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(54) **REMOTE COMMUNICATIONS PROTOCOL**

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(51) **Int. Cl.**

H05B 37/02	(2006.01)
H04L 12/24	(2006.01)

(52) **U.S. Cl.**
CPC ***H05B 37/029*** (2013.01); ***H04L 41/12*** (2013.01); ***H05B 37/0254*** (2013.01)

(58) **Field of Classification Search**
CPC H05B 37/0254; H05B 37/029; H04L 41/12
See application file for complete search history.

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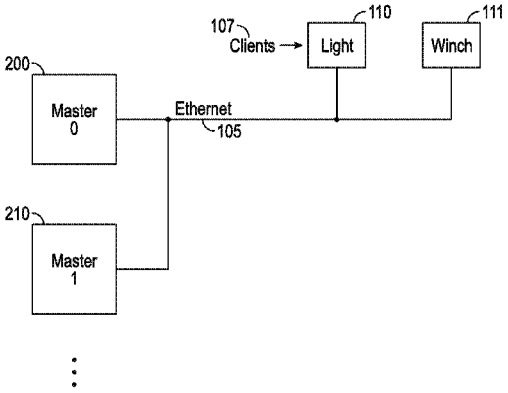
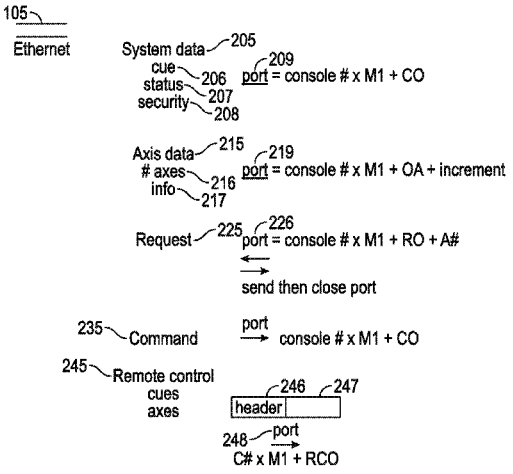
(57) **ABSTRACT**

A format for controlling information between multiple masters and clients uses each of a plurality of ports over a specified line, where the specified line can be ethernet, and where the ports can be opened and closed, and where the ports are calculated based on the number assigned to the console, a console multiplier, and at least one increment that represents the kind of information where there are multiple kinds of information.

