

Art-Net 3

Specification for the
Art-Net 3 Ethernet Communication Standard



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Comments on Revisions AJ-BD:

1. Concept of Binding Address added to ArtPollReply.
2. Error in Filler count in ArtPollReply corrected.
3. DHCP Flag added to ArtPollReply.
4. ArtDiagData packet added.
5. ArtCommand packet added.
6. Detail of ArtDmx unicast corrected.
7. Notes on ArtDmx length added.
8. ArtTimeCode packet added.
9. Art-Net 3 release.
10. 15 bit universe addresses added.
11. Error in description of 'Net' corrected.
12. Confusion over limited vs. directed broadcast resolved.

Comments on Revision BE:

1. Typing error in ArtFirmwareMaster corrected - incorrectly defined FirmwareLength as Int32.
2. ArtNzs packet added.
3. EstaCode in ArtPollReply redefined as two bytes
4. Port Address programming authority explanation improved
5. Error in default IP address example corrected.

Overview:

Art-Net is an Ethernet protocol based on the TCP/IP protocol suite. Its purpose is to allow transfer of large amounts of DMX512 data over a wide area using standard networking technology.

The latest revision of the protocol implements a number of new features and also simplifies the data transfer mechanism. The changes are all based on feed back from manufacturers who are using the protocol.

Universe Addressing:

A theoretical limit of 32,768 universes exists in the Art-Net 3 specification. The actual number of universes that can be transmitted is dependent upon both the network physical layer and whether unicast or broadcast is used. The following table provides a rule of thumb.

	Physical: 10BaseT	Physical: 100BaseT	Physical: 1000BaseT
Broadcast	40	40	40
Unicast	40	400	4000+

The Port-Address of each DMX512 Universe is encoded as an 15-bit number as shown in the following table.

Bit 15	Bits 14-8	Bits 7-4	Bits 3-0
0	Net	Sub-Net	Universe
Port Address			

The high byte is called the 'Net'. This was introduced at Art-Net 3 and was previously zero. The Net has a single value for each node. The high nibble of the low byte is referred to as the Sub-Net address and is set to a single value for each Node. The low nibble of the low byte is used to define the individual DMX512 Universe within the Node.

This means that any Node will have:

1. One "Net" switch.
2. One "Sub-Net" switch.
3. One "Universe" switch for each implemented DMX512 input or output.

A product designer may opt to implement these as hard or soft switches.

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Terminology:

- Node: A device that translates DMX512 to or from Art-Net is referred to as a Node.
- Port-Address: one of the 32,768 possible addresses to which a DMX frame can be directed. The Port-Address is a 15 bit number composed of Net+Sub-Net+Universe.
- Net: A group of 16 consecutive Sub-Nets or 256 consecutive Universes is referred to as a net. There are 128 Nets in total.
- Sub-Net: A group of 16 consecutive universes is referred to as a sub-net. (Not to be confused with the subnet mask).
- Universe: A single DMX512 frame of 512 channels is referred to as a Universe.
- Kiloverse: A group of 1024 Universes.

- A central controller or monitoring device (lighting console) is referred to as a Controller.
- IP: The IP is the Internet protocol address. It is expressed in either a long word format (0x12345678) or dot format (2.255.255.255). Convention is that the former is hexadecimal and the latter is decimal. The IP uniquely identifies any Nodes or Controllers on a network.
- Subnet Mask: Defines which part of the IP represents the Network address and which part represents the Node address. Example: A Sub-Net mask of 255.0.0.0 means that the first byte of the IP is the network address and the remaining three bytes are the Node address.
- Port: Actual data transmission on Art-Net uses the UDP protocol that operates 'on top of' the TCP/IP protocol. UDP data transfer operates by transferring data from a specific IP:Port address on a Node or Controller to a second specific IP:Port address on a second Node or Controller. Art-Net uses only one port address of 0x1936.
- Directed Broadcast: When a network first connects, the Controller does not know the number of Nodes on the network, nor does it know their IP addresses. The Directed broadcast address allows the Controller to send an ArtPoll to all Nodes on the network.
- Limited Broadcast: Art-Net packets should not be broadcast to the Limited Broadcast address off 255.255.255.255.
- Controller: A generic term describing an Art-Net device with the primary task of generating control data. For example, a lighting console.
- Node: A generic term describing an Art-Net device with the primary task of receiving control data. For example, a dimmer or an Ethernet to DMX gateway.
- Media Server: A generic term describing an Art-Net device capable of generating control data based on the 'mx' Media Extensions to Art-Net.

Ethernet Implementation:

General Notes:

- All communication is UDP. Each packet format defined in this document form the Data field of an enclosing UDP packet.
- Packet formats are specified in a manner similar to C-language structures, in which all data items are considered to be unsigned integers of type INT8, INT16 or INT32 according to the number of bits. There are no hidden padding bytes, except at the very end of a packet, which may be rounded up to a multiple of 2 or 4 bytes. Extra bytes at the end of a valid received packet are ignored.
- The protocols are generalised for handling future versions with increased numbers of ports.
- Many bit data fields contain unused positions. These may be used in future versions of the protocol. They should be transmitted as zero and not tested by receivers.
- All packet definitions are designed such that their length can be increased in future revisions, whilst retaining compatibility. For this reason, only minimum packet length is checked in this protocol.

Protocol Operation:

A Node operates in one mode, each Node having a unique IP address derived from its Ethernet MAC address. The UDP port used as sources and destinations is 0x1936.

IP address configuration

The Art-Net protocol can operate on either a DHCP managed address scheme or using static addresses. By default an Art-Net product will factory start using a Class A IP address scheme. This allows Art-Net products to communicate directly and without the need for a DHCP server to be connected to the network.

IP address configuration - DHCP

Nodes report whether they are DHCP capable in the ArtPollReply packet. This document details packets on the assumption that static addressing is used. When DHCP is used, the addressing and subnet masks will be modified as dictated by the DHCP server.

IP address configuration - Static Addressing

The use of Class A addressing is allowed within a closed network. It is important to ensure that Art-Net data is not routed onto the Internet.

Products implementing Art-Net should default to the Primary IP address of 2.?.?.?.

The IP address consists of a 32 bit number designated as A.B.C.D. The lower the bytes B.C.D is calculated from the MAC address. The high byte 'A' is set to one of two values as shown in the following table.

The MAC address is a 48 bit number designated u:v:w:x:y:z. This is a globally unique number. The upper three bytes 'u:v:w' are registered to a specific organisation. The lower three bytes 'x:y:z' are assigned by that organisation. In order to ensure that there is minimal possibility of IP address conflicts between different manufacturers supporting Art-Net, the product OEM code is added to the MAC address.

The 'B' field of the IP address is calculated by adding the high byte of the OEM code with the low byte of the OEM code and the 'x' field of the MAC address.

On power up, the Node checks its configuration for IP addressing mode. If it has been programmed to use a custom IP address, the following procedure is not used.

Product Switch Settings	IP Address A.B.C.D				Subnet Mask
	A	B	C	D	
Custom IP Programmed	As Programmed				As Programmed
Network Switch Off	2	x+OEM	y	z	255.0.0.0
Network Switch On	10	x+OEM	y	z	255.0.0.0

The sub-net mask is always initialised to 255.0.0.0, unless a custom IP address is in use. This means that the network address is the most significant 8 bits and the Node address is the least significant 24 bits of the IP address. This is a Class A network address and for this reason care must be exercised when connecting to other networks. If an installation requires connection of an Art-Net network to another network that has Internet access, then the connection must be implemented via a router that filters out the Class A addresses.

IP address Example

Given the following settings, the IP address calculation will be as follows:

Network Switch = Off

MAC address = 12:45:78:98:34:76 (hexadecimal number)

OEM code = 0x0010

Calculation:

IP Address A = 2 (Because Network switch is off).

IP Address B = 168 (0x98 + 0 + 16).

IP Address C = 52 (0x34 from MAC address).

IP Address D = 118 (0x98 from MAC address).

IP Address = 2.168.52.118.

Controller Default Poll

By default a Controller should poll both the primary and secondary Art-Net addresses:

- 2.255.255.255:0x1936 Primary Art-Net Address
- 10.255.255.255:0x1936 Secondary Art-Net Address

Network Topology:

Art-Net allows two network topologies to operate simultaneously:

1. Peer to Peer: This is an unmanaged network where multiple Nodes transfer data without the intervention of a controller. All data transfer uses ArtDmx packets. All data is Directed Broadcast. This is the power on mode of operation for all Art-Net compliant nodes designed to receive DMX512. In Peer to Peer mode, all IP packets are sent to the Directed Broadcast address 2.255.255.255 (or 10.255.255.255 depending upon the Network Switch setting), and are therefore received by all Nodes on the same local network.
2. Controller to Peer: This is the most sophisticated implementation whereby one or more Nodes communicate with one or more central controllers (lighting consoles). This mode of operation data transfer operates by unicast transmission of ArtDmx packets. This topology allows greater than 40 universes to be transferred over a single network.

