



Nodel:

A digital media control system
for museums and galleries

Developed by Museum Victoria
and Lumericom Pty. Ltd.

Version 2.0
2 April 2014

Joe Coleman
Michael Cartmel
Keith Vaz

TABLE OF CONTENTS

Summary.....	3
Issues of the existing gallery control system.....	4
Requirements and Objectives.....	6
Solution.....	8
Benefits of Open Systems.....	9
System Architecture.....	11
Overview.....	11
Implementation.....	12
Conclusion.....	14

SUMMARY

Modern museums and galleries incorporate a substantial amount of digital media in their public offerings. The control and maintenance of these systems can impose a significant overhead in terms of staff resources if not automated in some way. There are several ways that this can be achieved, ranging from simply hard switching devices at a common circuit breaker to sophisticated computerised management systems.

The former option does not offer any flexibility to control devices independently, nor does it allow for any operational feedback. Moreover, considering the delicate and complex nature of modern digital media equipment, hard switching devices has a detrimental effect on the lifespan of equipment. This leaves institutions wanting a more sophisticated automation approach looking at the latter option.

In 2010, the Digital Media Systems team at Museum Victoria initiated a project to examine products available for the control of gallery media presentation equipment and provide recommendations to management for the replacement of the existing bespoke control system.

At the time of the survey, there were several products that are designed to control and integrate audio-visual devices. Most of these products were designed for the purpose of automated control of audio-visual systems in presentation spaces such as meeting rooms and lecture theatres, or for the sequencing of complex entertainment experiences such as theme park rides. Furthermore, all of the extant products surveyed were only available under commercial licenses that involved ongoing fees or charges based on the number of rooms or devices being controlled. Such proprietary solutions impose limits on the customer's ability to customise and alter the system and frequently lock the end user into expensive maintenance contracts.

This white paper will outline the background to the project, and describe the steps that were taken in reaching a decision for a new gallery control system. It will also give an overview of the bespoke control system that was chosen – Nodel – its system design and architecture and operation.

ISSUES OF THE EXISTING GALLERY CONTROL SYSTEM

In the late 1990s, Museum Victoria was developing Melbourne Museum, its flagship venue which at that time was envisaged to be a highly media rich venue. Plans incorporated a centralised control system to manage all of the gallery devices and integrated streaming of digital content to approximately 70 points of presence throughout the museum. An existing technology company was commissioned to supply and implement their Media and Venue Management System (MVMS).

MVMS was subsequently deployed to all of Museum Victoria's permanent galleries and public spaces, controlling around 270 exhibits. Since the initial deployment however, a major new release and many minor revisions left the MVMS software at Museum Victoria in a fragmented state. Furthermore, MVMS was built using obsolete code and is unable to run on modern equipment. Development of MVMS ended in 2010 and the company ceased trading shortly thereafter. MVMS is now an orphaned product.

As a mid to large sized museum organisation, Museum Victoria makes extensive use of digital media ranging in complexity from simple video playback to a localised screen, to complex interactive exhibits involving multiple display devices, computers, online content and occasionally, mechatronic components. Public opening hours are 10.00am to 5.00pm but increasingly, museum exhibitions are popular venues for commercial functions, and these can be held outside of opening hours. Operation and maintenance of all digital media exhibits is the responsibility of the Digital Media Systems team, a small workgroup of six staff providing technical support for the three public venues – Melbourne Museum, Immigration Museum and Scienceworks –seven days a week. This team is also responsible for the installation of digital media technology in new exhibitions and must be able to resource several exhibition changeovers each year.

To efficiently manage a large number of exhibits, remote administration and an effective centralised management system is necessary to ensure minimal disruption to the visitor's experience. Effective integration of digital media exhibits requires a dependable software platform and the ability to manage a wide range of equipment and devices without having to pay for integration specialists each time a new exhibition is installed.

