

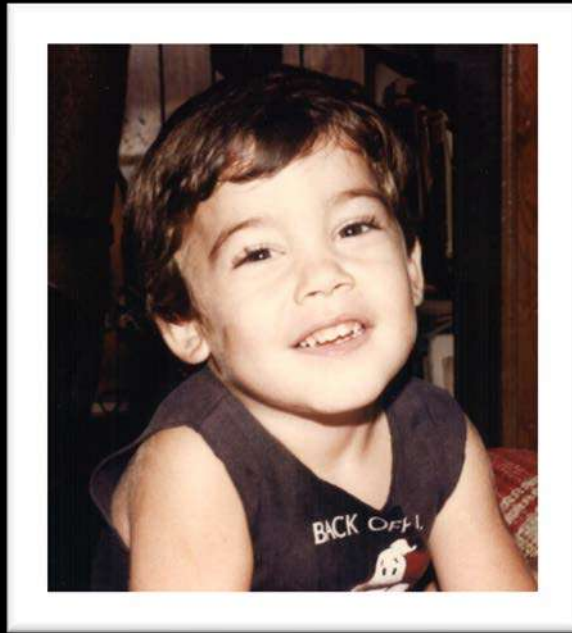
## Designers Lighting Forum

**A Lighting Designer, A Component Engineer, & An Integrator  
walk into a bar...**

**Gonsman & Segal**

August, 2020

## Your Presenters:



Gonsman



Segal

Credit(s) earned on completion of this course will be reported to **AIA CES** for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

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material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

## Learning Objectives

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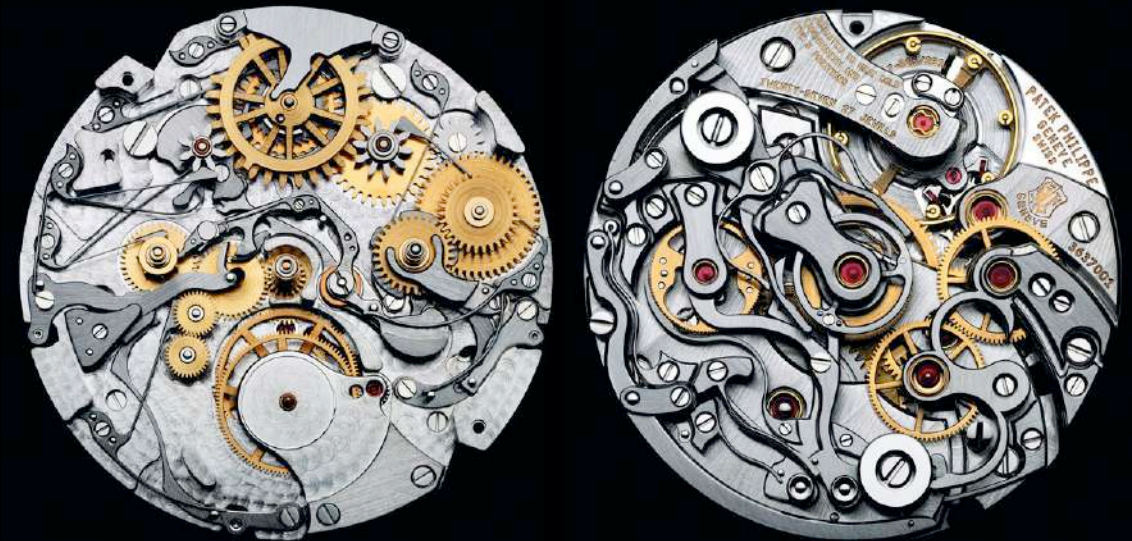
At the end of this course, participants will:

1. Gain a basic understanding of the uses, limits & capabilities of the DMX 512-A control protocol in architectural & commercial applications.
2. Learn about the history of DMX, current best practices & types of DMX lighting control products.
3. Be able to identify when DMX should be used as a control system & how to craft the narrative for the application.
4. Learn how to describe current best practices for installing & implementing DMX.

A LIGHTING DESIGN IS...

A LIGHTING DESIGN IS...

- LIKE A SWISS WATCH



A LIGHTING DESIGN IS...

- LIKE A LAYER CAKE



A LIGHTING DESIGN IS...