Operation

All UDP packets accepted by the Node conform to the Art-Net protocol specification as defined below. Any other packets are ignored.

ArtPoll:

Implementation		
Entity	Direction	Action
Controller	Receive	Send ArtPollReply.
	Unicast Transmit	Not Allowed.
	Directed Broadcast	Controller broadcasts this packet to poll all Controllers and Nodes on the network.
Node	Receive	Send ArtPollReply.
	Unicast Transmit	Not Allowed.
	Broadcast	Not Allowed.
Media Server	Receive	Send ArtPollReply.
	Unicast Transmit	Not Allowed.
	Broadcast	Not Allowed.

The ArtPoll packet is used to discover the presence of other Controllers, Nodes and Media Servers. The ArtPoll packet is only sent by a Controller. Both Controllers and Nodes respond to the packet. A Controller broadcasts an ArtPoll packet to IP address 2.255.255.255 (sub-net mask 255.0.0.0) at UDP port 0x1936, this is the Directed Broadcast address.

The Controller may assume a maximum timeout of 3 seconds between sending ArtPoll and receiving all ArtPollReply packets.

The Controller that broadcasts an ArtPoll should also reply to its own message (to Directed Broadcast address) with an ArtPollReply. This ensures that any other Controllers listening to the network will detect all devices without the need for all Controllers connected to the network to send ArtPoll packets.

ArtPoll				
Field	Name	Size	Bit	Description
1	ID[8]	Int8	-	Array of 8 characters, the final character is a null termination. Value = 'A' 'r' 't' '-' 'N' 'e' 't' 0x00
2	OpCode	Int 16	-	The OpCode defines the class of data following ArtPoll within this UDP packet. Transmitted low byte first. See Table 1 for the OpCode listing. Set to OpPoll.
3	ProtVerHi	Int8	-	High byte of the Art-Net protocol revision number.
4	ProtVerLo	Int8	-	Low byte of the Art-Net protocol revision number. Current value 14. Controllers should ignore communication with nodes using a protocol version lower than 14.
5	TalkToMe	Int8	-	Set behaviour of Node
			7-4	Unused, transmit as zero, do not test upon receipt.
			3	0 = Diagnostics messages are broadcast. (if bit 2).
				1 = Diagnostics messages are unicast. (if bit 2).
			2	0 = Do not send me diagnostics messages.
				1 = Send me diagnostics messages.
			1	0 = Only send ArtPollReply in response to an ArtPoll or ArtAddress.
				1 = Send ArtPollReply whenever Node conditions change. This selection allows the Controller to be informed of changes without the need to continuously poll.

ArtPoll				
Field	Name	Size	Bit	Description
			0	0 = Deprecated.
6	Priority	Int8	-	The lowest priority of diagnostics message that should be sent. See Table 5.

Table 1 - OpCodes:

The following table details the legal OpCode values used in Art-Net packets:

OpCodes		
Name	Value	Definition
OpPoll	0x2000	This is an ArtPoll packet, no other data is contained in this UDP packet.
OpPollReply	0x2100	This is an ArtPollReply Packet. It contains device status information.
OpDiagData	0x2300	Diagnostics and data logging packet.
OpCommand	0x2400	Used to send text based parameter commands.
OpOutput / OpDmx	0x5000	This is an ArtDmx data packet. It contains zero start code DMX512 information for a single Universe.
OpNzs	0x5100	This is an ArtNzs data packet. It contains non-zero start code (except RDM) DMX512 information for a single Universe.
OpAddress	0x6000	This is an ArtAddress packet. It contains remote programming information for a Node.
OpInput	0x7000	This is an ArtInput packet. It contains enable - disable data for DMX inputs.
OpTodRequest	0x8000	This is an ArtTodRequest packet. It is used to request a Table of Devices (ToD) for RDM discovery.
OpTodData	0x8100	This is an ArtTodData packet. It is used to send a Table of Devices (ToD) for RDM discovery.
OpTodControl	0x8200	This is an ArtTodControl packet. It is used to send RDM discovery control messages.
OpRdm	0x8300	This is an ArtRdm packet. It is used to send all non discovery RDM messages.
OpRdmSub	0x8400	This is an ArtRdmSub packet. It is used to send compressed, RDM Sub-Device data.
OpVideoSetup	0xa010	This is an ArtVideoSetup packet. It contains video screen setup information for nodes that implement the extended video features.
OpVideoPalette	0xa020	This is an ArtVideoPalette packet. It contains colour palette setup information for nodes that implement the extended video features.
OpVideoData	0xa040	This is an ArtVideoData packet. It contains display data for nodes that implement the extended video features.
OpMacMaster	0xf000	This is an ArtMacMaster packet. It is used to program the Node's MAC address, Oem device type and ESTA manufacturer code. This is for factory initialisation of a Node. It is not to be used by applications.
OpMacSlave	0xf100	This is an ArtMacSlave packet. It is returned by the node to acknowledge receipt of an ArtMacMaster packet.
OpFirmwareMaster	0xf200	This is an ArtFirmwareMaster packet. It is used to upload new firmware or firmware extensions to the Node.
OpFirmwareReply	0xf300	This is an ArtFirmwareReply packet. It is returned by the node to acknowledge receipt of an ArtFirmwareMaster packet or ArtFileTnMaster packet.
OpFileTnMaster	0xf400	Uploads user file to node.

Opcodes		
Name	Value	Definition
OpFileFnMaster	0xf500	Downloads user file from node.
OpFileFnReply	0xf600	Node acknowledge for downloads.
OpIpProg	0xf800	This is an ArtIpProg packet. It is used to reprogramme the IP, Mask and Port address of the Node.
OpIpProgReply	0xf900	This is an ArtIpProgReply packet. It is returned by the node to acknowledge receipt of an ArtIpProg packet.
OpMedia	0x9000	This is an ArtMedia packet. It is Unicast by a Media Server and acted upon by a Controller.
OpMediaPatch	0x9100	This is an ArtMediaPatch packet. It is Unicast by a Controller and acted upon by a Media Server.
OpMediaControl	0x9200	This is an ArtMediaControl packet. It is Unicast by a Controller and acted upon by a Media Server.
OpMediaControlReply	0x9300	This is an ArtMediaControlReply packet. It is Unicast by a Media Server and acted upon by a Controller.
OpTimeCode	0x9700	This is an ArtTimeCode packet. It is used to transport time code over the network.
OpTimeSync	0x9800	Used to synchronise real time date and clock
OpTrigger	0x9900	Used to send trigger macros
OpDirectory	0x9a00	Requests a node's file list
OpDirectoryReply	0x9b00	Replies to OpDirectory with file list

Table 2 - OemCode:

The registered OEM codes are detailed in “Art-NetOemCodes.h” which is found in the SDK directory of the DMX-Workshop installation.

The OEM code defines a specific manufacturer’s product type. The OemCode is returned in the ArtPollReply.

Table 3 - NodeReport Codes:

The following table details the NodeReport codes. TheNodeReport code defines generic error, advisory and status messages for both Nodes and Controllers. The NodeReport is returned in ArtPollReply.

Code	Mnemonic	Description
0x0000	RcDebug	Booted in debug mode (Only used in development)
0x0001	RcPowerOk	Power On Tests successful
0x0002	RcPowerFail	Hardware tests failed at Power On
0x0003	RcSocketWr1	Last UDP from Node failed due to truncated length, Most likely caused by a collision.
0x0004	RcParseFail	Unable to identify last UDP transmission. Check OpCode and packet length.
0x0005	RcUdpFail	Unable to open Udp Socket in last transmission attempt
0x0006	RcShNameOk	Confirms that Short Name programming via ArtAddress, was successful.
0x0007	RcLoNameOk	Confirms that Long Name programming via ArtAddress, was successful.
0x0008	RcDmxError	DMX512 receive errors detected.
0x0009	RcDmxUdpFull	Ran out of internal DMX transmit buffers.
0x000a	RcDmxRxFull	Ran out of internal DMX Rx buffers.
0x000b	RcSwitchErr	Rx Universe switches conflict.
0x000c	RcConfigErr	Product configuration does not match firmware.
0x000d	RcDmxShort	DMX output short detected. See GoodOutput field.
0x000e	RcFirmwareFail	Last attempt to upload new firmware failed.

Code	Mnemonic	Description
0x000f	RcUserFail	User changed switch settings when address locked by remote programming. User changes ignored.

Table 4 - Style Codes:

The following table details the Style codes. The Style code defines the general functionality of a Controller. The Style code is returned in ArtPollReply.

Code	Mnemonic	Description
0x00	StNode	A DMX to / from Art-Net device
0x01	StController	A lighting console.
0x02	StMedia	A Media Server.
0x03	StRoute	A network routing device.
0x04	StBackup	A backup device.
0x05	StConfig	A configuration or diagnostic tool.
0x06	StVisual	A visualiser.