14 Claims, 2 Drawing Sheets





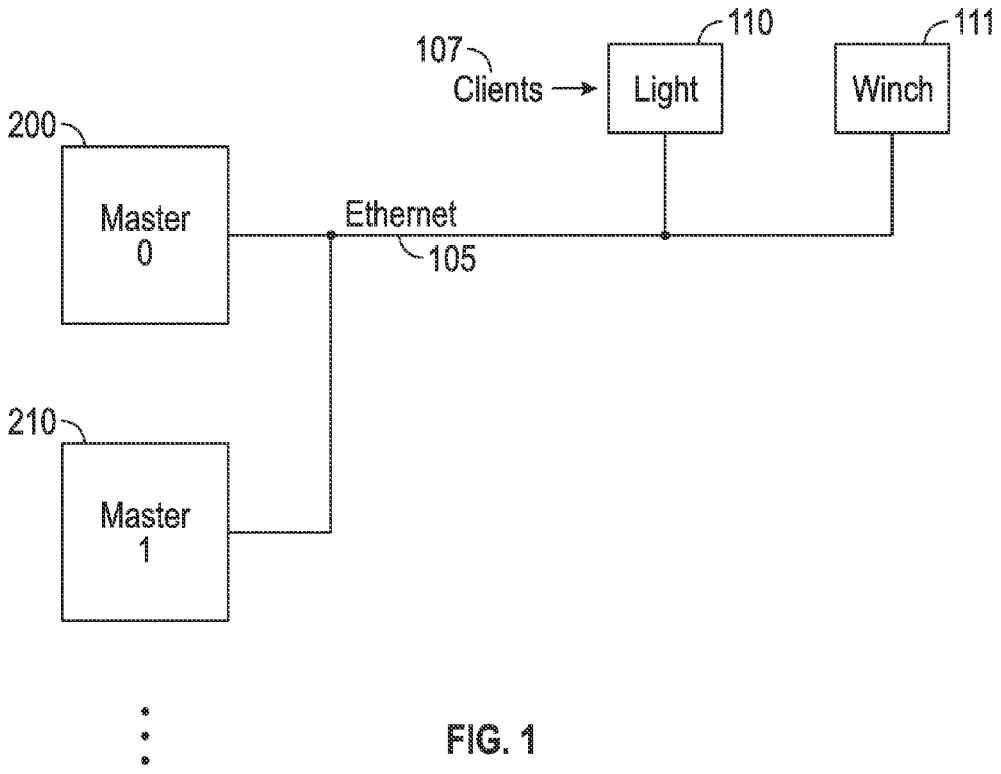

107
Clients
110
Light
111
Winch
200
Master
0
Ethernet
105
210
Master
1

FIG. 1

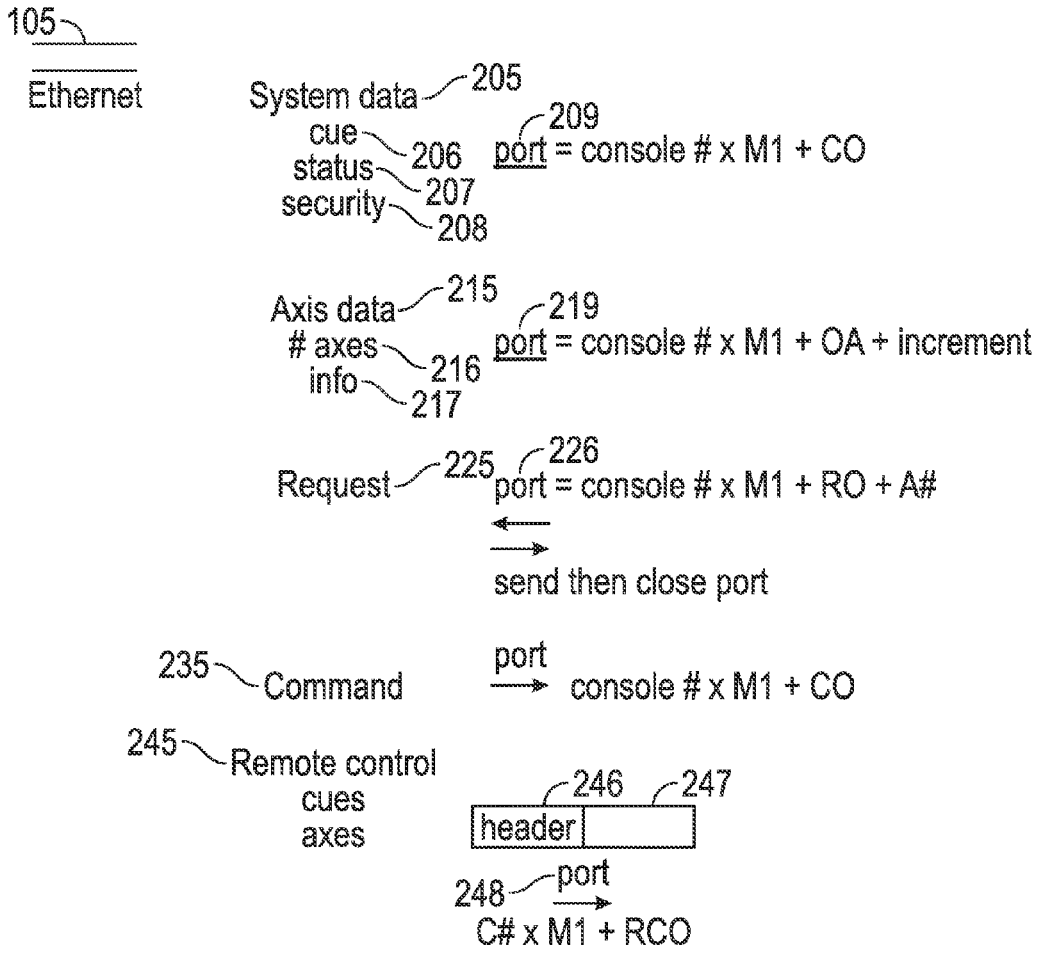

105
Ethernet
System data
205
cue
206
status
207
security
208
209
port = console # x M1 + CO
Axis data
215
axes
216
info
217
219
port = console # x M1 + OA + increment
Request
225
226
port = console # x M1 + RO + A#
send then close port
235
Command
port
console # x M1 + CO
245
Remote control
cues
axes
246
247
header
248
port
C# x M1 + RCO

FIG. 2

REMOTE COMMUNICATIONS PROTOCOL

This application claims priority from provisional application No. 61714492 filed Oct. 16, 2012, the entire contents of which are herewith incorporated by reference.

This is a continuation of Ser. No. 14/055,678, filed 16 Oct. 2013, the entire contents of which are herewith incorporated by reference.

BACKGROUND

Different protocols exist for exchanging information between a controlling computer such as a console or the like, and devices that become part of a stage lighting show. Exemplary protocols include so-called show control, as well as DMX, and others. The kinds of devices that can be controlled include controllable lights, winches, other movement devices, video walls, and the like.

SUMMARY

An embodiment describes a flexible process and system for exchanging information between an automation control computer and show devices. According to an embodiment, the protocol is used to provide status information, print position, and movement for any device on the network.

According to an embodiment, all of the control is carried out over a single common line, and parameters are used to define ports according to the function of the signal or request.

BRIEF DESCRIPTION OF THE DRAWINGS

the figures show aspects of the invention.

Specifically:

FIG. **1** shows a block diagram of the system, including multiple masters and multiple remote client;

FIG. **2** shows a layout of the structure of the ethernet signal including the clients and ports that are used.

DETAILED DESCRIPTION

According to an embodiment, a communication protocol between a plurality of controlling computers **200** and **210**, and a plurality of controlled devices **109** is carried out. This protocol may be carried out using UDP, User Datagram Protocol over Ethernet **105**. However, other wireless and wired protocols can alternatively be used.

