cinema Market with a brand new solution that exactly matches the actual and future expectations.

EXECUTIVE SUMMARY

Cinemeccanica spa
- Industry,
  An Italian Company working in manufacturing and distributing Cinema equipments since 1920

In.I.T. srl
- Networking,
  An Italian Cisco System Integrator, Corporate Partner since 1996

ART srl
- R&D,
  An Italian R&D and Manufacturing Company, expert in Digital Media, Space, Motorsport and Advanced Transportation. Systems.

Business Challenge
- To provide a cost effective solution to exhibitors that exploits and extends the benefit of the Second Generation of Digital Cinema Projectors
- To improve Performance, Flexibility, Availability and Reliability of existing Digital Cinema Solutions
- To centralize and simplify system management and maintenance

Network Solution
- The Cisco Catalyst 2960-S with FlexStack Technology or Catalyst 3750 with StackWise and RSTP configuration as core switches
- The Cisco 300 Series as access switch for Projectors.

Business Value
- A significant reduction of TCO for Exhibitors
- Improved system performance and programming flexibility
- A coherent, management of the whole infrastructure
- A non-supervised Projection Booth
- A centralized and simplified system management and maintenance

Challenge

Second Generation of Digital Projectors in Digital Cinema Market allow best **4K (Super HD)** image resolution and Motion Picture quality and introduced a new system architecture concept: The Image Decoder (IMB) becomes embedded in the Projector. A server (SMS) capable of feeding this IMB with real-time streaming compressed and encrypted content has to be include in this scenario to allow system operation. The bandwidth of such an High Quality bitstream very high to preserve image quality: 250 Mbit/s for the picture payload only. Taking into account Audio, and ancillary information, the gross bandwidth may overcome 350 Mbit/s. This value is still growing, since increased picture bit rate "profiles" are under evaluation inside Standardization Organizations as ISO, and SMPTE.

Until now, all the Digital Cinema Manufacturers proposed "Projector Attached SMS Servers". This approach is sub-optimal, since it fails reducing TCO costs, obliges servers to operate in the challenging "Projection Booth" environment, and complicates management and maintenance operations.

Cinemeccanica spa, together with their technical partners ART srl and In.I.T. srl designed and developed a completely new system architecture in which the SMS server, or a cloud of "physical/virtual SMS servers" is "detached" form the projector, centralized in a properly equipped room inside the theater and feeding "in streaming mode" all the IMBs and the Projectors of the Multiplex. Cinemeccanica spa calls this approach "**CM-Cloud**". While this allow to reduce costs, improve performance, system management and maintenance, and SMS server reliability, this approach posed non trivial networks challenges.
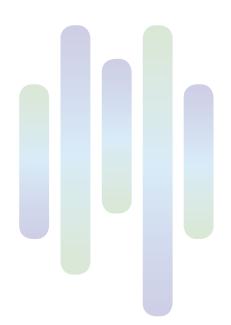
DCI (Digital Cinema Initiative) specs and good design practices prescribes that no "single point of failure" must be present in the system architecture, thus the system architecture itself must be conceived and designed with a very specific requirement: "The show must go on".

From the network point of view, this means that complete fault tolerance, redundancy and of course adequate throughput has do be granted from the **CM-Cloud** to the IMBs attached to the projectors, while keeping the global cost significantly lower than the traditional approach.

The Cisco Catalyst 2960-S is the core platform that In.I.T. srl., thanks to the FlexStack Technology and the Rapid Spanning Tree Protocol (RSTP; IEEE 802.1w), is using to deploy the efficient and very fast failover solution for the new Digital Cinema Solution engineered by ART.

The Cisco 300 Series is the Easy-to-Use Managed Switch Series that Provide the Ideal Combination of Features and Affordability. The SG300-10P used for this solution provide 14.88 Millions of Packets per Second (mpps) (64-byte packets) and a Switching Capacity in Gigabits per Second equal to 20.0 Gbps
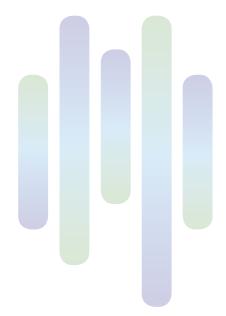
Solution

Cinemeccanica spa and ART srl developed an innovative **(DCTSA) Digital Cinema Theater System Architecture**, whose diagram is shown in Figure 1, characterized by the centralization of theater management servers in a location separated from the projection booths.