The unique setting of museums and galleries, including the use of innovative digital media, makes them increasingly attractive venues for hosting commercial functions and events. Finding a balance between meeting operational requirements and accommodating commercial events is a condition that Museum Victoria has in common with many public galleries and museum venues today. To support both these modes of operation without automation would require a large pool of available staff, well trained in the specific systems in use at the venue. While technical staff are still required, they can be rostered to support the daily operations and after hours scheduling of media services can be done in advance to meet the requirements of the event.

Even smaller museums and galleries that may not have onsite technical support can stand to gain from an effective digital media control and management system if it has been appropriately deployed. In many instances rebooting a device can rectify software faults or more detailed troubleshooting can be carried out remotely by contract technicians, without the need of paying call out fees. Moreover, a gallery control system has the potential to save small museums and galleries significant costs by extending the lifespan of equipment and consumables. It is the cost of initial deployment, licensing and ongoing maintenance contracts that become the barrier to entry for a small organisation.

REQUIREMENTS AND OBJECTIVES

As part of the 2010 review of digital media control requirements, the Digital Media Systems team identified the following core functions of a gallery control system:

- Device control
- Monitoring
- Scheduling

These functions need to be enabled by a robust architecture that distributes points of failure so that in the event that one component fails, others continue to function. It was also noted that a new system must be able to operate on the widest range of hardware and software possible to reduce the reliance on one or small number of manufacturers and allowing for greater flexibility when selecting digital equipment for exhibitions.

Once deployed, the system must be able to operate with little or no direct intervention. System functions need to be easily accessible by staff via a simple interface onsite as well as from remote locations via the Internet, if required. Today, with the ever-increasing rise in mobile computing, a primary objective of the new gallery control system was the ability for Museum Victoria staff to access it from any web-enabled device such as a computer, tablet or smartphone.

Owing to the large number of exhibitions to be integrated, a staged deployment was proposed, with the initial roll-out to two new galleries, First Peoples and Think Ahead both due to open in late 2013 at Melbourne Museum and Scienceworks respectively. Both galleries make extensive use of digital media and employ a wide range of equipment and modes of presentation.

Requirements of a gallery control system were prioritised in the following manner:

- Level 1 – Essential: basic functionality of the system that would ensure First Peoples, Think Ahead and any other galleries meet the core requirements of device control and scheduling
- Level 2 – Desirable and Important: additional features such as improved monitoring and feedback that could be added on at a later stage without disruption to the current system
- Level 3 – Nice to have: more advanced features such as the addition of a content management to be incorporated at a later date if desired

Although the initial deployment was to be only to two galleries, a significant requirement of the project was to implement the selected system in legacy galleries. Avoiding parallel systems would ensure efficient management of the digital media displays across the organisation. The benefits of managing a single gallery control system are quicker response times, a more productive use of support staff time and better planning when developing new galleries. The overall cost of integrating legacy equipment was to be considered as part of the review.

SOLUTION

In exploring different options, the project team conducted an analysis of five products currently in the marketplace. Of the products surveyed, three were established, commercial products and two were proprietary solutions that had been developed for other museums.

A project brief was developed and distributed to vendors. Solutions were considered according to their ability to meet the deadline for deployment in the initial exhibitions, flexibility in implementing Level 2 and 3 priorities and total cost of ownership on a per-gallery basis to factor in future exhibitions and deployment to older galleries. Responses were ranked and given a score weighted according to the overall value offered to Museum Victoria.

The project team also considered an alternative approach to commission a bespoke system meeting the exact specifications of the project brief with the ownership of the intellectual property for the source code held by Museum Victoria. This same brief was submitted to developers who were asked to meet the same criteria as the suppliers of existing products. After carefully considering the solutions provided by each of the vendors, this bespoke solution was found to be the most cost effective option when factoring in future development and the replacement of the existing system.

Melbourne-based audio-visual system integrators and software development firm Lumicom were commissioned to develop the new gallery control system. Lumicom team members have had a history of working with Museum Victoria, having been involved in the development of the existing MVMS gallery control system. The project was developed under the title 'Nodel' to reflect the modular and nodal architecture of the system.

