Understanding DMX

- Fundamentals - What are the Highlights
- Communication Protocol – Data Packets & Addressing
- Wiring Limitation & Topology
- Extending the capability
- Connectivity

Make it happen

How to validate the topology & network continuity

Intended to provide an overview of DMX that helps explain what it is and how a system should be designed. There are some rules that are fixed based on the nature of the RS-485 / DMX data communication, and other rules are best practices that together will provide the foundations for a capable functioning system.

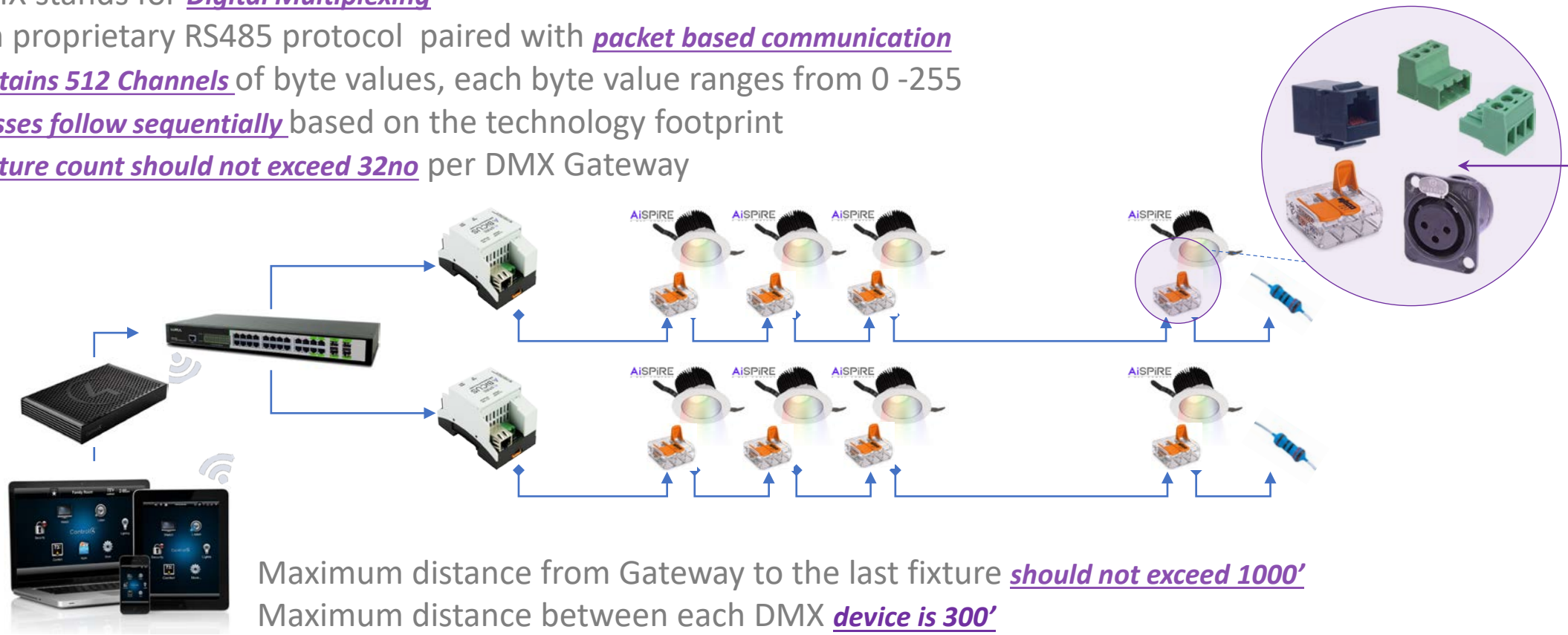
WAC

Revision ONE January 2022

A brief history of the DMX protocol

Developed by the US Institute of Theater Technology – 1986
Remote Device Management approved by ANSI – 2006
Ethernet adapted – CAN & Art-Net - 2009

The Term DMX stands for ***Digital Multiplexing***
DMX is a non proprietary RS485 protocol paired with ***packet based communication***
A ***Universe contains 512 Channels*** of byte values, each byte value ranges from 0 -255
Fixture ***addresses follow sequentially*** based on the technology footprint
Maximum ***fixture count should not exceed 32no*** per DMX Gateway



Maximum distance from Gateway to the last fixture ***should not exceed 1000'***
Maximum distance between each DMX ***device is 300'***
Each ***fixture must be connected in Series***, most have an IN & OUT terminations
Terminate each DMX line with a 120 Ohm resistor DMX (+) & (-)
There are many ways to connect a fixture to the DMX bus run – ***RJ45, Phoenix, Wago*** …