ArtPollReply:

Implementation		
Entity	Direction	Action
All devices	Receive	No Art-Net action.
	Unicast Transmit	Not allowed.
	Broadcast	Directed Broadcasts this packet in response to an ArtPoll.

A device, in response to a Controller's ArtPoll, sends the ArtPollReply. This packet is also broadcast to the Directed Broadcast address by all Art-Net devices on power up.

ArtPollReply				
Field	Name	Size	Bit	Description
1	ID[8]	Int8	-	Array of 8 characters, the final character is a null termination. Value = 'A' 'r' 't' '-' 'N' 'e' 't' 0x00
2	OpCode	Int1 6	-	OpPollReply Transmitted low byte first.
3	IP Address[4]	Int8	-	Array containing the Node's IP address. First array entry is most significant byte of address.
4	Port	Int1 6	-	The Port is always 0x1936 Transmitted low byte first.
5	VersInfoH	Int8	-	High byte of Node's firmware revision number. The Controller should only use this field to decide if a firmware update should proceed. The convention is that a higher number is a more recent release of firmware.
6	VersInfo	Int8	-	Low byte of Node's firmware revision number.
7	NetSwitch	Int8	-	Bits 14-8 of the 15 bit Port-Address are encoded into the bottom 7 bits of this field. This is used in combination with SubSwitch and SwIn[] or SwOut[] to produce the full universe address.
8	SubSwitch	Int8	-	Bits 7-4 of the 15 bit Port-Address are encoded into the bottom 4 bits of this field. This is used in combination with NetSwitch and SwIn[] or SwOut[] to produce the full universe address.
9	OemHi	Int8	-	The high byte of the Oem value.

ArtPollReply				
Field	Name	Size	Bit	Description
10	Oem	Int8	-	The low byte of the Oem value. The Oem word describes the equipment vendor and the feature set available. Bit 15 high indicates extended features available. Current registered codes are defined in Table 2.
11	Ubea Version	Int8	-	This field contains the firmware version of the User Bios Extension Area (UBEA). If the UBEA is not programmed, this field contains zero.
12	Status1	Int8	-	General Status register containing bit fields as follows.
			7-6	Indicator state.
			00	Indicator state unknown.
			01	Indicators in Locate Mode.
			10	Indicators in Mute Mode.
			11	Indicators in Normal Mode.
			5-4	Port Address Programming Authority
			00	Port Address Programming Authority unknown.
			01	All Port Address set by front panel controls.
			10	All or part of Port Address programmed by network.
			11	Not used.
			3	Not implemented, transmit as zero, receivers do not test.
			2	0 = Normal firmware boot (from flash). Nodes that do not support dual boot, clear this field to zero. 1 = Booted from ROM.
			1	0 = Not capable of Remote Device Management (RDM). 1 = Capable of Remote Device Management (RDM).
			0	0 = UBEA not present or corrupt 1 = UBEA present
13	EstaManLo	Int8	-	The ESTA manufacturer code. These codes are used to represent equipment manufacturer. They are assigned by ESTA. This field can be interpreted as two ASCII bytes representing the manufacturer initials.
14	EstaManHi	Int8	-	Hi byte of above
15	ShortName [18]	Int8	-	The array represents a null terminated short name for the Node. The Controller uses the ArtAddress packet to program this string. Max length is 17 characters plus the null. This is a fixed length field, although the string it contains can be shorter than the field.
16	LongName [64]	Int8	-	The array represents a null terminated long name for the Node. The Controller uses the ArtAddress packet to program this string. Max length is 63 characters plus the null. This is a fixed length field, although the string it contains can be shorter than the field.

ArtPollReply				
Field	Name	Size	Bit	Description
17	NodeReport [64]	Int8	-	The array is a textual report of the Node's operating status or operational errors. It is primarily intended for 'engineering' data rather than 'end user' data. The field is formatted as: "#xxxx [yyyy..] zzzzz..." xxxx is a hex status code as defined in Table 3. yyyy is a decimal counter that increments every time the Node sends an ArtPollResponse. This allows the controller to monitor event changes in the Node. zzzz is an English text string defining the status. This is a fixed length field, although the string it contains can be shorter than the field.
18	NumPortsHi	Int8	-	The high byte of the word describing the number of input or output ports. The high byte is for future expansion and is currently zero.
19	NumPortsLo	Int8	-	The low byte of the word describing the number of input or output ports. If number of inputs is not equal to number of outputs, the largest value is taken. Zero is a legal value if no input or output ports are implemented. The maximum value is 4.
20	PortTypes [4]	Int8	-	This array defines the operation and protocol of each channel. (Ether-Lynx example = 0xc0, 0xc0, 0xc0, 0xc0). The array length is fixed, independent of the number of inputs or outputs physically available on the Node.
			7	Set if this channel can output data from the Art-Net Network.
			6	Set if this channel can input onto the Art-NetNetwork.
			5-0	00000 = DMX512 00001 = MIDI 00010 = Avab 00011 = Colortran CMX 00100 = ADB 62.5 00101 = Art-Net
21	GoodInput [4]	Int8	-	This array defines input status of the node.
			7	Set - Data received.
			6	Set - Channel includes DMX512 test packets.
			5	Set - Channel includes DMX512 SIP's.
			4	Set - Channel includes DMX512 text packets.
			3	Set - Input is disabled.
			2	Set - Receive errors detected.
			1-0	Unused and transmitted as zero.
22	GoodOutput [4]	Int8	-	This array defines output status of the node.
			7	Set - Data is being transmitted.
			6	Set - Channel includes DMX512 test packets.
			5	Set - Channel includes DMX512 SIP's.
			4	Set - Channel includes DMX512 text packets.
			3	Set - Output is merging ArtNet data.
			2	Set - DMX output short detected on power up
			1	Set - Merge Mode is LTP.
			0	Unused and transmitted as zero.
23	SwIn [4]	Int8	-	Bits 3-0 of the 15 bit Port-Address for each of the 4 possible input ports are encoded into the low nibble.

ArtPollReply				
Field	Name	Size	Bit	Description
24	SwOut [4]	Int8	-	Bits 3-0 of the 15 bit Port-Address for each of the 4 possible output ports are encoded into the low nibble.
25	SwVideo	Int8	-	Set to 00 when video display is showing local data. Set to 01 when video is showing ethernet data.
26	SwMacro	Int8	-	If the Node supports macro key inputs, this byte represents the trigger values. The Node is responsible for 'debouncing' inputs. When the ArtPollReply is set to transmit automatically, (TalkToMe Bit 1), the ArtPollReply will be sent on both key down and key up events. However, the Controller should not assume that only one bit position has changed. The Macro inputs are used for remote event triggering or cueing. Bit fields are active high.
			7	Set - Macro 8 active.
			6	Set - Macro 7 active.
			5	Set - Macro 6 active.
			4	Set - Macro 5 active.
			3	Set - Macro 4 active.
			2	Set - Macro 3 active.
			1	Set - Macro 2 active.
			0	Set - Macro 1 active.
27	SwRemote	Int8	-	If the Node supports remote trigger inputs, this byte represents the trigger values. The Node is responsible for 'debouncing' inputs. When the ArtPollReply is set to transmit automatically, (TalkToMe Bit 1), the ArtPollReply will be sent on both key down and key up events. However, the Controller should not assume that only one bit position has changed. The Remote inputs are used for remote event triggering or cueing. Bit fields are active high.
			7	Set - Remote 8 active.
			6	Set - Remote 7 active.
			5	Set - Remote 6 active.
			4	Set - Remote 5 active.
			3	Set - Remote 4 active.
			2	Set - Remote 3 active.
			1	Set - Remote 2 active.
			0	Set - Remote 1 active.
28	Spare	Int8		Not used, set to zero
29	Spare	Int8		Not used, set to zero
30	Spare	Int8		Not used, set to zero
31	Style	Int8		The Style code defines the equipment style of the device. See Table 4 for current Style codes.
32	MAC Hi	Int8		MAC Address Hi Byte. Set to zero if node cannot supply this information.
33	MAC	Int8		MAC Address
34	MAC	Int8		MAC Address
35	MAC	Int8		MAC Address
36	MAC	Int8		MAC Address
37	MAC Lo	Int8		MAC Address Lo Byte

ArtPollReply				
Field	Name	Size	Bit	Description
38	BindIp[4]	Int8		If this unit is part of a larger or modular product, this is the IP of the root device.
39	BindIndex	Int8		Set to zero if no binding, otherwise this number represents the order of bound devices. A lower number means closer to root device. A value of 1 means root device.
40	Status2	Int8	0	Set = Product supports web browser configuration.
			1	Clr = Node's IP is manually configured. Set = Node's IP is DHCP configured.
			2	Clr = Node is not DHCP capable. Set = Node is DHCP capable.
			3	Clr = Node supports 8 bit Port-Address (Art-Net II). Set = Node supports 15 bit Port-Address (Art-Net 3).
41	Filler	26 x 8		Transmit as zero. For future expansion.