While it was acknowledged that developing a new control system entirely from scratch carried a number of risks for the organization, a risk management plan was developed by the project team to mitigate these risks. The project team closely monitored progress and Lumicom worked alongside Digital Media Systems staff with the deployment phase of the project. Due to the tight timeline that was imposed by the project, testing of the Nodel system, including troubleshooting and defects rectification was carried out during the installation of the First Peoples gallery.

BENEFITS OF OPEN SYSTEMS

An advantage of commissioning a completely new control system was that Museum Victoria would own outright the intellectual property of the resulting code. This presented Museum Victoria with a number of benefits, namely:

- Developing the software as an open-source project means Museum Victoria doesn't rely on a single supplier or developer for support, and can call on a variety of developers in the open-source community for assistance or further development
- An opportunity to strengthen its position within the museum community as a leader in the digital space by releasing the code as an open-source project that could be used by other institutions without engaging in a proprietary license
- The adoption of Nodel by other institutions under an open license has the potential to generate a community of users where the development of new nodes can be shared, as can the function of error checking and quality assurance

The partnership with Lumicom offered the opportunity to develop a product tailored specifically for the museum or gallery environment that could be offered to other organisations under an open source license. Offering the code for free was seen as strengthening Museum Victoria's position as a leader among the community of museum organisations within Australia and the rest of the world. The arrangement was also commercially attractive to Lumicom through opportunities to install and develop customisations for other adopters of the product.

Key to developing a successful product and a fruitful relationship between Lumicom and Museum Victoria was choosing the best license under which to release the resulting code. The choice of license would impact not only the potential for ease of adoption by other organisations, but also the incentive to develop and share improvements and new modules among users of the software.

The project team conducted research into different licensing models and proposed an open source approach using two distinct licenses to offer the greatest flexibility and potential for collaborative development.

Under this proposal the primary elements of Nodel, developed largely in the Java language and comprising the communication layer and core functionality would be released under the Mozilla Public License (version 2.0). The application scripts, written in Python and used to integrate with exhibits and devices would be offered under the MIT License.

Terms of the Mozilla Public License require that improvements made to the core components of the system be shared and made public under the same license. In this way the benefits of development by other users can be invested back into the project. The Mozilla Public License is similar in philosophy to the well known GNU Public License (GPL); however it differs from GPL in that it is broadly compatible with other license approaches and can be used in conjunction with proprietary code if need be. This approach was adopted to encourage the sharing of developments made to the core components of the system.

On the other hand, the MIT License was chosen for application scripts because it makes no requirements to return changes to the project. As a 'permissive' software license, the MIT License places no demands on the user, other than a waiver of warranty. This is useful because the application scripts will vary with each installation and may contain information that is site-specific or sensitive to an organisation. To require the contribution of such scripts might be an obstacle to adopting the system. The broad compatibility of the Mozilla Public License with other license types makes this approach possible.

SYSTEM ARCHITECTURE

Overview

The architecture of Nodel is based on individual “nodes” that each performs a specific task. A node can run on any platform capable of executing Java runtime binaries, including OS X, Windows and Linux based devices. As such, no proprietary hardware is required to install and run the system, allowing a wide range of devices to be used in a gallery design, including the cost-effective [Raspberry Pi](#).

Nodes themselves communicate using a common, open language and may be programmed to act as a translator between other protocols. For example, a node may control a device such as a projector that uses the [PJLink](#) protocol, or a display that uses the [RS232](#) protocol. Equipment can range from a simple I/O device such as a pushbutton to a very complex device such as a video matrix switcher. Effectively, a node may be programmed to control any piece of digital equipment that provides an external communication interface.

A node may also control other nodes on the network. For example, one node may be programmed to poll a node to retrieve its status or instruct a number of other nodes to perform a series of actions at a specific time.

Each node in the network is capable of operating independently of others, self-managing connections to other nodes on the network and automatically re-establishing communications in the event of a disruption. Nodes present their own web-based user interface for configuration, control and diagnostics.