- LIKE A PATCHWORK QUILT





A LIGHTING DESIGN IS...

- GREATER THAN THE SUM OF ITS PARTS
  - CONCEPTS
  - DOCUMENTATION
  - SPECIFICATIONS
  - ILLUMINANCE LEVELS
  - OPERATIONAL CHARACTERISTICS  
(control)

- CONTROL IS JUST ONE ASPECT OF THE MULTIPLE PARTS THAT GO INTO THE CREATION AND IMPLEMENTATION OF A SUCCESSFUL DESIGN



- CONTROL IS JUST ONE ASPECT OF THE MULTIPLE PARTS THAT GO INTO THE CREATION AND IMPLEMENTATION OF A SUCCESSFUL DESIGN
- BUT YOU'LL KNOW IF YOU'VE MISSED IT



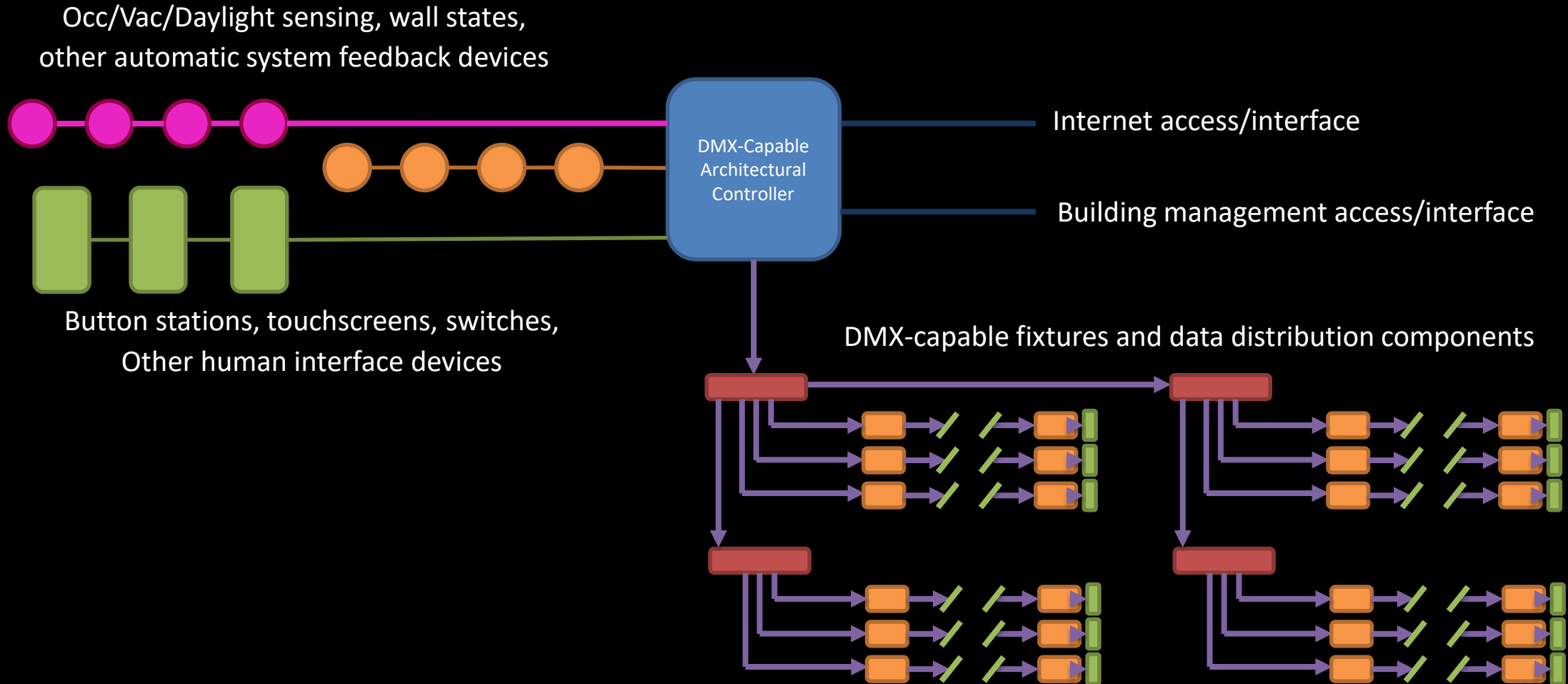
- KNOWING HOW LUMINAIRES WILL COMMUNICATE WITH EACH OTHER AND THE REST OF THE CONTROL SYSTEM IS CRUCIAL