ArtIpProg:

Implementation		
Entity	Direction	Action
Controller	Receive	No Action.
	Unicast Transmit	Controller transmits to a specific node IP address.
	Broadcast	Not Allowed.
Node	Receive	Reply with ArtIpProgReply.
	Unicast Transmit	Not Allowed.
	Broadcast	Not Allowed.
Media Server	Receive	Reply with ArtIpProgReply.
	Unicast Transmit	Not Allowed.
	Broadcast	Not Allowed.

The ArtIpProg packet allows the IP settings of a Node to be reprogrammed.

The ArtIpProg packet is sent by a Controller to the private address of a Node. If the Node supports remote programming of IP address, it will respond with an ArtIpProgReply packet. In all scenarios, the ArtIpProgReply is sent to the private address of the sender.

ArtIpProg				
Field	Name	Size	Bit	Description
1	ID[8]	Int8	-	Array of 8 characters, the final character is a null termination. Value = 'A' 'r' 't' '-' 'N' 'e' 't' 0x00
2	OpCode	Int16	-	OplpProg Transmitted low byte first.
3	ProtVerHi	Int8	-	High byte of the Art-Net protocol revision number.
4	ProtVerLo	Int8	-	Low byte of the Art-Net protocol revision number. Current value 14
5	Filler1	Int8	-	Pad length to match ArtPoll.
6	Filler2	Int8	-	Pad length to match ArtPoll.
7	Command	Int8	-	Action this packet as follows:
			-	Defines the how this packet is processed. If all bits are clear, this is an enquiry only.
			7	Set to enable any programming.
			6	Set to enable DHCP (if set ignore lower bits).
			5-4	Not used, transmit as zero
			3	Set to return all three parameters to default
			2	Program IP Address
			1	Program Subnet Mask
			0	Program Port
8	Filler4	Int8		Set to zero. Pads data structure for word alignment.
9	ProgIpHi	Int8		IP Address to be programmed into Node if enabled by Command Field
10	ProgIp2	Int8		
11	ProgIp1	Int8		
12	ProgIpLo	Int8		
13	ProgSmHi	Int8		Subnet mask to be programmed into Node if enabled by Command Field
14	ProgSm2	Int8		
15	ProgSm1	Int8		
16	ProgSmLo	Int8		

ArtpProg				
Field	Name	Size	Bit	Description
17	ProgPort Hi	Int8		PortAddress to be programmed into Node if enabled by Command Field
18	ProgPort Lo	Int8		
19-26	Spare1-8	Int8		Transmit as zero, receivers don't test.

ArtpProgReply:

Implementation		
Entity	Direction	Action
Controller	Receive	No Action.
	Unicast Transmit	Not Allowed.
	Broadcast	Not Allowed.
Node	Receive	No Action.
	Unicast Transmit	Transmits to specific Controller IP address.
	Broadcast	Not Allowed.
Media Server	Receive	No Action
	Unicast Transmit	Transmits to specific Controller IP address.
	Broadcast	Not Allowed.

The ArtpProgReply packet is issued by a Node in response to an ArtpProg packet. Nodes that do not supports remote programming of IP address do not reply to ArtpProg packets. In all scenarios, the ArtpProgReply is sent to the private address of the sender.

Field	Name	Size	Description	
1	ID[8]	Int8	Array of 8 characters, the final character is a null termination. Value = 'A' 'r' 't' '-' 'N' 'e' 't' 0x00	
2	OpCode	Int16	OpIpProgReply Transmitted low byte first.	
3	ProtVerHi	Int8	High byte of the Art-Net protocol revision number.	
4	ProtVerLo	Int8	Low byte of the Art-Net protocol revision number. (14)	
5	Filler1	Int8	Pad length to match ArtPoll.	
6	Filler2	Int8	Pad length to match ArtPoll.	
7	Filler3	Int8	Pad length to match ArtpProg.	
8	Filler4	Int8	Pad length to match ArtpProg.	
9	ProgIpHi	Int8	IP Address of Node.	
10	ProgIp2	Int8		
11	ProgIp1	Int8		
12	ProgIpLo	Int8		
13	ProgSmHi	Int8	Subnet mask of Node.	
14	ProgSm2	Int8		
15	ProgSm1	Int8		
16	ProgSmLo	Int8		
17	ProgPort Hi	Int8	Port Address of Node.	
18	ProgPort Lo	Int8		
19	Status	Int8	Bit 7	0
			Bit 6	DHCP enabled.
			Bit 5-0	0
20	Spare2	Int8	Transmit as zero, receivers don't test.	
21	Spare3	Int8	Transmit as zero, receivers don't test.	
22	Spare4	Int8	Transmit as zero, receivers don't test.	
23	Spare5	Int8	Transmit as zero, receivers don't test.	
24	Spare6	Int8	Transmit as zero, receivers don't test.	

Field	Name	Size	Description
25	Spare7	Int8	Transmit as zero, receivers don't test.
26	Spare8	Int8	Transmit as zero, receivers don't test.

IP Address Override:

All Art-Net compatible devices provide a temporary override facility that defeats any non-standard IP address programming.

Setting the Sub-Net switch and all available Universe switches to 'F' enables IP override. In IP override mode, the Node ignores all parameters programmed by ArtIpProg commands.

ArtAddress:

Implementation		
Entity	Direction	Action
Controller	Receive	No Action.
	Unicast Transmit	Controller transmits to a specific node IP address.
	Broadcast	Not Allowed.
Node	Receive	Reply with ArtPollReply.
	Unicast Transmit	Not Allowed.
	Broadcast	Not Allowed.
Media Server	Receive	Reply with ArtPollReply.
	Unicast Transmit	Not Allowed.
	Broadcast	Not Allowed.

A Controller or monitoring device on the network can reprogram numerous controls of a node remotely. This, for example, would allow the lighting console to re-route DMX512 data at remote locations. This is achieved by sending an ArtAddress packet to the Node's IP address. (The IP address is returned in the ArtPoll packet). The node replies with an ArtPollReply packet.

Fields 5 to 13 contain the data that will be programmed into the node.

Field	Name	Size	Description
1	ID[8]	Int8	Array of 8 characters, the final character is a null termination. Value = 'A' 'r' 't' '-' 'N' 'e' 't' 0x00
2	OpCode	Int16	OpAddress Transmitted low byte first.
3	ProtVerHi	Int8	High byte of the Art-Net protocol revision number.
4	ProtVerLo	Int8	Low byte of the Art-Net protocol revision number. Current value 14
5	NetSwitch	Int8	Bits 14-8 of the 15 bit Port-Address are encoded into the bottom 7 bits of this field. This is used in combination with SubSwitch and SwIn[] or SwOut[] to produce the full universe address. This value is ignored unless bit 7 is high. i.e. to program a value 0x07, send the value as 0x87. Send 0x00 to reset this value to the physical switch setting. Use value 0x7f for no change.
6	Filler2	Int8	Pad length to match ArtPoll.
7	Short Name [18]	Int8	The array represents a null terminated short name for the Node. The Controller uses the ArtAddress packet to program this string. Max length is 17 characters plus the null. The Node will ignore this value if the string is null. This is a fixed length field, although the string it contains can be shorter than the field.

Field	Name	Size	Description		
8	Long Name [64]	Int8	The array represents a null terminated long name for the Node. The Controller uses the ArtAddress packet to program this string. Max length is 63 characters plus the null. The Node will ignore this value if the string is null. This is a fixed length field, although the string it contains can be shorter than the field.		
9	SwIn [4]	Int8	Bits 3-0 of the 15 bit Port-Address for a given input port are encoded into the bottom 4 bits of this field. This is used in combination with NetSwitch and SubSwitch to produce the full universe address. This value is ignored unless bit 7 is high. i.e. to program a value 0x07, send the value as 0x87. Send 0x00 to reset this value to the physical switch setting. Use value 0x7f for no change.		
10	SwOut [4]	Int8	Bits 3-0 of the 15 bit Port-Address for a given output port are encoded into the bottom 4 bits of this field. This is used in combination with NetSwitch and SubSwitch to produce the full universe address. This value is ignored unless bit 7 is high. i.e. to program a value 0x07, send the value as 0x87. Send 0x00 to reset this value to the physical switch setting. Use value 0x7f for no change.		
11	SubSwitch	Int8	Bits 7-4 of the 15 bit Port-Address are encoded into the bottom 4 bits of this field. This is used in combination with NetSwitch and SwIn[] or SwOut[] to produce the full universe address. This value is ignored unless bit 7 is high. i.e. to program a value 0x07, send the value as 0x87. Send 0x00 to reset this value to the physical switch setting. Use value 0x7f for no change.		
12	SwVideo	Int8	Reserved.		
13	Command	Int8	Node configuration commands:		
			Val	Mnemonic	Action
			0x00	AcNone	No action
			0x01	AcCancel Merge	If Node is currently in merge mode, cancel merge mode upon receipt of next ArtDmx packet. See discussion of merge mode operation.
			0x02	AcLedNormal	The front panel indicators of the Node operate normally.
			0x03	AcLedMute	The front panel indicators of the Node are disabled and switched off.
			0x04	AcLedLocate	Rapid flashing of the Node's front panel indicators. It is intended as an outlet locator for large installations.
			0x05	AcResetRx Flags	Resets the Node's Sip, Text, Test and data error flags. If an output short is being flagged, forces the test to re-run.
			Node configuration commands: Note that Ltp / Htp settings should be retained by the node during power cycling.		