The Nodel control system is based on protocols and formats that are commonly available and openly documented. It is designed to be self-announcing, self-configuring and network independent. It is also designed to be platform independent, with the ability to operate with a wide variety of hardware and software.

Implementation

In order to establish communication on a network, a group of technologies known as [Zero configuration networking](#) are utilised. A node will firstly obtain an IP address automatically from the network it is connected to. This is usually via DHCP, but will typically fall back to [Link-local addresses](#) in the event that DHCP is unavailable.

Secondly, the node will then join the network using [Multicast DNS](#) (mDNS). This protocol allows each node on a network to keep its own list of device records without using a central server. Communication between nodes on the same network is established using the node name independently of IP address configuration.

Thirdly, the node announces the services it offers on the network so that other nodes can understand how to connect to it. This is achieved using the [DNS Service Discovery](#) (DNS-SD) protocol. A node announces the service name, type and port when started, or in response to a 'browse' request made by any other node or user on the network. In the case of this system, the service type is always “_tcp._nodel” for the communications interface.

Finally, each node in the network also announces the presence of its own web interface for setup and troubleshooting. This is also announced via mDNS as “_tcp._http”.

By utilising these technologies, a museum exhibit that uses multiple devices on a local network switch could be disconnected from the main museum network and continue to operate in a stand-alone fashion, such as when an exhibit is taken on tour. In addition, central IT services that are usually essential for the operation of a network such as [DHCP](#), [directory services](#) and [DNS](#) could fail and the system will continue to operate normally.

Nodes communicate with each other using a simple, open, language independent, text-based, human readable protocol written in [JSON](#) (JavaScript Object Notation) using the principles of [REST](#) (REpresentational State Transfer). Being text-based, commonly available tools such as [Telnet](#) and any text editor can be used to test and diagnose problems on a given network. JSON is also a very lightweight data structure, when compared to alternatives such as [XML](#), and requires only a small amount processing to decode. A

[RESTful API](#) is provided which allows 3rd party systems to communicate directly with nodes if required.

Each node is programmed to perform its task using the open-source, high-level [Python](#) scripting language. Python has a large worldwide user base, and examples of scripts that perform all manner of tasks are readily available on the Internet. In addition, there is a large amount of training material available to learn the language. Utilising Python removes the need to learn a proprietary language in order to program the system and it also means that there is a much greater pool of resources and programmers to draw from.

The node handles all basic communications tasks automatically, freeing up a programmer to concentrate on core functionality. For example, whenever a node is removed or reappears on the network, reconnection to the node is managed without any intervention from the programmer. All nodes are addressed using node names only, so knowledge of the configuration of the network, such as IP address and port, is not required when programming.

CONCLUSION

The Nodel gallery control system was developed in response to an identified need for a tailored control solution specific to the needs of digital media exhibits in museums and galleries. Museum Victoria conducted a cost benefit analysis of alternate solutions and chose to develop a bespoke product. This decision was based on the total cost of ownership and the ability to fully meet requirements defined by the project team including the flexibility to deploy into existing and new exhibitions using in house resources. It was acknowledged that there were risks associated with this approach, however adopting a tailored solution offered many benefits, including the freedom of being able to release the product as an open source project. An intention of the project was to create a community of users that could share the further development of the product.

The modular and distributed design of the product makes Nodel robust in the event of infrastructure failure and adaptable to many situations. Nodes can be developed to respond to a wide variety of design requirements, while the use of open source development tools and protocols makes the system simple to customise without the need for specialist training.

Nodel was initially deployed in the First Peoples exhibition at Melbourne Museum in September 2013. This was the most ambitious and technically challenging exhibition developed by Museum Victoria to date with more than 40 digital media exhibits. It has subsequently been installed in other permanent and temporary exhibitions across the organisation, increasing the number of exhibits under Nodel control to more than 120. It has proven itself to be reliable and adaptable, putting the control of gallery infrastructure in the hands of museum staff.