Packet based communication

A packet consists of ***512 channels*** or byte values, each value ranging from 0 to 255 ***(0 = ZERO / 255 = FULL)***
The DMX packet could look like the example below, with values for each of the 512 channels.
These byte packets are sent out from the controller at rates of up to 44 times per second, with the signal being a continuous send unless the controller stops sending, or the connection is broken.
The appearance of a change in value is smooth, given the human eye can observe at best 30 frames per second

Channel	1	2	3	4	5	6	6	8	9	10	… 512
Byte Value	255	200	0	0	115	10	25	0	0	133	202

A fixture will operate based on byte values of a channel.
Each fixture type will have a number of channels necessary to operate.
The quantity of channels used per fixture can be called a “footprint”.
For example, ***an Aurora fixture*** using four (4) channels has a footprint of four (4).
First ***(1)*** = Intensity / Second ***(2)*** = CCT (Correlated Color Temp) / Third ***(3)*** = Saturation / Fourth ***(4)*** = Hue

There are several factors to consider when populating a universe with fixtures, and limits of these factors should be considered together. When one of the limits is reached, a necessary addition must be made to the system before continuing with more fixtures.

Address Usage - There are 512 addresses available on each DMX universe. Once the addresses have all been allocated, an additional universe should be added to accommodate more fixtures.

When addressing the fixture, the first address is assigned on the fixture, and any additional "channel" addresses in the DMX profile are understood as being part of the fixture as well.
Aurora example, if the fixture has a DMX footprint of 4, and the fixture is addressed as 1, then it uses addresses 1-4.

Starting Address ***(Base DMX) 1***
Using Addresses ***1-4***

1 = starting address & Intensity (value 255 = FULL ON)
2 = CCT 6628 (value 200 = 78.4% of dynamic range)
3 = Saturation (value 0 = zero saturation)
4 = Hue (value 0 = zero hue)

Atmosphere example, if the fixture has a DMX footprint of 2, and the fixture is addressed as 1, then it uses addresses 1-2.

Starting Address ***(Base DMX) 5***
Using Addresses ***5-6***

5 = starting address & Intensity (value 127 = 50% ON)
6 = CCT 4600 (value 127 = 50% of dynamic range)

Addressing Fixtures

There are several factors to consider when populating a universe with fixtures, and limits of these factors should be considered together. When one of the limits is reached, a necessary addition must be made to the system before continuing with more fixtures.

Address Usage *- There are 512 addresses available on each DMX universe. Once the addresses have all been allocated, an additional universe should be added to accommodate more fixtures.*

Fixture addresses must not overlap. After an address range has been allocated to a given fixture, the next address range must start after the previous range. Overlapping addresses will result in erratic behavior as the same channel is affecting two different fixtures.

For example, the fixture following the one using addresses 1-4 should have a starting address of 5.