Each auditorium in the theater is provided with a rack, mounted inside the projection booth, which includes all the equipments needed to make a theatrical presentation of Digital Cinema contents (trailers, features...) or alternative contents (ads, trailers, live shows...):

- The *Image Media Block* (**IMB**) is responsible for real-time extraction of video, audio and subtitles from a Digital Cinema Package (DCP), and for providing these contents to other auditorium equipments: projector, audio processor, external subtitle renderer...

- The *Video Scaler* (**VSC**) allows feeding the IMB with alternative contents from a wide array of sources (DVD/Blu-Ray players, PC video cards...) connected to its HDMI or DVI (digital + analog) interfaces. The VSC provides scaling capabilities in order to make the image quality suited to projection on large auditorium screens.

- One of the sources of alternative contents is the *Multiple Access Inputs* (**MAI**) unit, designed by ART srl, which implements playback of files encoded in a variety of formats (e.g. H.264/MPEG2 video, MP3/AAC/AC3 audio, AVI/MP4 containers), decoding of RTSP streams coming from a satellite receiver (e.g. live shows, sport events...) and video enhancement capabilities.

- Video contents (both DCP and alternative) coming from the IMB are shown on the auditorium screen by the **Projector**, which supports 2K or **4K (Super HD)** resolution depending on the specific model.

- Audio contents coming from the IMB are sent to the *Audio Processor* which performs surround decoding, preamplification, equalization, volume control etc.; the processed audio is sent to the auditorium PA system.

- An *Automation Processor* manages various automation events related to the auditorium.

All the auditoriums are managed by a set of equipments which is physically located separated from the projectors.

- Each *Screen Management System* (**SMS**) node controls all the functionalities related to a single auditorium, for example:

  - Provides an user interface for local control of the auditorium by theater staff;

  - Controls all the aspects related to the auditorium: projector management, playback through the media block, automation (e.g. open/close curtains, turn on/off lights), sound processing and more.

  - Directs security functions which allow secure streaming of a *Digital Cinema Package* (DCP) to the projector;

  - Schedules the execution of a show by following a playlist which specifies which content must be directed to the screen (e.g. trailers, ads, main feature, live content, cues such as automation actions);

  - Collects diagnostic information from the auditorium equipments and provides them to the exhibitor and/or the distributors.
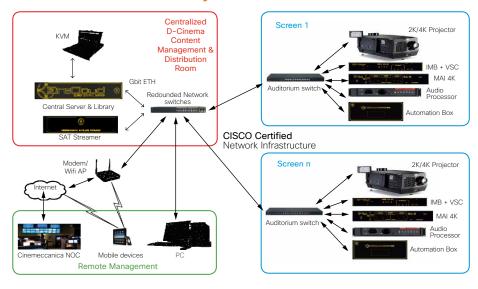
– The **Content Library** unit is a centralized storage for different kinds of files: DCP contents, alternative contents, show playlists, Key Delivery Messages (KDM) needed for playback of encrypted DCPs. Contents are copied from the Content Library to the local storage available into the SMS units before playback.

Communications and data exchange between all the equipments are performed using the theater LAN. The SMS and Content Library units can be operated in various manners:

– **Locally**, i.e. directly connecting a keyboard, mouse and monitor to the unit or remotely.

– **Remotely**, with different levels of interaction:

– In Theather users (e.g. **Personal Computers** or **mobile devices** connected to the theater LAN) are able to manage the system as if they are connected locally.

– External users (e.g. a **Network Operations Center**) are able to monitor system operation over a WAN in order to prevent critical issues, and to troubleshoot some of the issues. In this case in each Theather is installed also a Cisco ASA Unit (Firewall and VPN Concentrator) that provides a secure VPN between Cinemeccanica spa NOC and Theater LAN.

Figure1. Cinemeccanica spa In-Theater System Architecture

CMCloud System Architecture

To sustain an High Quality bitstream **with a very low latency and delay for the failover procedures, In.I.T srl engineered a Cisco Certified Solution for that IP Network Infrastructure**, using, for the Distribution Room, a Stack of Cisco Catalyst 2960S Series Switches, and for the Auditorium Room, the Cisco 300 Series Switches. (For theaters with a large deployment of projectors, the Cisco Catalyst 3750 Series Switches are used)

The Cisco Catalyst 2960-S Series Switches are the leading Layer 2 edge, providing improved ease of use, highly secure business operations, improved sustainability, and a borderless network experience. The Catalyst 2960-S Series Switches include new FlexStack switch stacking capability with 1 and 10 Gigabit connectivity, and Power over Ethernet Plus (PoE+). The Cisco Catalyst 2960-S and 2960 Series are fixed-configuration access switches designed for enterprise, midmarket, and branch office networks to provide lower total cost of ownership.