FIG. **1** shows the clients **109** including a light **110** and a winch **111**, however it should be understood that the device can control many such different clients. Multiple different controlling computers can be used and all connected together. A port configuration system as described herein allows automated definition of different information being sent over different ports over the same ethernet. The packets sent and received by either the Multicast or Broadcast method of Ethernet.

A user configurable series of parameters determines the port on which this data is both sent and received. This provides a flexible, extensible and logical method of exchanging large amounts of data in a predetermined format. Due to the use of the UDP architecture, a virtually unlimited number of Masters and Remotes can be present on the same network. The protocol is formed by sending these packets over Ethernet with port numbers that are configured by a program that runs on one or all of the computers.

Master controllers functions as server computers while all Remote devices such as **109** are treated as client computers. There can be more than one Master in the network. The Master sends data on a user configurable ports using a port-definition technique as described herein. Each Master is given a unique console number.

All Masters send two types of data packets continuously, System packets and Axis packets. A third type of data, named Positions is transmitted only when requested by a Remote **109**.

System data packets such as **205** contain information on the current status of the show. This information includes cue information **206** that indicates information about the current cue that is being executed about the show. For example, this can include Current cue number and description, executed cue number, Estop condition, fader values and cue conditional data.

Status information **207** can also be included which represents the condition of the different parts of the show. The status information can also indicate system fault conditions, or other information about the show such as the brightness of the lights, the condition of the winches, temperatures of the devices, and the like.