Starting Address
1
Using Addresses
1-4

Starting Address
5
Using Addresses
5-8

Addressing Fixtures

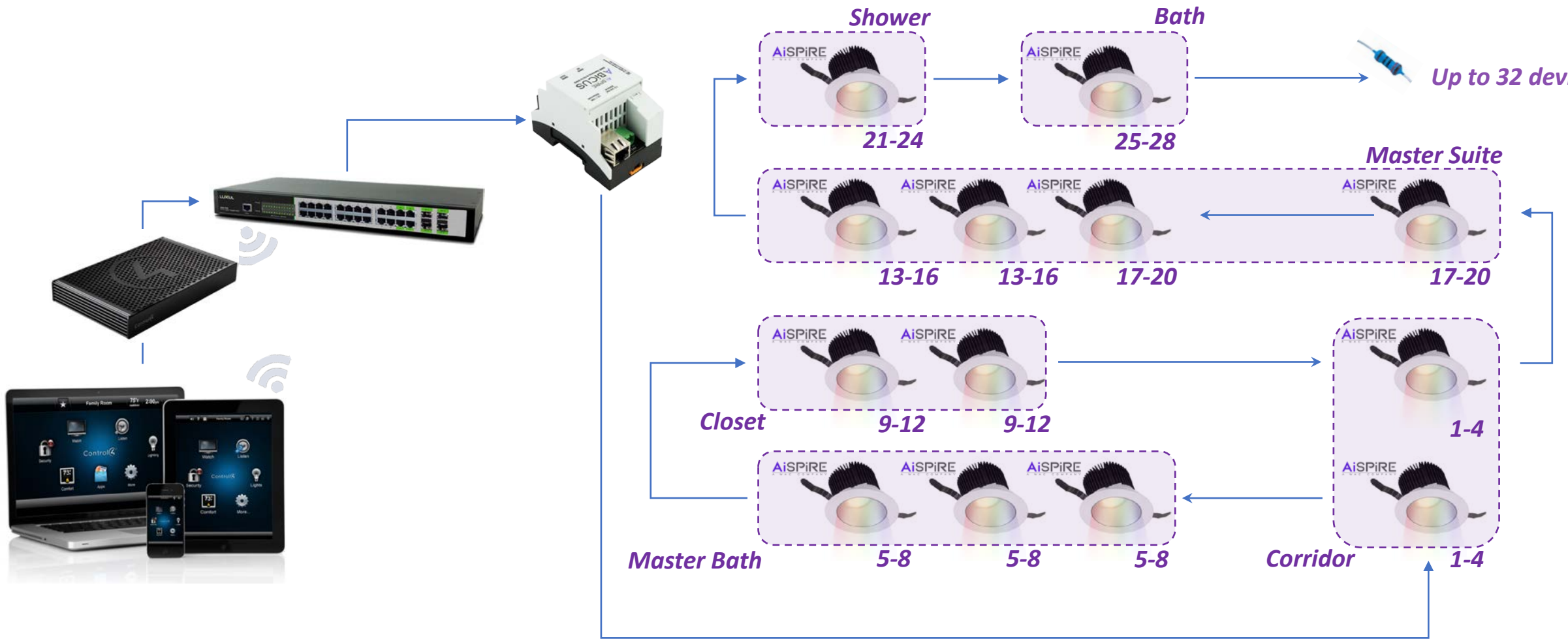
There are several factors to consider when populating a universe with fixtures, and limits of these factors should be considered together. When one of the limits is reached, a necessary addition must be made to the system before continuing with more fixtures.

Address Usage - *There are 512 addresses available on each DMX universe. Once the addresses have all been allocated, an additional universe should be added to accommodate more fixtures*

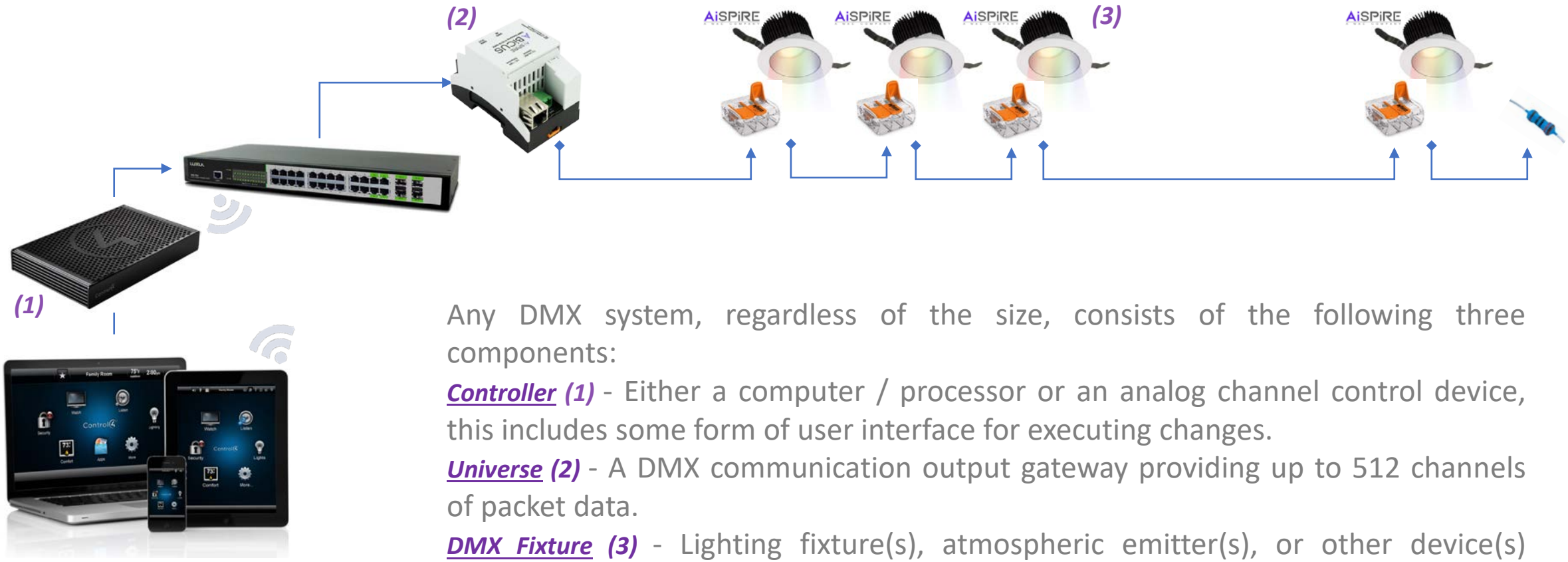
It is possible to assign the ***same address to multiple fixtures***, only if their DMX profile is exactly the same. Doing this will allow multiple fixtures to be controlled simultaneously as one.
Once all of the 512 addresses of a universe have been allocated, if more addresses are needed, an additional universe will need to be added to the system.