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- AND CONFUSING

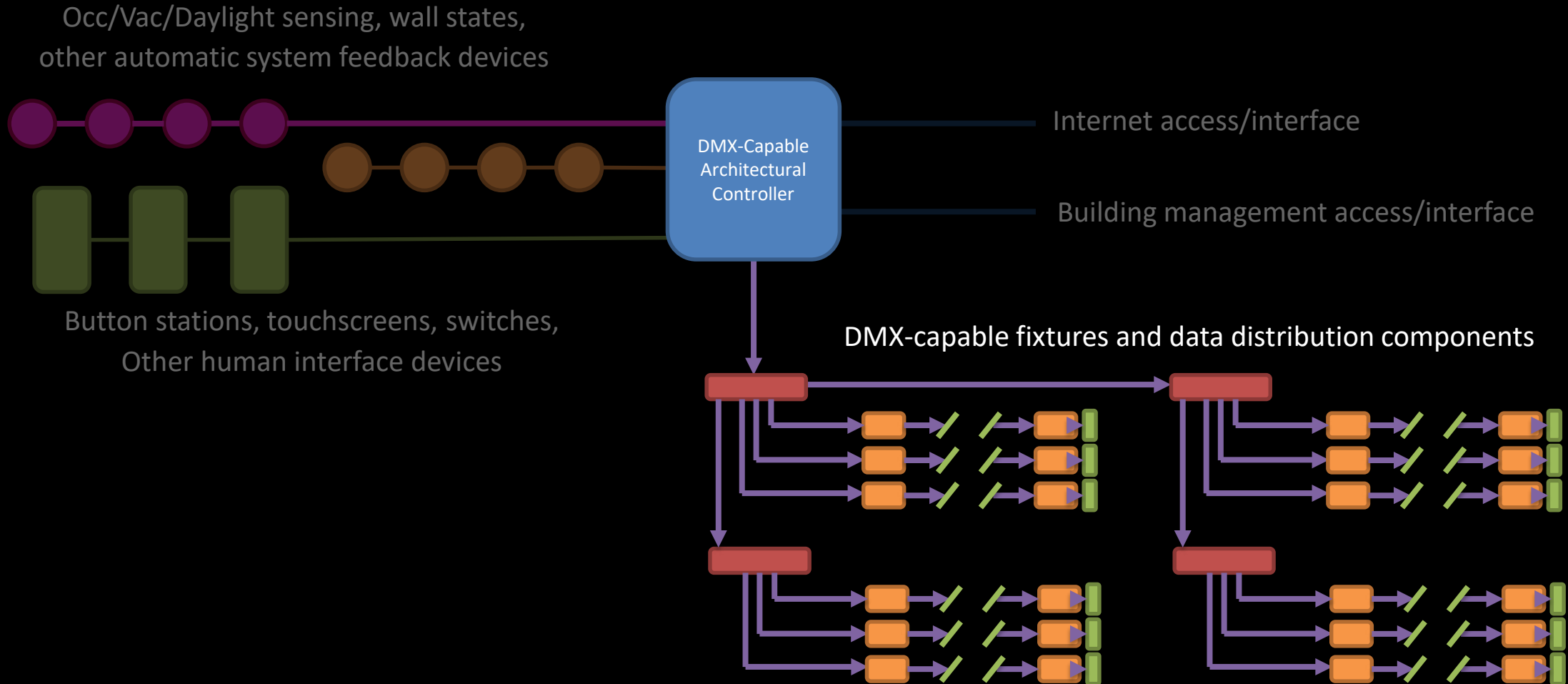


- THERE ARE SEVERAL WAYS FOR LUMINAIRES TO RECEIVE CONTROL INFORMATION

# Full Lighting Control System



# Full Lighting Control System – DMX Portion





## THERE ARE SEVERAL WAYS FOR LUMINAIRES TO RECEIVE CONTROL INFORMATION

- AND ALL OF THEM HAVE STRENGTHS AND WEAKNESSES
- KNOWING AS MUCH AS POSSIBLE ABOUT THE PROTOCOLS YOUR LUMINAIRES & CONTROL COMPONENTS USE IS CRUCIAL

## WE CALL THESE METHODS “CONTROL PROTOCOLS”

- THEY ARE ESSENTIALLY LANGUAGES

TODAY WE'RE GOING TO SPEND  
SOME TIME TALKING ABOUT ONE  
OF THESE LANGUAGES

# Point / Counterpoint



# Why DMX/RDM?

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- Flexibility for field fixes/changes.
- Many controllers have advanced programming capabilities to help with field changes or misbehaving fixtures.