System and security information **208** can also be provided. This can include for example security information such as a password for securing remote access. This can also include information about the show that is used including the show number and the version number.

The console number and a user configurable multiplier plus an offset determines the port number for system data uses. This is shown as **209**, where the port being used by a master for the system information is calculated based on the console number*multiplier M1+the console offset CO.

An example of this procedure is as follows. The first Master computer **200** is assigned console number 0. The console multiplier M1 is set as 10,000, although this number can be user-configured. The console offset CO is 1000. System Data for the first master is transmitted and received at a Multicast address with the port number of (0×10,000)+1000. In this case the port number of 1000 is used to transmit and receive System data for master 0.

Subsequent Masters such as **210** are also given unique console numbers. The second Master could have a console number of 1. For Master **210**, therefore, system data packets are transmitted and received on port 11,000. (1×10,000)+1000.

Axis data packets **215** describe the show in terms of the number of axes making up the show. A first part of the information, e.g., a header, provides the number of axis in the show **216**. Information about each of the axes is also provided at **217**. According to an embodiment, relevant information for each of up to 10 axes can be provided. This information includes the axis number and description, sub-master assignment, owner ID, type, profile count, and profile data.

Profile data can include acceleration, velocity, decay and time for each of the axes. Parameter data in the packet includes both high and low soft limit values and maximum velocity. Additionally status words in the packet provide fault and motion bits.

In one embodiment, Information for each axis is held to a fixed number of bytes. In an embodiment, there are a maximum of ten axes of data available on each Axis port. This means that for each multiple of 10 axes being controlled, an additional port is created. By limiting the number of axes to 10 per port, the total size in bytes stays less than

1000 bytes. This size is less than the most stringent switching protocols that restrict MTU, Maximum Transmission Units.

Port numbers at **219** are determined by using the console number*the console multiplier M**1**, +the axis offset OA+an increment of one for each additional port required after the first port. If a Master computer controlled 65 axes, then the header **216** would indicate 65 and would indicate that 65/10 or 7 packets would be needed for axes. This means that there would be packets transmitted and received on seven sequential ports with each sequential port being the next number in the increment information. The header in each packet contains the total number of axis in that packet.

The total number of ports to create by a Remote is determined by examining the total axes value sent with the system data. The first port would be at (Console number× console multiplier)plus(axis offset+0) Using the above example and an axis offset of 3000 this would be (0×10,000)+(3000+0) or port 3000. The second set of 10 axes would be at port 3,001. (0×10,000)+(3000+1). The third set of 10 would be at port 3,002. (0×10,000)+(3000+2). The last 5 axis would be at port 3,006. (0×10,000)+(3000+6).

A third type of packet called Request data can be requested from a Master. This data typically includes target positions and target descriptions. It is requested by a Remote client such as **110** using a remote control port **226**. Port **226** is determined by multiplying the console number times console multiplier M**1**, then adding a request offset RO and the axis number A#. A Master with a console multiplier/offset of 10,000 and a request offset of 5,000 receiving a request for axis 12 position data from a Remote would send the data on port (0×10,000)+(5,000+12) or port 5012.

The request port is only active while a remote is requesting the data. Once a remote has successfully received the data it stops the request and both Master and Remote close the port.

The Receive Protocols This portion of the protocol allows two way communications between Remotes and Master controllers. These protocols are designed to minimize the amount of processing required by the Master while providing extensive control from the Remote.

A Command data port **235** is constantly monitored by each Master. The sole purpose of the command data port is to receive a request from another Master device to take primary control. This is commonly used to provide hot backup of one Master that runs in parallel with another Master. The port for this is configured using the command port offset C**0**. A Master configured as console 0 with a console offset of 10,000 and a command port offset C**0** of 2,000 would listen for a take control request on port 2,000, (0×10,000)+2,000=2,000.