Starting Address
1
Using Addresses
1-4

Addressing Fixtures - Application



Topology ONE



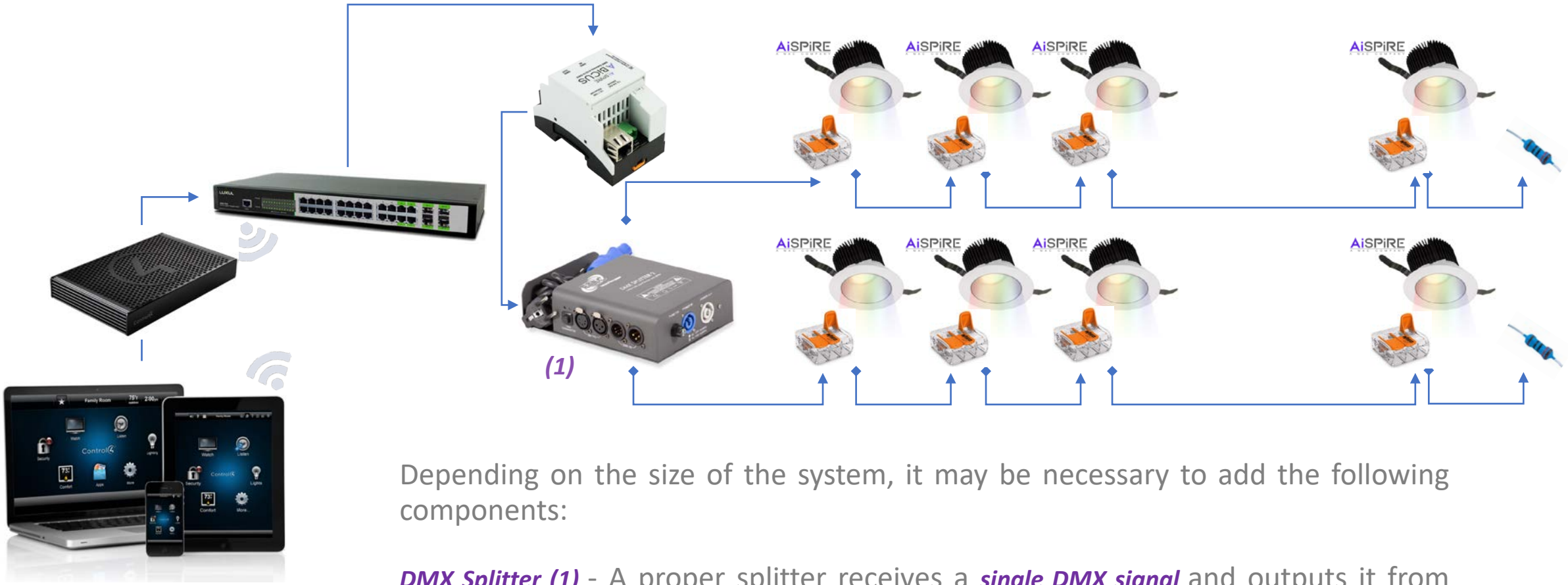
Any DMX system, regardless of the size, consists of the following three components:

Controller (1) - Either a computer / processor or an analog channel control device, this includes some form of user interface for executing changes.

Universe (2) - A DMX communication output gateway providing up to 512 channels of packet data.

DMX Fixture (3) - Lighting fixture(s), atmospheric emitter(s), or other device(s) controlled by DMX.