Field	Name	Size	Description		
			0x10	AcMergeLtp0	Set DMX Port 0 to Merge in LTP mode.
			0x11	AcMergeLtp1	Set DMX Port 1 to Merge in LTP mode.
			0x12	AcMergeLtp2	Set DMX Port 2 to Merge in LTP mode.
			0x13	AcMergeLtp3	Set DMX Port 3 to Merge in LTP mode.
			0x50	AcMergeHtp0	Set DMX Port 0 to Merge in HTP (default) mode.
			0x51	AcMergeHtp1	Set DMX Port 1 to Merge in HTP (default) mode.
			0x52	AcMergeHtp2	Set DMX Port 2 to Merge in HTP (default) mode.
			0x53	AcMergeHtp3	Set DMX Port 3 to Merge in HTP (default) mode.
			0x90	AcClearOp0	Clear DMX Output buffer for Port 0
			0x91	AcClearOp1	Clear DMX Output buffer for Port 1
			0x92	AcClearOp2	Clear DMX Output buffer for Port 2
			0x93	AcClearOp3	Clear DMX Output buffer for Port 3

ArtDiagData:

Implementation		
Entity	Direction	Action
Controller	Receive	Application Specific.
	Unicast Transmit	As defined by ArtPoll.
	Broadcast	As defined by ArtPoll.
Node	Receive	No Action
	Unicast Transmit	As defined by ArtPoll.
	Broadcast	As defined by ArtPoll.
Media Server	Receive	No Action
	Unicast Transmit	As defined by ArtPoll.
	Broadcast	As defined by ArtPoll.

ArtDiagData is a general purpose packet that allows a node or controller to send diagnostics data for display.

The ArtPoll packet sent by controllers defines the destination to which these messages should be sent.

ArtDiagData				
Field	Name	Size	Bit	Description
1	ID[8]	Int8	-	Array of 8 characters, the final character is a null termination. Value = 'A' 'r' 't' '-' 'N' 'e' 't' 0x00
2	OpCode	Int16	-	OpOutput Transmitted low byte first.
3	ProtVerHi	Int8	-	High byte of the Art-Net protocol revision number.

4	ProtVerLo	Int8	-	Low byte of the Art-Net protocol revision number. Current value 14
5	Filler1	Int8	-	Ignore by receiver, set to zero by sender.
6	Priority	Int8	-	The priority of this diagnostic data. See Table 5.
7	Filler2	Int8	-	Ignore by receiver, set to zero by sender.
8	Filler3	Int8	-	Ignore by receiver, set to zero by sender.
9	LengthHi	Int8	-	The length of the text array below. High Byte.
10	LengthLo	Int8	-	Low Byte.
11	Data [Length]	Int8	-	ASCII text array, null terminated. Max length is 512 bytes including the null terminator.

Table 5 - Priority Codes:

The following table details the Diagnostics Priority codes. These are used in ArtPoll and ArtDiagData.

Code	Mnemonic	Description
0x10	DpLow	Low priority message.
0x40	DpMed	Medium priority message.
0x80	DpHigh	High priority message.
0xe0	DpCritical	Critical priority message.
0xff	DpVolatile	Volatile message. Messages of this type are displayed on a single line in the DMX-Workshop diagnostics display. All other types are displayed in a list box.

ArtTimeCode:

Implementation		
Entity	Direction	Action
Controller	Receive	Application Specific.
	Unicast Transmit	Application Specific.
	Broadcast	Application Specific.
Node	Receive	Application Specific.
	Unicast Transmit	Application Specific.
	Broadcast	Application Specific.
Media Server	Receive	Application Specific.
	Unicast Transmit	Application Specific.
	Broadcast	Application Specific.

ArtTimeCode allows time code to be transported over the network. The data format is compatible with both longitudinal time code and MIDI time code. The four key types of Film, EBU, Drop Frame and SMPTE are also encoded.

Use of the packet is application specific but in general a single controller will broadcast the packet to the network.

ArtTimeCode				
Field	Name	Size	Bit	Description
1	ID[8]	Int8	-	Array of 8 characters, the final character is a null termination. Value = 'A' 'r' 't' '-' 'N' 'e' 't' 0x00
2	OpCode	Int16	-	OpTimeCode Transmitted low byte first.
3	ProtVerHi	Int8	-	High byte of the Art-Net protocol revision number.

4	ProtVerLo	Int8	-	Low byte of the Art-Net protocol revision number. Current value 14
5	Filler1	Int8	-	Ignore by receiver, set to zero by sender.
6	Filler2	Int8	-	Ignore by receiver, set to zero by sender.
7	Frames	Int8	-	Frames time. 0 - 29 depending on mode.
8	Seconds	Int8	-	Seconds. 0 - 59.
9	Minutes	Int8	-	Minutes. 0 - 59.
10	Hours	Int8	-	Hours. 0 - 23.
11	Type	Int8	-	0 = Film (24fps) 1 = EBU (25fps) 2 = DF (29.97fps) 3 = SMPTE (30fps)

ArtDmx:

Implementation		
Entity	Direction	Action
Controller	Receive	Application Specific.
	Unicast Transmit	Preferred. See Note 1.
	Broadcast	Not preferred.
Node	Receive	No Action
	Unicast Transmit	Preferred. See Note 1.
	Broadcast	Not preferred.
Media Server	Receive	No Action
	Unicast Transmit	See Note 1.
	Broadcast	Not Applicable.

ArtDmx is the data packet used to transfer DMX512 data. The format is identical for Node to Controller, Node to Node and Controller to Node.

The Node initially transmits ArtDmx on the Directed Broadcast address.

The Data is output through the DMX O/P port corresponding to the Universe setting. In the absence of received ArtDmx packets, each DMX O/P port re-transmits the same frame continuously.

The first complete DMX frame received at each input port is placed in an ArtDmx packet as above and transmitted as an ArtDmx packet containing the relevant Universe parameter. Each subsequent DMX frame containing **new data** (different length or different contents) is also transmitted as an ArtDmx packet.

Nodes do not transmit ArtDmx for DMX512 inputs that have not received data since power on.

However, an input that is active but not changing, will re-transmit the last valid ArtDmx packet at approximately 4-second intervals.

A DMX input that fails, will not continue to transmit ArtDmx data.

Note 1 Broadcast vs Unicast:

ArtDmx packets can be broadcast, but it is not recommended. Significant network efficiency gains can be achieved by unicasting ArtDmx. When ArtDmx is Unicast, the following rules must be used:

The transmitting device must regularly ArtPoll the network to detect any change in universe switch settings. If the transmitting device opts to Unicast, then it must Unicast ArtDmx to all nodes that are subscribed (In the ArtPollReply) to that universe. ***Subscribed means any universes listed in both the Swin and Swout array.***

If there are no subscribers to a universe that the transmitter wishes to send, then the ArtDmx may be broadcast. Implementers should provide for dynamic change between Unicast and broadcast. If the number of universe subscribers exceeds a given number, it may become more efficient to broadcast.

Use of unicast only is mandatory for systems using greater than 30 universes.

ArtDmx				
Field	Name	Size	Bit	Description
1	ID[8]	Int8	-	Array of 8 characters, the final character is a null termination. Value = 'A' 'r' 't' '-' 'N' 'e' 't' 0x00
2	OpCode	Int16	-	OpOutput Transmitted low byte first.
3	ProtVerHi	Int8	-	High byte of the Art-Net protocol revision number.
4	ProtVerLo	Int8	-	Low byte of the Art-Net protocol revision number. Current value 14

5	Sequence	Int8	-	The sequence number is used to ensure that ArtDmx packets are used in the correct order. When Art-Net is carried over a medium such as the Internet, it is possible that ArtDmx packets will reach the receiver out of order. This field is incremented in the range 0x01 to 0xff to allow the receiving node to resequence packets. The Sequence field is set to 0x00 to disable this feature.
6	Physical	Int8	-	The physical input port from which DMX512 data was input. This field is for information only. Use Universe for data routing.
7	SubUni	Int8	-	The low byte of the 15 bit Port-Address to which this packet is destined.
8	Net	Int8	-	The top 7 bits of the 15 bit Port-Address to which this packet is destined.
9	LengthHi	Int8	-	The length of the DMX512 data array. This value should be an even number in the range 2 - 512. It represents the number of DMX512 channels encoded in packet. NB: Products which convert Art-Net to DMX512 may opt to always send 512 channels. High Byte.
10	Length	Int8	-	Low Byte of above.
11	Data [Length]	Int8	-	An variable length array of DMX512 lighting data.