If needed, any Remote can communicate with any Master using the Remote Control protocol **245**. This formatted data packet provides for individual or multiple axis control from a Remote. All or parts of cues can be selected and executed. Axis can also be controlled alone or in groups. This is done using a fixed length header **246** for cue manipulation combined with a repeating block of bytes **247** for each axis being controlled. Remotes can Arm, Disarm, Jog, Preset, Request Positions, Reset an axis and vary the velocity movement using this protocol. A Remote that commands a Master establishes a port at **248** by multiplying the console number times the console multiplier then adding the remote control offset R**0**. If the Master console number is 0 with a console multiplier of 10,000 and a remote control offset of 4,000 then the Remote would be expected to transmit on Port 4,000, (0×10,000)+4,000.

Configurable Parameters By configuring these parameters, the Remote Protocol is capable of providing a useful, robust and extensible framework of two way communications and change the port numbers.

Console number Value or C# is used to identify a Master controller. More than one Master can have the same console number but only one Master with the same console number can take control of the assigned axes at a time. The Master that currently has control is described as being Primary. Additional controllers with the same console number are considered Secondary and can function as hot backup. Console multiplier M**1** is the value used as a multiplier in conjunction with the console number to determine the spacing of ports between Master controllers. Console offset CO is the value added to the product of the console number and console multiplier in conjunction with the console number to determine the port number used for system data.

Axis offset AO is the value added to the product of the console number and console offset that determines the starting port number for axes information. The port used for each group of ten axes after the first group of ten increments the axis offset by 1. Request offset RO is the value added to the product of the console number and console offset that determines the port number for request data.

Command offset CO is the value added to the product of the console number and console offset that determines the port number for requesting transfer of control from a Primary to a Secondary controller.

Remote Control offset RCO is the value added to the product of the console number and console multiplier that determines the port number used by a remote device to send data to a Master controller.

The System Data Packet Structure forms the port number by multiplying the console number with the console multiplier then adding the console offset. The bits can be assigned as in Table 1.

TABLE 1

Index	Length	Type	Description
0	1	Int	Primary/Secondary
1	3		Unused
4	4	Int32	Show number
8	4	Int32	Version number
12	4	Int32	Cue number
16	4	Int32	Total number of Axis
20	4	Single	Submaster Value 1
24	4	Single	Submaster Value 2
28	4	Single	Submaster Value 3
32	4	Single	Submaster Value 4
36	4	Single	Submaster Value 5
40	4	Single	Submaster Value 6
44	4	Single	Submaster Value 7
48	4	Single	Master Value
52	1		Submaster Force Bits
Bit 0		Submaster force 1	
Bit 1		Submaster force 2	
Bit 2		Submaster force 3	
Bit 3		Submaster force 4	
Bit 4		Submaster force 5	
Bit 5		Submaster force 6	
Bit 6		Submaster force 7	
Bit 7			
53	1		Submaster Stop Bits
Bit 0		Submaster stop 1	
Bit 1		Submaster stop 2	
Bit 2		Submaster stop 3	
Bit 3		Submaster stop 4	
Bit 4		Submaster stop 5	
Bit 5		Submaster stop 6	
Bit 6		Submaster stop 7	
Bit 7			

TABLE 1-continued

Index	Length	Type	Description
54	1	System Bits	
Bit 0		Master force bit	
Bit 1		Estop bit	
Bit 2		System stopped bit	
Bit 3			
Bit 4			
Bit 5			
Bit 6			
Bit 7			
55	4	Remote password	
59	30	String	Cue Conditional string
89	50	String	Cue Description string
139	4	Int32	Executing cue number

The Axis Data Packet Structure uses Axis data transmitted in blocks of 10 axis on ports. Each block of 10 axes is another port. Port number is determined by multiplying the console number with the console multiplier then adding the request offset. The data structure can be as in Table 2.