# Why DMX/RDM?



# Point / Counterpoint



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- It was designed to bring interoperability between manufacturers of controllers and receivers (fixtures and dimmers/relays) in the entertainment lighting industry.
- It is gaining more traction in commercial applications, due to its flexibility, ease of deployment, and robustness.

# History of the DMX Standard

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# Component Standards

- Electrical components used for DMX/RDM communication must be compliant with the RS-485 electrical standard: [TIA-485-A](#) or [ANSI/TIA/EIA-485-A-1998](#).

# What's the point?

- Relevant Standards:
  - [ANSI/TIA/EIA-485-A-1998](#): RS-485 Electrical Components
  - [ANSI E1.11-2008 \(R2018\)](#): DMX-512-A Protocol
  - [ANSI E1.20-2010](#): Remote Device Management Protocol

# What's the point?

- Relevant Standards:
  - ANSI/TIA/EIA-485-A-1998: RS-485 Electrical Components
  - ANSI E1.11-2008 (R2018): DMX-512-A Protocol
  - ANSI E1.20-2010: Remote Device Management Protocol
- “The DMX specification calls for interoperability **at both mechanical and communication levels** between controllers and receivers made by different manufacturers”

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**A product is either DMX/RDM compliant, or it is not.**

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As a specifier or purchaser, you are ensured that components will give the performance expected, regardless of manufacturer.

# Point / Counterpoint



# The Rules of DMX

- In this section, we will cover how to lay out a successful DMX data distribution system
- POWER:
  - For the sake of this presentation, we will assume that all devices are receiving the uninterrupted power they need to function – we will only discuss the data distribution rules.
  - There are, of course, some best practices for power zoning as it relates to data distribution – if you have aching questions about that, we can cover it in Q&A.

# The Rules of DMX

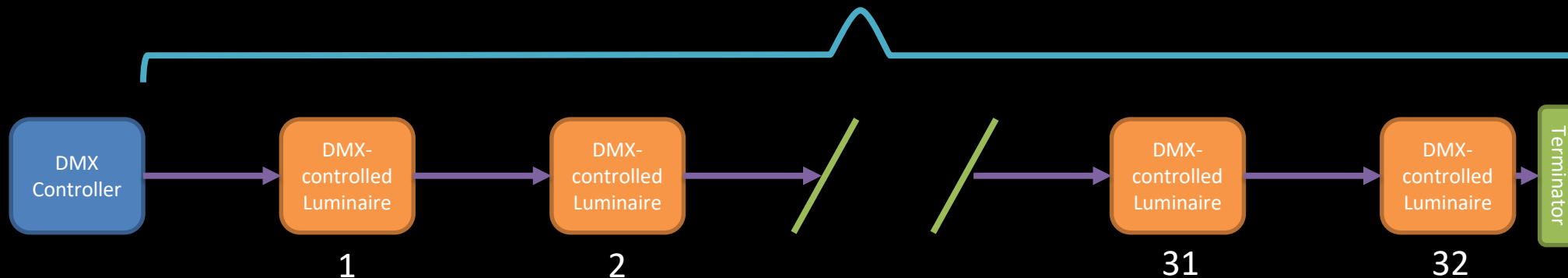
## Five Simple Rules:

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*Let's break the rules*

(or at least know how to bend them)

# The Rules of DMX

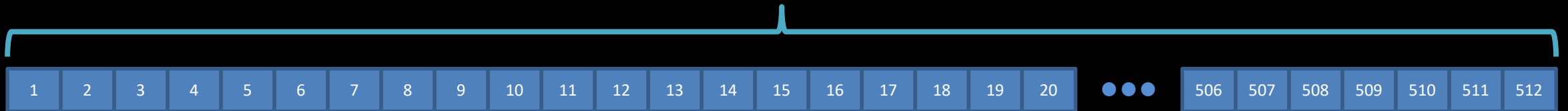
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# DMX Universe

Each DMX data cable can carry 512 unique control addresses, which is referred to as a **Universe** of DMX.