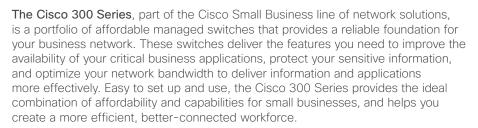These equipments are connected between them via Flex Stack Technology.

Cisco FlexStack stacking with a hot-swappable module and IOS software provides true stacking, all switches in a stack act as a single switch unit. The Cisco FlexStack provides a unified data plane, unified configuration, and single IP address management for a group of switches. The advantages of true stacking are lower total cost of ownership through simplified management and higher availability. Cisco FlexStack supports cross-stack features including Etherchannel, SPAN and FlexLink technology. A stack module can be added to any Catalyst 2960-S switch with LAN Base software to quickly upgrade the switch to make it stack capable, and the switch added to the stack will upgrade to the correct Cisco IOS® Software version and transparently become a stack member.

The main feature used in this configuration is the Rapid Spanning Tree Protocol.

The 802.1D Spanning Tree Protocol (STP) standard was designed at a time when the recovery of connectivity after an outage within a minute or so was considered adequate performance. With the advent of Layer 3 switching in LAN environments, bridging now competes with routed solutions where protocols, such as Open Shortest Path First (OSPF) and Enhanced Interior Gateway Routing Protocol (EIGRP), are able to provide an alternate path in less time. Cisco enhanced the original 802.1D specification with features such as Uplink Fast, Backbone Fast, and Port Fast to speed up the convergence time of a bridged network. The drawback is that these mechanisms are proprietary and need additional configuration.

Rapid Spanning Tree Protocol (RSTP; IEEE 802.1w) can be seen as an evolution of the 802.1D standard more than a revolution. The 802.1D terminology remains primarily the same. Most parameters have been left unchanged so users familiar with 802.1D can rapidly configure the new protocol comfortably. In most cases, RSTP performs better than proprietary extensions of Cisco without any additional configuration. 802.1w can also revert back to 802.1D in order to interoperate with legacy bridges on a per-port basis. This drops the benefits it introduces.
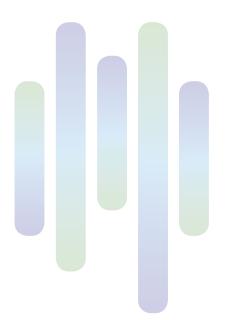
The new edition of the 802.1D standard, IEEE 802.1D-2004, incorporates IEEE 802.1t-2001 and IEEE 802.1w standards.

The Cisco 300 Series, part of the Cisco Small Business line of network solutions, is a portfolio of affordable managed switches that provides a reliable foundation for your business network. These switches deliver the features you need to improve the availability of your critical business applications, protect your sensitive information, and optimize your network bandwidth to deliver information and applications more effectively. Easy to set up and use, the Cisco 300 Series provides the ideal combination of affordability and capabilities for small businesses, and helps you create a more efficient, better-connected workforce.

The Cisco 300 Series is broad portfolio of fixed-configuration managed Ethernet switches. Models are available with 8 to 48 ports of Fast Ethernet and 10 to 52 ports of Gigabit Ethernet connectivity, providing optimal flexibility to create exactly the right network foundation for your business. However, unlike other small business switching solutions that provide managed network capabilities only in the costliest models, all Cisco 300 Series Switches support the advanced security management capabilities and network features you need to support business-class data, voice, security, and wireless technologies. At the same time, these switches are simple to deploy and configure, allowing you to take advantage of the managed network services your business needs.

This switch is connected to the Stack in the Distribution room via 2 copper Gigabit Ethernet uplink linked to each stack member. For most demanding installation, is it possible also using 2 fiber link, thanks to the combo ports (SFP-RJ45) onboard.

The CM-Cloud nodes are connected to the Cisco **Catalyst** Series switch via 2 copper link using a **bonding configuration**. The configuration uses the mode called "Active-backup". With this mode only one slave in the bond is active; a different slave becomes active if, and only if, the active slave fails. Sends and receives traffic only through the master port. If the master port becomes unavailable, the next active port is used. The first interface added is the master port; any interfaces added after that are used as failover devices. If failover to a non-master port occurs, the original port will become master when it becomes available again. The bond's MAC address is externally visible on only one port (network adapter) to avoid confusing the switch. This mode provides fault tolerance. The bonding has been configured to monitor the link status of the interfaces using the ARP monitoring mode. The ARP monitoring sends ARP queries (performed every T<1s with T=Time Interval.) to one or more designated peer systems on the network, and uses the response as an indication that the link is operating. This gives assurance that traffic is actually flowing to and from one or more peers on the local network. In particular T is defined according the buffer size of the CM-Cloud to ensure smoothness in the video broadcast.