Refresh Rate:

The ArtDmx packet is intended to transfer DMX512 data. For this reason, the ArtDmx packet for a specific IP Address should not be transmitted at a repeat rate faster than the maximum repeat rate of a DMX packet containing 512 data slots.

Data Merging:

The Art-Net protocol allows multiple nodes or controllers to transmit ArtDmx data to the same universe.

A node can detect this situation by comparing the IP addresses of received ArtDmx packets. If ArtDmx packets addressed to the same Universe are received from different IP addresses, a potential conflict exists.

The Node can legitimately handle this situation using one of two methods:

- Consider this to be an error condition and await user intervention.
- Automatically merge the data.

Nodes should document the approach that is implemented in the product user guide. The Merge option is preferred as it provides a higher level of functionality.

Merge is implemented in either LTP or HTP mode as specified by the ArtAddress packet.

Merge mode is implemented as follows:

1. If ArtDmx is received from differing IP addresses, the data is merged to the DMX output. In this situation, *ArtPollReply-GoodOutput-Bit3* is set. If *Art-Poll-TalkToMe Bit 1* is set, an ArtPollReply should be transmitted when merging commences.
2. Exit from Merge mode is handled as follows:
 - If *ArtAddress AcCancelMerge* is received, the Next ArtDmx message received ends Merge mode. The Node then discards any ArtDmx packets received from an IP address that does not match the IP address of the ArtDmx packet that terminated Merge mode.
 - If either (but not both) sources of ArtDmx stop, the failed source is held in the merge buffer for 10 seconds. If, during the 10 second timeout, the failed source

returns, Merge mode continues. If the failed source does not recover, at the end of the timeout period, the Node exits Merge mode.

- If both sources of ArtDmx fail, the output holds the last merge result.

Merging is limited to two sources, any additional sources will be ignored by the Node.

The Merge implementation allows for the following two key modes of operation.

- **Combined Control:** Two Controllers (Consoles) can operate on a network and merge data to multiple Nodes.
- **Backup:** One Controller (Console) can monitor the network for a failure of the primary Controller. If a failure occurs, it can use the *ArtAddress AcCancelMerge* command to take instant control of the network.

When a node provides multiple DMX512 inputs, it is the responsibility of the Node to handle merging of data. This is because the Node will have only one IP address. If this were not handled at the Node, ArtDmx packets with identical IP addresses and identical universe numbers, but conflicting level data would be transmitted to the network.

ArtInput:

Implementation		
Entity	Direction	Action
Controller	Receive	No Action.
	Unicast Transmit	Controller transmits to a specific node IP address.
	Broadcast	Not Allowed.
Node	Receive	Reply with ArtPollReply.
	Unicast Transmit	Not Allowed.
	Broadcast	Not Allowed.
Media Server	Receive	Reply with ArtPollReply.
	Unicast Transmit	Not Allowed.
	Broadcast	Not Allowed.

A Controller or monitoring device on the network can enable or disable individual DMX512 inputs on any of the network nodes. This allows the Controller to directly control network traffic and ensures that unused inputs are disabled and therefore not wasting bandwidth.

All nodes power on with all inputs enabled.

Caution should be exercised when implementing this function in the controller. Keep in mind that some network traffic may be operating on a node to node basis.

ArtInput				
Field	Name	Size	Bit	Description
1	ID[8]	Int8	-	Array of 8 characters, the final character is a null termination. Value = 'A' 'r' 't' '-' 'N' 'e' 't' 0x00
2	OpCode	Int16	-	OpInput Transmitted low byte first.
3	ProtVerHi	Int8	-	High byte of the Art-Net protocol revision number.
4	ProtVerLo	Int8	-	Low byte of the Art-Net protocol revision number. Current value 14
5	Filler1	Int8	-	Pad length to match ArtPoll.
6	Filler2	Int8	-	Pad length to match ArtPoll.

ArtInput				
Field	Name	Size	Bit	Description
7	NumPortsHi	Int8	-	The high byte of the word describing the number of input or output ports. The high byte is for future expansion and is currently zero.
8	NumPortsLo	Int8	-	The low byte of the word describing the number of input or output ports. If number of inputs is not equal to number of outputs, the largest value is taken. The maximum value is 4.
9	Input [4]	Int8	-	This array defines input disable status of each channel. (Example = 0x01, 0x00, 0x01, 0x00 to disable first and third inputs)
			7-1	Not currently used
			0	Set to disable this input.

Firmware and UBEA upgrades:

This section defines the packets used to send firmware revisions to a node. In all instances, communication is private. Under no circumstances should the broadcast address be used.

The transaction involves the controller sending multiple ArtFirmwareMaster packets to a Node's IP address. Each packet is acknowledged by the Node with an ArtFirmwareReply.

The controller allows a 20 second maximum delay for reception of the ArtFirmwareReply.

If the reply is not received in this time, the controller aborts the transaction. The large time period is to allow for Nodes that are writing directly to slow non-volatile memory.

The Node allows a 20 second delay between sending an ArtFirmwareReply and receipt of the next consecutive ArtFirmwareMaster. If the next consecutive block is not received within this time, the Node aborts the transaction. In this instance the Node returns to it's previous operating system and sets ArtPollReply->Status and ArtPollReply->NodeReport accordingly.

The firmware update file contains a header that defines the Node OEM values that are valid for this update. The Controller must check this value before sending to a Node. The Node also checks this data on receipt of the first packet. If the Node receives a packet with an invalid code, it sends an error response.

The UBEA is the User Bios Expansion Area. This is a limited firmware upload mechanism that allows third party firmware extensions to be added to a Node.

Manufacturers who implement this feature must document the software interface requirements.

ArtFirmwareMaster:

Implementation		
Entity	Direction	Action
Controller	Receive	No Action.
	Unicast Transmit	Controller transmits to a specific node IP address.
	Broadcast	Not Allowed.
Node	Receive	Reply with OpFirmwareReply.
	Unicast Transmit	Not Allowed.
	Broadcast	Not Allowed.
Media Server	Receive	Reply with OpFirmwareReply.
	Unicast Transmit	Not Allowed.
	Broadcast	Not Allowed.

ArtFirmwareMaster						
Field	Name	Size	Bit	Description		
1	ID[8]	Int8	-	Array of 8 characters, the final character is a null termination. Value = 'A' 'r' 't' '-' 'N' 'e' 't' 0x00		
2	OpCode	Int16	-	OpFirmwareMaster. Transmitted low byte first.		
3	ProtVerHi	Int8	-	High byte of the Art-Net protocol revision number.		
4	ProtVerLo	Int8	-	Low byte of the Art-Net protocol revision number. Current value 14		
5	Filler1	Int8	-	Pad length to match ArtPoll.		
6	Filler2	Int8	-	Pad length to match ArtPoll.		
7	Type	Int8	-	Defines the packet contents as follows:		
				Value	Mnemonic	Function
				0x00	FirmFirst	The first packet of a firmware upload.
				0x01	FirmCont	A consecutive continuation packet of a firmware upload.
				0x02	FirmLast	The last packet of a firmware upload.
				0x03	UbeaFirst	The first packet of a UBEA upload.
				0x04	UbeaCont	A consecutive continuation packet of a UBEA upload.
0x05	UbeaLast	The last packet of a UBEA upload.				
8	BlockId	Int8	-	Counts the consecutive blocks of firmware upload. Starting at 0x00 for the FirmFirst or UbeaFirst packet.		
9	Firmware Length3	Int8	-	The total number of words (Int16) in the firmware upload plus the firmware header size. Eg a 32K word upload plus 530 words of header information == 0x00008212. This value is also the file size (in words) of the file to be uploaded.		
10	Firmware Length2	Int8	-			
11	Firmware Length1	Int8	-			
12	Firmware Length0	Int8	-	LSB		
13	Spare[20]	Int8	-	Controller sets to zero, Node does not test.		
14	Data[512]	Int16	-	This array contains the firmware or UBEA data block. The order is hi byte first. The interpretation of this data is manufacturer specific.		

ArtFirmwareReply:

Implementation		
Entity	Direction	Action
Controller	Receive	Send next OpFirmwareMaster.
	Unicast Transmit	Not Allowed.
	Broadcast	Not Allowed.
Node	Receive	No Action.
	Unicast Transmit	Node transmits to a specific Controller IP address.
	Broadcast	Not Allowed.
Media Server	Receive	No Action.
	Unicast Transmit	Node transmits to a specific Controller IP address.
	Broadcast	Not Allowed.