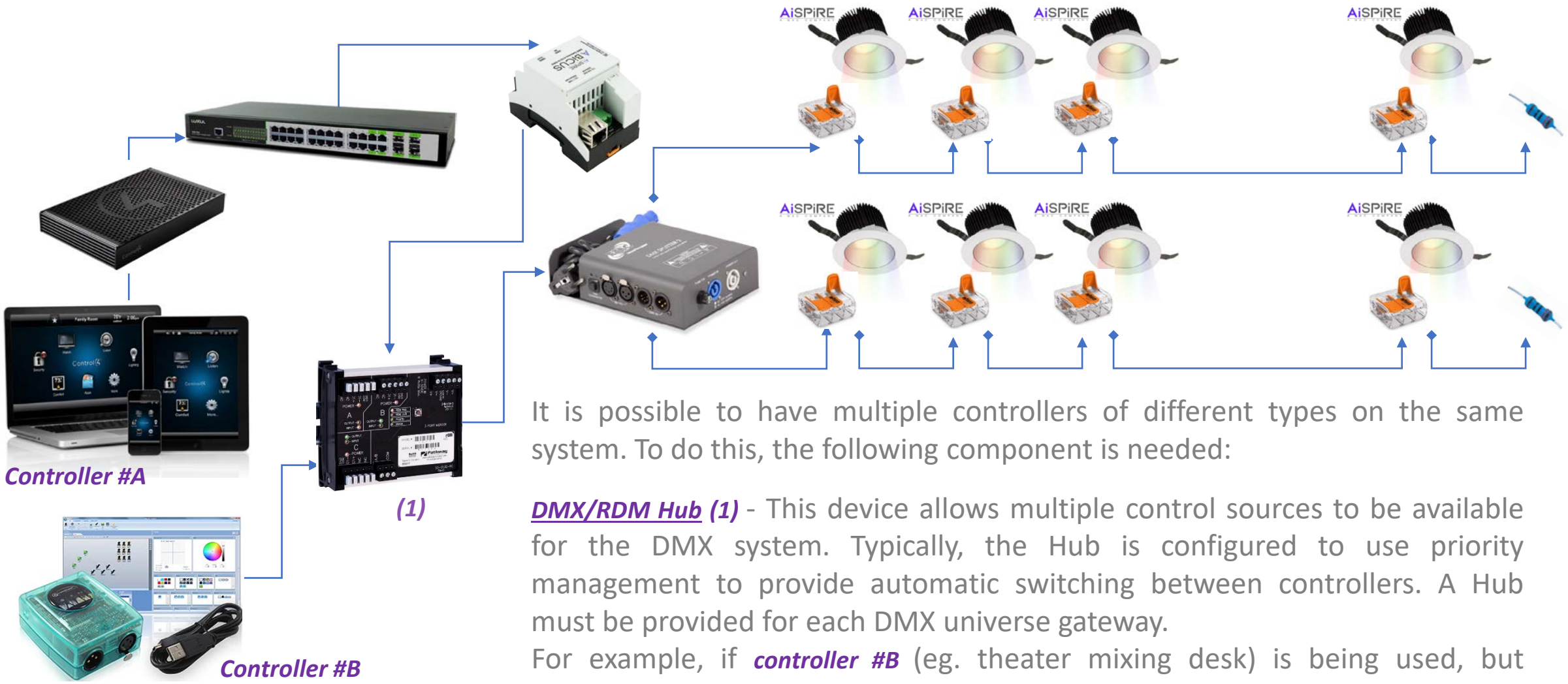
Topology TWO



Depending on the size of the system, it may be necessary to add the following components:

DMX Splitter (1) - A proper splitter receives a ***single DMX signal*** and outputs it from multiple opto-isolated ports, typically with 2, 4, or 8 ports from the splitter. Each port reproduces the signal from the DMX universe ***up to 1000-feet***.

Topology THREE



It is possible to have multiple controllers of different types on the same system. To do this, the following component is needed:

DMX/RDM Hub (1) - This device allows multiple control sources to be available for the DMX system. Typically, the Hub is configured to use priority management to provide automatic switching between controllers. A Hub must be provided for each DMX universe gateway.

For example, if ***controller #B*** (eg. theater mixing desk) is being used, but ***controller #A*** starts sending DMX signal, the Hub will automatically close signal from controller #B and pass signal from controller #A.

Topology FOUR

There are several factors to consider when populating a universe with fixtures, and limits of these factors should be considered together. When one of the limits is reached, a necessary addition must be made to the system before continuing with more fixtures.