TABLE 2

Index	Length	Type	Description
Packet Header			
0	1	Byte	Total axis in packet
Packet payload for 1st axis in packet (payload repeats for next axis every 92 bytes)			
1	4	Int32	Axis number
5	20	String	Axis description
25	1	Submaster ID	
Bit 0		Submaster 1	
Bit 1		Submaster 2	
Bit 2		Submaster 3	
Bit 3		Submaster 4	
Bit 4		Submaster 5	
Bit 5		Submaster 6	
Bit 6		Submaster 7	
Bit 7			
26		Byte	Owner ID
27		Byte	Axis type
28		Byte	AVD count
1st AVD Profile			
29	4	Single	Current Position
33	4	Single	Target Position
37	4	Single	Accel
41	4	Single	Decel
45	4	Single	Time
49	4	Single	Velocity
Axis Conditional			
53	20	String	Axis Conditional String
Axis Parameters			
73	4	Single	Soft Plus limit
77	4	Single	Soft Minus limit
81	4	Single	Vmax (maximum velocity)
Updated fault bits			
85	1	Fault Bits 1	

Remote Control Packet Structure uses request data transmitted from remot Master controller. The port number is determined by multiplying the console number with the console multiplier then adding the axis offset plus 1 for each block of ten axes after the first block of ten. Packet is fixed length of 558 bytes in length. This can use the data Structure as in Table 3.

TABLE 3

Index	Length	Type	Description
Packet Header			
0	1	Byte	Owner ID (last 3 digits of IP address)
1	1	System Commands	
Bit 0			
Bit 1		Go	
Bit 2		Stop	
Bit 3		Advance	
Bit 4		Reverse	
Bit 5		Select Cue	
Bit 6			
Bit 7			
2	4	Int32	Cue number request
6	2	Int16	Total number of Axis
Packet Payload begins here and repeats every 11 bytes			
8	2	Int16	Axis Number
10	1	Axis Commands	
Bit 0		Disarm/Arm	
Bit 1		Jog	
Bit 2		Preset	
Bit 3		Send Existing Positions	
Bit 4		Handheld Reset	
Bit 5		Relinquish Ownership	
Bit 6			
Bit 7			
11 Jog Target Preset Position	4	Single	Command Value 1
15 Jog Velocity	4	Single	Command Value 2
16		Payload for next Axis begins here.	

Request Data Packet Structure receives existing position values and names from a Master Port is determined by multiplying the console number with console multiplier then adding the command offset. This can have the Structure of Table 4

TABLE 4

Index	Length	Type	Description
0	8	Currently unused.	
Packet Payload begins here and repeats every 20 bytes			
8	4	single	Target value
12	16	String	Target Description
28		Payload for next existing position begins here . . . Maximum of 50 existing positions	

Take Control Packet Structure

Sent from a Secondary Master to the Primary Master to request control as Primary. Port is determined by multiplying the console number with the console multiplier then adding the Command offset. This can have the structure shown in Table 5.

TABLE 5

Index	Length	Type	Description
0	1		Send value of 1 to rRequest control = 1

These parameters can be affected by programming that is put onto the master and run simultaneously in any and/or all of the Masters either at the same time or individually. The programs that run on the master may both assign the ports and recognize the ports, so that all of the Masters and clients have the same definition of ports.

Although only a few embodiments have been disclosed in detail above, other embodiments are possible and the inventors intend these to be encompassed within this specification. The specification describes specific examples to accomplish a more general goal that may be accomplished in another way. This disclosure is intended to be exemplary, and the claims are intended to cover any modification or alternative which might be predictable to a person having ordinary skill in the art. For example, other formats and other port numbers can be can be used.

Those of skill would further appreciate that the various illustrative logical blocks, modules, circuits, and algorithm steps described in connection with the embodiments disclosed herein may be implemented as electronic hardware, computer software, or combinations of both. To clearly illustrate this interchangeability of hardware and software, various illustrative components, blocks, modules, circuits, and steps have been described above generally in terms of their functionality. Whether such functionality is implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system. Skilled artisans may implement the described functionality in varying ways for each particular application, but such implementation decisions should not be interpreted as causing a departure from the scope of the exemplary embodiments.