This packet is sent by the Node to the Controller in acknowledgement of each OpFirmwareMaster packet.

ArtFirmwareReply					
Field	Name	Size	Bit	Description	
1	ID[8]	Int8	-	Array of 8 characters, the final character is a null termination. Value = 'A' 'r' 't' '-' 'N' 'e' 't' 0x00	
2	OpCode	Int16	-	OpFirmwareReply. Transmitted low byte first.	
3	ProtVerHi	Int8	-	High byte of the Art-Net protocol revision number.	
4	ProtVerLo	Int8	-	Low byte of the Art-Net protocol revision number. Current value 14	
5	Filler1	Int8	-	Pad length to match ArtPoll.	
6	Filler2	Int8	-	Pad length to match ArtPoll.	
7	Type	Int8	-	Defines the packet contents as follows. Codes are used for both firmware and UBEA.	
				Value	Mnemonic
				0x00	FirmBlockGood
				0x01	FirmAll Good
				0xff	FirmFail
8	Spare[21]	Int8	-	Node sets to zero, Controller does not test.	

Firmware File Format:

All firmware and UBEA upload files should be of the following format.

The firmware file extension is .alf.

The UBEA file extension is .alu.

Byte	Name	Description
1	ChecksumHi	This is a 16 bit, one's compliment checksum of the firmware data area.
2	ChecksumLo	LSB of above
3	VersInfoHi	High byte of Node's firmware revision number. The Controller should only use this field to decide if a firmware update should proceed. The convention is that a higher number is a more recent release of firmware.

Byte	Name	Description
4	VersInfoLo	LSB of above
5-34	UserName	30 byte field of user name information. This information is not checked by the Node. It is purely for display by the Controller. It should contain a human readable description of file and version number. Whilst this is a fixed length field, it must contain a null termination.
35-546	Oem[256]	An array of 256 words. Each word is hi byte first and represents an Oem code for which this file is valid. Unused entries must be filled with 0xffff.
547-1054	Spare[254]	An array of 254 words. Currently unused and should be set to zero.
1055	Length3	The total length in words of the firmware information following this field.
1056	Length2	
1057	Length1	
1058	Length0	LSB
1059	Data[]	The firmware data as an array of 16 bit values ordered hi byte first. The actual data is manufacturer specific.

RDM Support:

This section defines the packet structure used to gate the Remote Device Management (RDM) protocol across Art-Net. It is assumed that the reader is familiar with the RDM document.

Art-Net devices support RDM as follows:

- All RDM discovery commands are proxied; Art-Net devices hold local RDM device lists and conduct their own discovery.
- All RDM Get / Set commands are non-proxied; they are passed to end devices for response.

This document defines the following terms:

- **Input Gateway:** A device that inputs DMX512 onto the Art-Net network (e.g. Up-Lynx).
- **Output Gateway:** A device that outputs DMX512 from the Art-Net network (e.g. Down-Lynx)
- **Table of Devices (TOD):** The list of RDM devices maintained by both Input and Output Gateways.

RDM Discovery

Output Gateway Operation

Output Gateways perform RDM discovery independent of network operation. This includes full discovery upon power-on and incremental discovery as a background task. The Output Gateway informs the network about its TOD as follows:

- Upon receipt of an ArtTodRequest packet, the Output Gateway Directed Broadcasts an ArtTodData packet containing the entire TOD. All Input Gateways parse the ArtTodData packets. If the Sub-Net and Universe fields match, the Input Gateway adds the TOD contents to their own internal TOD. This allows Input Gateways to respond to any RDM discovery commands they receive.
- Upon completion of initial RDM discovery, Output Gateways Directed Broadcast their TOD in an ArtTodData packet.
- When an RDM device is added to or removed from the Output Gateway's TOD (during incremental discovery), an ArtTodData packet is broadcast automatically.

Input Gateway Operation

Input Gateways generate a TOD by monitoring Art-Net traffic. The TOD is then used to reply to RDM discovery commands by proxy. Operation is as follows:

- Upon power-on, Input Gateways Directed Broadcast an ArtTodRequest packet.
- The network is monitored for ArtTodData packets. If the Sub-Net and Universe fields match, the Input Gateway adds the TOD contents to its own internal TOD. This allows Input Gateways to respond to any RDM discovery commands they receive.
- Input Gateways do not transmit any RDM discovery messages to the network.

Controller Operation:

Controllers emulate the operation of Input Gateways.

ArtTodRequest:

This packet is used to request the Table of RDM Devices (TOD). A Node receiving this packet must not interpret it as forcing full discovery. Full discovery is only initiated at power on or when an ArtTodControl.AtcFlush is received.

Implementation		
Entity	Direction	Action
Controller	Receive	No Action.
	Unicast Transmit	Not Allowed.
	Broadcast	Controller Directed Broadcasts to all nodes.
Node Output Gateway	Receive	Reply with ArtTodData.
	Unicast Transmit	Not Allowed.
	Broadcast	Not Allowed.
Node Input Gateway	Receive	No Action.
	Unicast Transmit	Not Allowed.
	Broadcast	Input Gateway Directed Broadcasts to all nodes.
Media Server	Receive	No Action.
	Unicast Transmit	Not Allowed.
	Broadcast	Not Allowed.

ArtTodRequest				
Field	Name	Size	Bit	Description
1	ID[8]	Int8	-	Array of 8 characters, the final character is a null termination. Value = 'A' 'r' 't' '-' 'N' 'e' 't' 0x00
2	OpCode	Int16	-	OpTodRequest. Transmitted low byte first.
3	ProtVerHi	Int8	-	High byte of the Art-Net protocol revision number.
4	ProtVerLo	Int8	-	Low byte of the Art-Net protocol revision number. Current value 14
5	Filler1	Int8	-	Pad length to match ArtPoll.
6	Filler2	Int8	-	Pad length to match ArtPoll.
7	Spare1	Int8	-	Transmit as zero, receivers don't test.
8	Spare2	Int8	-	Transmit as zero, receivers don't test.
9	Spare3	Int8	-	Transmit as zero, receivers don't test.
10	Spare4	Int8	-	Transmit as zero, receivers don't test.
11	Spare5	Int8	-	Transmit as zero, receivers don't test.
12	Spare6	Int8	-	Transmit as zero, receivers don't test.
13	Spare7	Int8	-	Transmit as zero, receivers don't test.

ArtTodRequest					
Field	Name	Size	Bit	Description	
14	Net	Int8	-	The top 7 bits of the 15 bit Port-Address of Nodes that must respond to this packet.	
15	Command	Int8	-	Value	Mnemonic
				0x00	TodFull
16	AddCount	Int8	-	The array size of the Address field. Max value is 32.	
17	Address [AdCount]	Int8	-	This array defines the low byte of the Port-Address of the Output Gateway nodes that must respond to this packet. The high nibble is the Sub-Net switch. The low nibble corresponds to the Universe. This is combined with the 'Net' field above to form the 15 bit address.	
				Function	Send the entire TOD.

ArtTodData:

Implementation		
Entity	Direction	Action
Controller	Receive	No Action.
	Unicast Transmit	Not Allowed.
	Broadcast	Not Allowed.
Node Output Gateway	Receive	No Action.
	Unicast Transmit	Not Allowed.
	Broadcast	Output Gateway always Directed Broadcasts this packet.
Node Input Gateway	Receive	No Action.
	Unicast Transmit	Not Allowed.
	Broadcast	Not Allowed.
Media Server	Receive	No Action.
	Unicast Transmit	Not Allowed.
	Broadcast	Not Allowed.

Field	Name	Size	Description
1	ID[8]	Int8	Array of 8 characters, the final character is a null termination. Value = 'A' 'r' 't' '-' 'N' 'e' 't' 0x00
2	OpCode	Int16	OpTodData. Transmitted low byte first.
3	ProtVerHi	Int8	High byte of the Art-Net protocol revision number.
4	ProtVerLo	Int8	Low byte of the Art-Net protocol revision number. Current value 14
5	RdmVer	Int8	Art-Net Devices that only support RDM DRAFT V1.0 set field to 0x00. Devices that support RDM STANDARD V1.0 set field to 0x01.
6	Port	Int8	Physical Port. Range 1-4.
7	Spare1	Int8	Transmit as zero, receivers don't test.
8	Spare2	Int8	Transmit as zero, receivers don't test.
9	Spare3	Int8	Transmit as zero, receivers don't test.
10	Spare4	Int8	Transmit as zero, receivers don't test.
11	Spare5	Int8	Transmit as zero, receivers don't test.
12	Spare6	Int8	Transmit as zero, receivers don't test.
13	Spare7	Int8	Transmit as zero, receivers don't test.
14	Net	Int8	The top 7 bits of the Port-Address of the Output Gateway DMX Port that generated this packet.