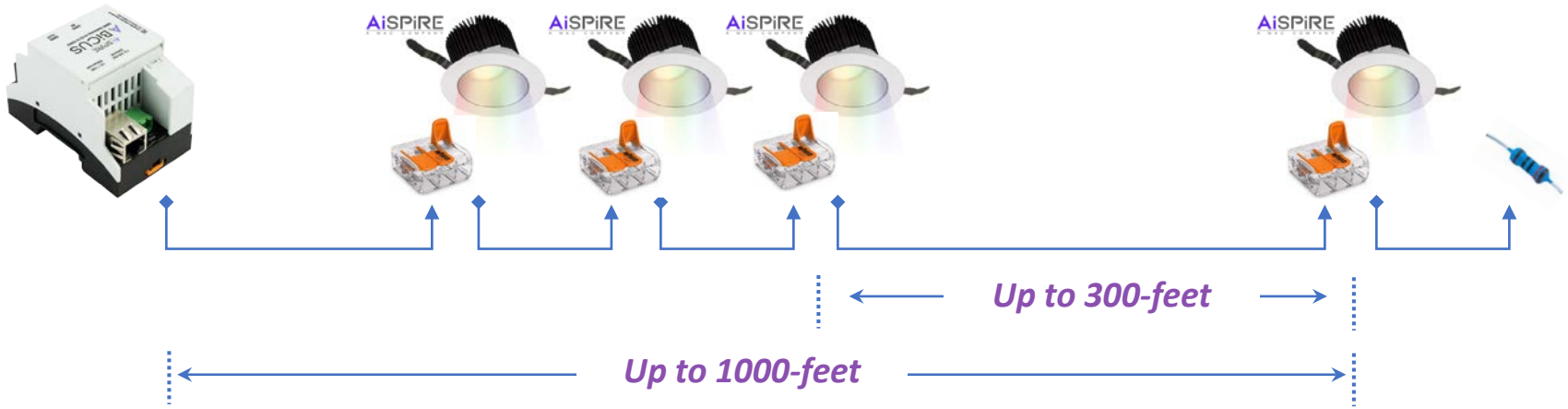
Fixture Quantity - Up to ***32 fixtures*** can be placed on any given DMX run. If more fixtures are to be added, and there are enough available addresses on the universe, a ***DMX Splitter*** should be used to provide more runs.

It is best practice to locate this splitter immediately after the Universe output device, but it can be added as the 32nd device on the main line run.

From the splitter, up to 32 fixtures can be placed on each of the output line runs *(example, 4-ports will yield 128 total fixture channels)*

If using a DMX Hub (prior), the Hub counts as one device, so the total number of devices after the Hub is 31.

Topology FIVE



From the output of each DMX universe, there are rules to how the wiring topology of a DMX system can be laid out.
The cable run between any two devices (universe gateway, splitter, fixture) should ***not exceed 300-feet***.

The total cable run from a universe output to the last fixture in a line should not exceed ***1000-feet***.

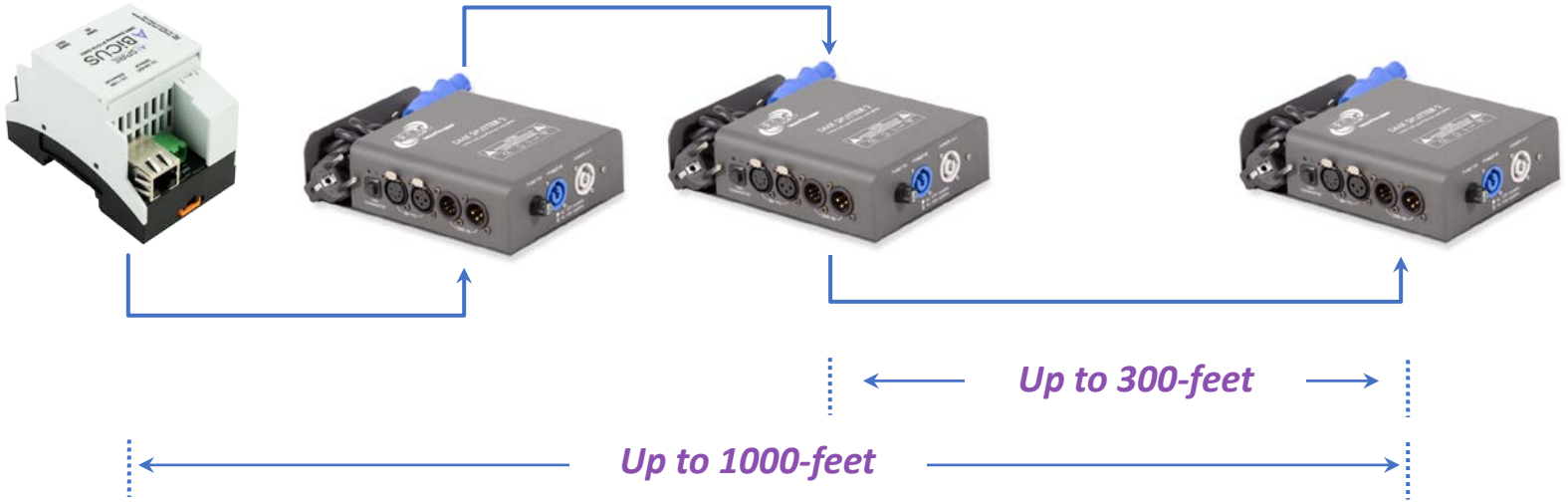
*While it is technically possible to run up to 4000-feet, a distance of **1000-feet** will allow use of an RDM (Remote Device Management) Tool if necessary.*