The lights which are described herein can be computer-controlled, and can be controlled for example over a network or DMX connection by sending remote controls over that connection. These lights can also, for example, the remotely controllable for pan and tilt.

Also, the inventor(s) intend that only those claims which use the words "means for" are intended to be interpreted under 35 USC 112, sixth paragraph. Moreover, no limitations from the specification are intended to be read into any claims, unless those limitations are expressly included in the claims.

The previous description of the disclosed exemplary embodiments is provided to enable any person skilled in the art to make or use the present invention. Various modifications to these exemplary embodiments will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other embodiments without departing from the spirit or scope of the invention. Thus, the present invention is not intended to be limited to the embodiments shown herein but is to be accorded the widest scope consistent with the principles and novel features disclosed herein.

What is claimed is:

1. A computer system, comprising:

a computer based show controlling console that communicates show information indicative of a show being carried out, said show information being communicated over a common line for each of a plurality of different types of information, and each of the different kinds of information receiving a port number, where the port number is defined as a console number adjusted by both a first compensation value, and a second compensation value, where the first compensation value indicates which of a plurality of consoles is communicating the information, and the second value indicates a kind of the information.

2. The system as in claim **1**, wherein the first and second values are user controllable.

3. The system as in claim **1**, wherein the show information includes system data including information indicative of the show including a cue number.

4. The system as in claim **1**, wherein the show information includes axis data including multiple different axes making up parameters in the show.

5. The system as in claim **1**, wherein the show information includes system data including at least a cue number, said system data having a first offset and being on first ports for each of a plurality of master units, axis data including multiple different axes making up the show, said axis data being arranged in groups, and each group having a second offset and being on second ports for each of a plurality of master units, request data, defining requests from remote clients, each of the request data having a third offset and being on an individual port and switchover data, that requests a master to switch over to another master, said switchover data having a fourth offset and being on fourth ports.

6. The system as in claim **1**, wherein the show information includes request data received from a remote client, on a specified port, where the port is opened for the request data and closed after sending the request data.

7. A system of communicating show information between devices, comprising:

a port calculator device, which determines a port to be used to communicate said show information, where said port calculator device determines said information based on a console number assigned to the console that is communicating with said show information, where there are multiple consoles and each console has a number, said console number being multiplied by a console multiplier, and added to an offset to determine the port, where said offset is based on a kind of information that is being sent.

8. The system as in claim **7**, wherein said offset is different for a first kind of information than it is for a second kind of information.

9. The system as in claim **7**, wherein the show information includes system data including at least a cue number on a port information defined by a first offset.

10. The system as in claim **9**, wherein the show is formed of multiple different axes, and port information indicating one of said axis being based on a second offset, and requests from remote clients being on a third port that is based on a third offset.

11. A method of communicating using the console, comprising:

using a computer based show controlling console to communicate show information indicative of a show being carried out,

communicating a plurality of different kinds of information with the controlling console;

said communicating using a port number, and the port number being based on both the kind of information and a specific one of the multiple consoles that is communicating the information, where the port number is defined as a console number that identifies the console adjusted by a first compensation value, and also defined by a second compensation value that indicates a kind of the information.

12. The method as in claim **11**, wherein the first compensation value is a multiplier which is used to multiply the port

number by a unique number indicating the console, and the second compensation value is an offset value which is added to a multiplied port number.

13. The method as in claim **11**, wherein the first and second values are user controllable.

14. The method as in claim **11**, wherein the different kinds of information includes system data including at least a number of a cue being executed by the show, said system data defined by a first offset, axis data defining multiple different axes of movement making up the show, said axis data defining a second offset, and request data defining requests from remote clients, said request data defining a third offset.

* * * * *