512 unique control addresses on one DMX cable





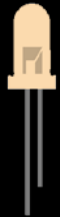
# DMX Footprint

DMX fixtures use a control address for each controllable property it has.

- Each controllable property is called a **Parameter**.
- The amount of DMX addresses a fixture needs to be controlled is its **DMX Footprint**.

# DMX Footprint

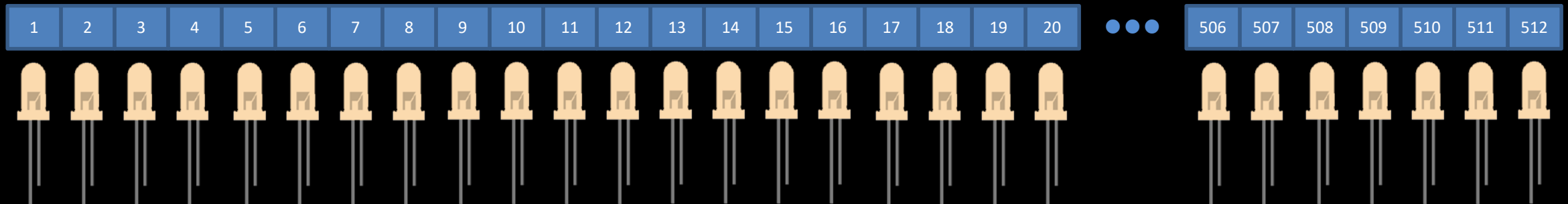
A standard fixture has a DMX footprint of 1 – you can only control intensity.



# DMX Footprint

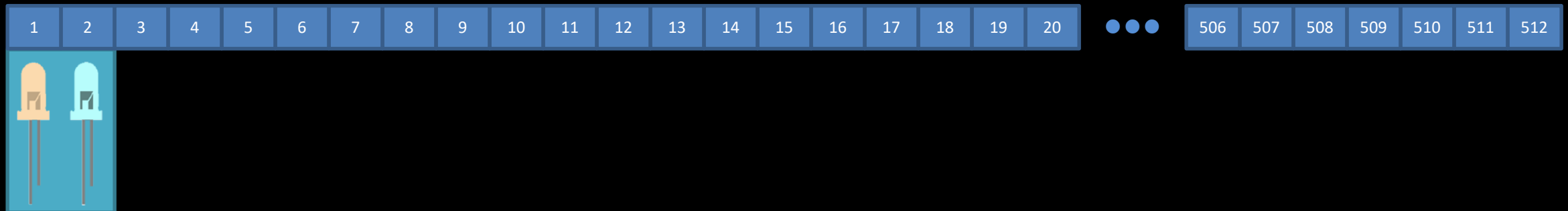
A standard fixture has a DMX footprint of 1 – you can only control intensity.

- 512 possible dimmers/fixtures.



# DMX Footprint

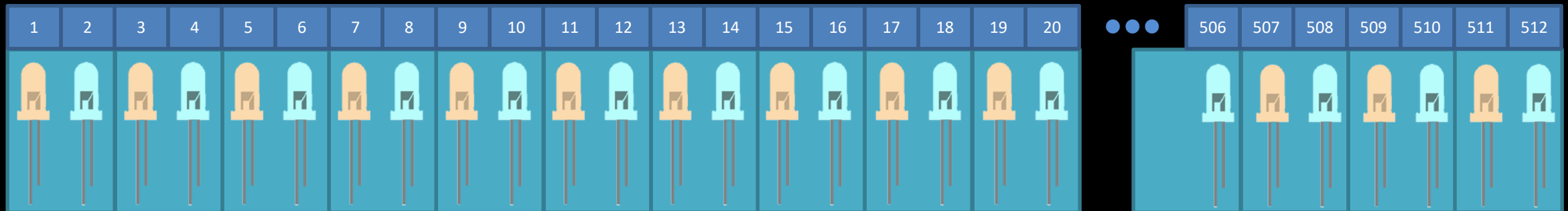
A tunable white fixture has a warm emitter, and a cool emitter – giving it a DMX footprint of two.