Topology SIX

From the output of each DMX universe, there are rules to how the wiring topology of a DMX system can be laid out.

A **DMX Splitter** can be used to extend a line *(consider this as additional DMX network with the same constraints)* by outputting from each opto-isolated port up to ***1000-feet***.

Splitters are also typically equipped with IN / OUT ports that are used for linking multiple splitters. *This OUT does not extend the signal like the opto-isolated ports, and when linking splitters, the* ***32-device / 1000-foot*** *rules apply between splitters*.



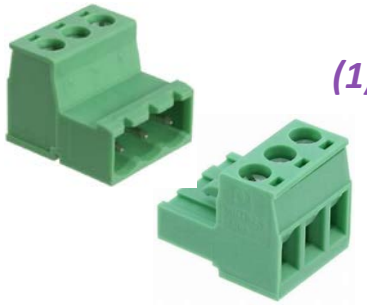
Depending on the physical port characteristics of a universe device and the fixtures, the signal cable could be one of the following types:

DMX Cable - Typically 22-24 AWG, two-conductor with ground. The cable should be made for DMX, as this is a digital data transfer cable.

Cat5e or Cat6 - When using this cable type, typical wire assignment is Org/W=Pos, Org=Neg, Brn+Brn/W=Gnd.

Beldon 9841

Pin 1 (+) White Orange
Pin 2 (-) Orange
Pin 7 (G) Brown



(1)

(2)

(3)

Open Terminal or Phoenix ***(1)*** - This is the most basic connection type that typically requires use of a small slot-blade screwdriver to secure wires.

XLR Connector ***(2)*** *(either 3-pin or 5-pin)* - This is a cable connector that has a specific pinout of 1=Gnd, 2=Neg, 3=Pos (4+5=NC).

RJ45 Cat5e or Cat6 ***(3)*** - Many DMX drivers / decoders have RJ45 ports rather than XLR or open terminal. The pinout is typically 1=Positive, 2=Negative, 7 (8)=Ground.

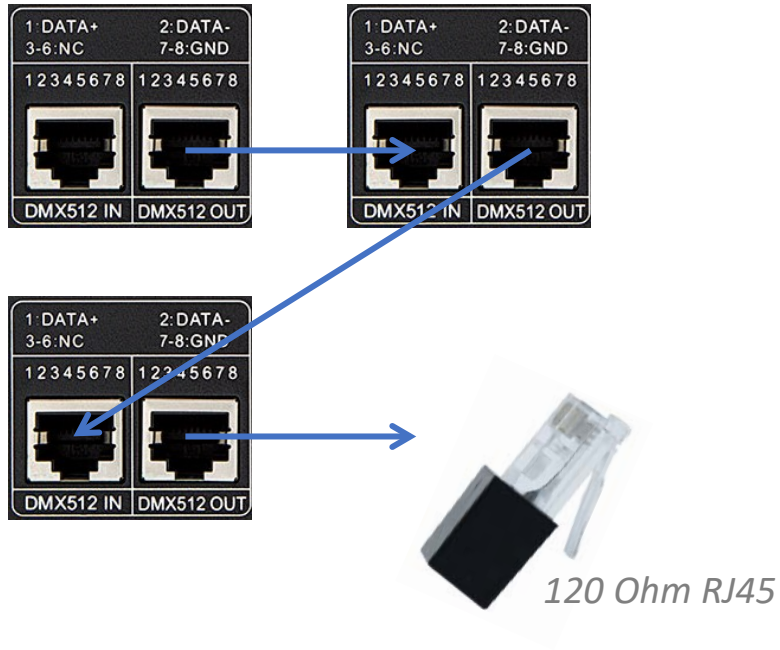
It is important to check the required pinout for each manufacturer device before making the necessary connections.