The active-backup policy is intended to provide fault tolerance and highest possible system availability.

Business Value

Digital Cinema Market is a really strong and competitive marked that has moved its first step just a few years ago. In 2004 the existing celluloid film production has started to move to Digital. During the first years the deployment of digital equipments had been quite slow (400 installation in 2006), then the market had a significant upward in requests. From about 5000 installation in 2007 to 16000 deployments in 2010, when the worldwide Cinema Market clearly understood the impossibility for the coexistence of film and digital film copies. At the present day, about the 40% of the worldwide Cinemas has already been converted to Digital. The forecast for 2012 is to get the 63% of the market and finally cover the totality of cinemas in the world at the end of 2015.
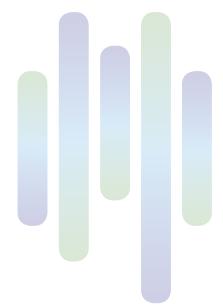
The CMCloud Architecture introduced by Cinemeccanica spa is exactly matching the actual and future need of Cinema Market since it is a technical answer to all the pressing requests of exhibitors: full automatic management system, top of flexibility in scheduling, energy saving, centralized control of projections, remote overview and control of the running system. In two words: drastic reduction in Ownership and maintenance cost of the equipment.

This goal can only be achievable by basing the architecture on a strong, reliable and fast networking system as it has been developed in cooperation with Cinemeccanica spa, ART srl and In.I.T srl.

Conclusion

The developed architecture and the complete Suite of products developed represent a breakthrough in Digital Cinema market. The cooperation of Cinemeccanica and ART with Cisco Italy trough In.I.T. srl. allowed to consolidate a network architecture that fulfill requirements of a complete fault tolerance, redundancy and adequate throughput. No single point of failure can affect system availability. The architecture can tolerate a cable loss or a even shutdown of an entire Central Switch, without any interruption of the show in any of the screen attached to the Cloud. The result is a robust and flexible in-theater network solution that allows some significant saving in ownership and maintenance costs for Cinema exhibitors, also introducing a more efficient control and troubleshooting for all the Digital Cinema Equipments.

About Cinemeccanica Spa

Founded in 1920 Cinemeccanica spa is one of the world`s pioneers in the production of Cinema equipment. The company based its own tradition on a long series of worldwide success. Worldwide leader in developing cinema technology, like projectors and sound equipment, Cinemeccanica spa is now present in 90 countries.

From the early beginning Cinemeccanica spa products are synonymous of quality, precision and innovation. Since 1920 quality, precision and customer service are the elements that drive the developement of the company and make Cinemeccanica spa able to sustain the evolution of the cinema: from the B&W film to digital 3D movie, from silent film to digital sound. Nowadays, Cinemeccanica spa can count on its Digital Division specialized in developing and producing a range of Digital Cinema projectors DCI compliant, thanks to a partnership with Barco. http://www.cinemeccanica.it

About Art Srl

ART srl is an R&D and Manufacturing company based in Italy. Main expertise and business areas are Digital Media, Space, Motorsport and Advanced Transportation. Systems. In the Digital Cinema Market, ART srl started relevant R&D activity in 2002. ART srl participated to European Projects WorldSCreen (years 2004-2006) and ED-Cine (2006-2009) leading Digital Cinema Distribution activites, developing solutions and expertise in the Digital Media and Digital Cinema Processing and Transmission. ART srl also participate to DCI, ISO JPEG2000 Working group and SMPTE Starndards Organizations. ART srl signed agreements with RAI (Italian National Broadcaster) and Cinemeccanica spa for the design and validation of systems, techniques and solutions for the Production, Post Production and Distribution of Digital Cinema. http://www.ilpischiello.com

About In.I.T srl

In.I.T srl., a Cisco Premier Certified Partner Corporate, has several years' experience in system integration and software development. In.I.T srl. implements and supports Cisco Systems technologies such as Data Center Networking , Routing & Switching, Security, Unified Communications, Unified Computing Technology , Unified Fabric Technology , Wireless LAN, Wireless Mesh, Video Surveillance. In.I.T. srl has a great experience supporting Service Providers and Telco Carrier with Value Added Services with Next Generation Intelligent Networks and Infrastructures: INFInIT platform, a In.I.T srl core technology, provides NGN services and is certified as a part of the Cisco Systems IMS architecture for service providers. In.I.T srl. is part of Gruppo Partner Associates with 13 offices in Italy, 8 branches in the rest of the world and more than 200 employees.
Additional information about In.I.T. srl. can be found at http://www.gruppoinit.it