Field	Name	Size	Description		
15	Command Response	Int8	Defines the packet contents as follows.		
			Value	Mnemonic	Function
			0x00	TodFull	The packet contains the entire TOD or is the first packet in a sequence of packets that contains the entire TOD.
			0xff	TodNak	The TOD is not available.
16	Address	Int8	The low 8 bits of the Port-Address of the Output Gateway DMX Port that generated this packet. The high nibble is the Sub-Net switch. The low nibble corresponds to the Universe.		
17	UidTotalHi	Int8	The total number of RDM devices discovered by this Universe.		
18	UidTotalLo	Int8			
19	BlockCount	Int8	The index number of this packet. When UidTotal exceeds 200, multiple ArtTodData packets are used. BlockCount is set to zero for the first packet, and incremented for each subsequent packet containing blocks of TOD information.		
20	UidCount	Int8	The number of UIDs encoded in this packet. This is the index of the following array.		
21	TOD [UidCount]	48 bit	An array of RDM UID.		

ArtTodControl:

Implementation		
Entity	Direction	Action
Controller	Receive	No Action.
	Unicast Transmit	Not Allowed.
	Broadcast	Controller Directed Broadcasts to all nodes.
Node Output Gateway	Receive	Reply with ArtTodData.
	Unicast Transmit	Not Allowed.
	Broadcast	Not Allowed.
Node Input Gateway	Receive	No Action.
	Unicast Transmit	Not Allowed.
	Broadcast	Input Gateway Directed Broadcasts to all nodes.
Media Server	Receive	No Action.
	Unicast Transmit	Not Allowed.
	Broadcast	Not Allowed.

The ArtTodControl packet is used to send RDM control parameters over Art-Net. The response is ArtTodData.

Field	Name	Size	Description
1	ID[8]	Int8	Array of 8 characters, the final character is a null termination. Value = 'A' 'r' 't' '-' 'N' 'e' 't' 0x00
2	OpCode	Int16	OpTodControl. Transmitted low byte first.
3	ProtVerHi	Int8	High byte of the Art-Net protocol revision number.
4	ProtVerLo	Int8	Low byte of the Art-Net protocol revision number. Current value 14
5	Filler1	Int8	Pad length to match ArtPoll.
6	Filler2	Int8	Pad length to match ArtPoll.

Field	Name	Size	Description
7	Spare1	Int8	Transmit as zero, receivers don't test.
8	Spare2	Int8	Transmit as zero, receivers don't test.
9	Spare3	Int8	Transmit as zero, receivers don't test.
10	Spare4	Int8	Transmit as zero, receivers don't test.
11	Spare5	Int8	Transmit as zero, receivers don't test.
12	Spare6	Int8	Transmit as zero, receivers don't test.
13	Spare7	Int8	Transmit as zero, receivers don't test.
14	Net	Int8	The top 7 bits of the Port-Address of the Output Gateway DMX Port that should action this command.
15	Command	Int8	Defines the packet action.
			Value Mnemonic Function
			0x00 AtcNone No action.
			0x01 AtcFlush The node flushes it's TOD and instigates full discovery.
16	Address	Int8	The low byte of the 15 bit Port-Address of the DMX Port that should action this command.

ArtRdm:

Implementation		
Entity	Direction	Action
Controller	Receive	No Action.
	Unicast Transmit	Allowed - Preferred .
	Broadcast	Allowed.
Node Output Gateway	Receive	No Action
	Unicast Transmit	Allowed - Preferred.
	Broadcast	Allowed.
Node Input Gateway	Receive	No Action.
	Unicast Transmit	Allowed - Preferred.
	Broadcast	Allowed.
Media Server	Receive	No Action.
	Unicast Transmit	Not Allowed.
	Broadcast	Not Allowed.

The ArtRdm packet is used to transport all non-discovery RDM messages over Art-Net.

Field	Name	Size	Description
1	ID[8]	Int8	Array of 8 characters, the final character is a null termination. Value = 'A' 'r' 't' '-' 'N' 'e' 't' 0x00
2	OpCode	Int16	OpRdm. Transmitted low byte first.
3	ProtVerHi	Int8	High byte of the Art-Net protocol revision number.
4	ProtVerLo	Int8	Low byte of the Art-Net protocol revision number. Current value 14
5	RdmVer	Int8	Art-Net Devices that only support RDM DRAFT V1.0 set field to 0x00. Devices that support RDM STANDARD V1.0 set field to 0x01.
6	Filler2	Int8	Pad length to match ArtPoll.
7	Spare1	Int8	Transmit as zero, receivers don't test.
8	Spare2	Int8	Transmit as zero, receivers don't test.

Field	Name	Size	Description
9	Spare3	Int8	Transmit as zero, receivers don't test.
10	Spare4	Int8	Transmit as zero, receivers don't test.
11	Spare5	Int8	Transmit as zero, receivers don't test.
12	Spare6	Int8	Transmit as zero, receivers don't test.
13	Spare7	Int8	Transmit as zero, receivers don't test.
14	Net	Int8	The top 7 bits of 15 bit Port-Address that should action this command.
15	Command	Int8	Defines the packet action.
			Value Mnemonic Function
			0x00 ArProcess Process RDM Packet.
16	Address	Int8	The low 8 bits of the Port-Address that should action this command.
17	RdmPacket	Int8 [Vari]	The RDM data packet excluding the DMX StartCode.

ArtRdmSub:

Implementation		
Entity	Direction	Action
Controller	Receive	No Action.
	Unicast Transmit	Yes.
	Broadcast	Not allowed.
Node Output Gateway	Receive	No Action
	Unicast Transmit	Yes.
	Broadcast	Not allowed.
Node Input Gateway	Receive	No Action.
	Unicast Transmit	Yes.
	Broadcast	Not allowed.
Media Server	Receive	No Action.
	Unicast Transmit	Not Allowed.
	Broadcast	Not Allowed.

The ArtRdmSub packet is used to Get, Set, GetResponse and Set Response data to multiple sub-devices within an RDM device. This packet is primarily used by Art-Net devices that proxy or emulate RDM. It offers very significant bandwidth gains over the approach of sending multiple ArtRdm packets. Please note that this packet was added at the release of Art-Net II. For backwards compatibility it is only acceptable to implement this packet in addition to ArtRdm. It must not be used instead of ArtRdm.

ArtRdmSub			
Field	Name	Size	Description
1	ID[8]	Int8	Array of 8 characters, the final character is a null termination. Value = 'A' 'r' 't' '-' 'N' 'e' 't' 0x00
2	OpCode	Int16	OpRdmSub. Transmitted low byte first.
3	ProtVerHi	Int8	High byte of the Art-Net protocol revision number.
4	ProtVerLo	Int8	Low byte of the Art-Net protocol revision number. Current value 14

ArtRdmSub				
Field	Name	Size	Description	
5	RdmVer	Int8	Art-Net Devices that only support RDM DRAFT V1.0 set field to 0x00. Devices that support RDM STANDARD V1.0 set field to 0x01.	
6	Filler2	Int8	Transmit as zero, receivers don't test.	
7	UID	Int8[6]	UID of target RDM device.	
8	Spare1	Int8	Transmit as zero, receivers don't test.	
9	CommandClass	Int8	As per RDM specification. This field defines whether this is a Get, Set, GetResponse, SetResponse.	
10	ParameterId	Int16	As per RDM specification. This field defines the type of parameter contained in this packet.	
11	SubDevice	Int16	Defines the first device information contained in packet. This follows the RDM convention that 0 = root device and 1 = first subdevice.	
12	SubCount	Int16	The number of sub devices packed into packet. Zero is illegal.	
13	Spare2	Int8	Transmit as zero, receivers don't test.	
14	Spare3	Int8	Transmit as zero, receivers don't test.	
15	Spare4	Int8	Transmit as zero, receivers don't test.	
16	Spare5	Int8	Transmit as zero, receivers don't test.	
17	Data	Int16 [Vari]	The size of the data array is defined by the contents of CommandClass and SubCount:	
			CommandClass	Array Size
			Get	0
			Set	SubCount
			GetResponse	SubCount
			SetResponse	0

Display of status:

Most Art-Net compliant equipment will provide some level of status indication. The following format is suggested:

Name	Mnemonic	Colour	Function	
Power	Pow	Red	Normally on, flashes if fault detected.	
Communication	Com	Amber	On if any Art-Net packets detected on network, timeout after 6 seconds.	
DMX512	DMX x	Green	DMX Input	On if good DMX received, Flashing if errors detected. Alternative Start Codes are not errors!
			DMX Output	On if receiving ArtDmx for this output. Timeout after 6 seconds.

Data Integrity:

Art-Net receivers should check one item:

- Compare the ID[8] field

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