Wire & Connectivity TWO

From the output of each DMX universe, there are rules to how the wiring topology of a DMX system can be laid out.

All DMX devices must be ***connected in series*** via the DMX communication cabling. *Most devices have two DMX ports, each labelled as IN or OUT.*

The end of every DMX run should have a ***120 Ohm, 0.5 Watt resistor*** in place *(this could be a switch on a device, or a separate part that connects to the line)*.



Understanding DMX …

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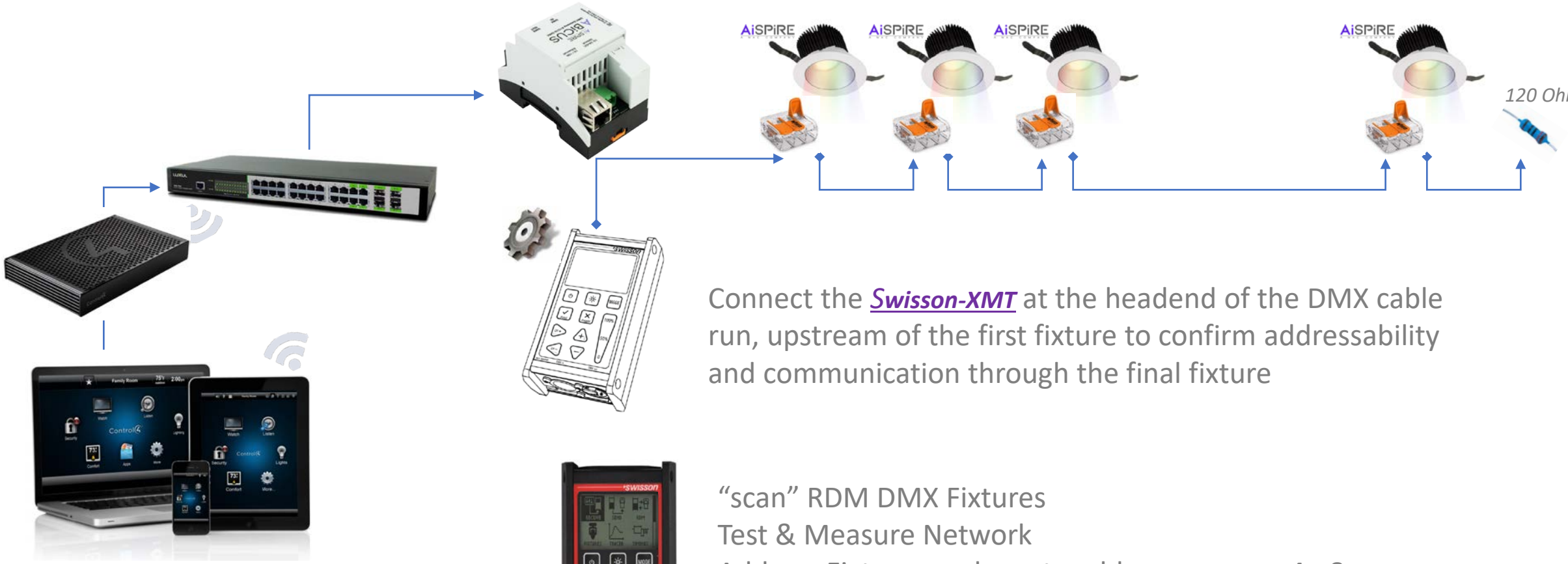
- Connectivity

How do we make it happen

How to validate the topology & Network Continuity

Validate Topology and Network Continuity



Connect the ***Swisson-XMT*** at the headend of the DMX cable run, upstream of the first fixture to confirm addressability and communication through the final fixture

"scan" RDM DMX Fixtures
Test & Measure Network
Address Fixtures and create addresses pages 4 - 8
Troubleshoot & resolve
Windows PC "enabled"

Conclusion

- A defined standard approved by ANSI
- Simple addressing & channel assignment
- Category or Beldon wire
- Multiple fixture types & manufactures can coexist
- Adapted for many connector types

Learn more about AiSPIRE's DMX fixtures & control

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