# DMX Footprint

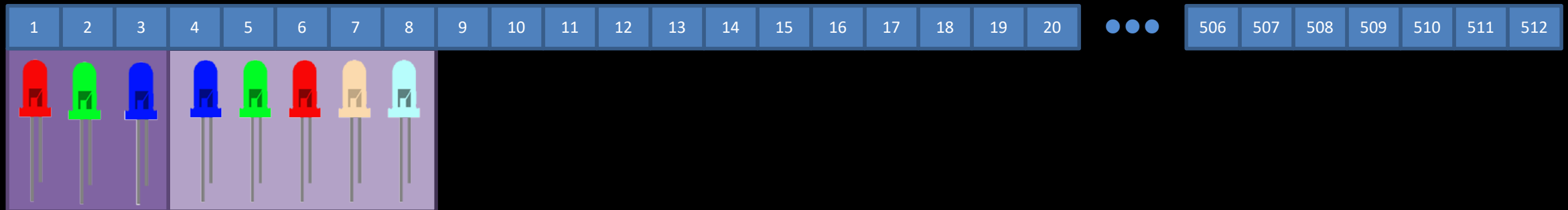
A tunable white fixture has a warm emitter, and a cool emitter – giving it a DMX footprint of two.

- 256 possible fixtures.



# DMX Footprint

A color changing fixture has many colors – each needs a control address.



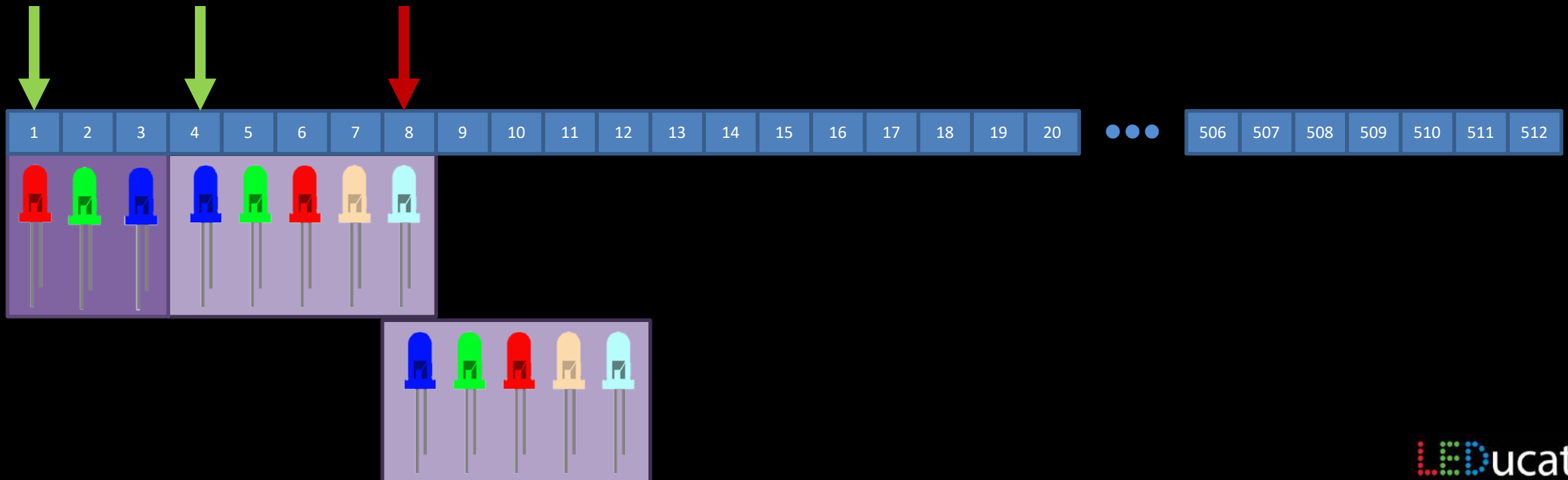
# DMX Start Address

Because we know the DMX footprint, we only need to document each fixtures' start address.



# DMX Start Address

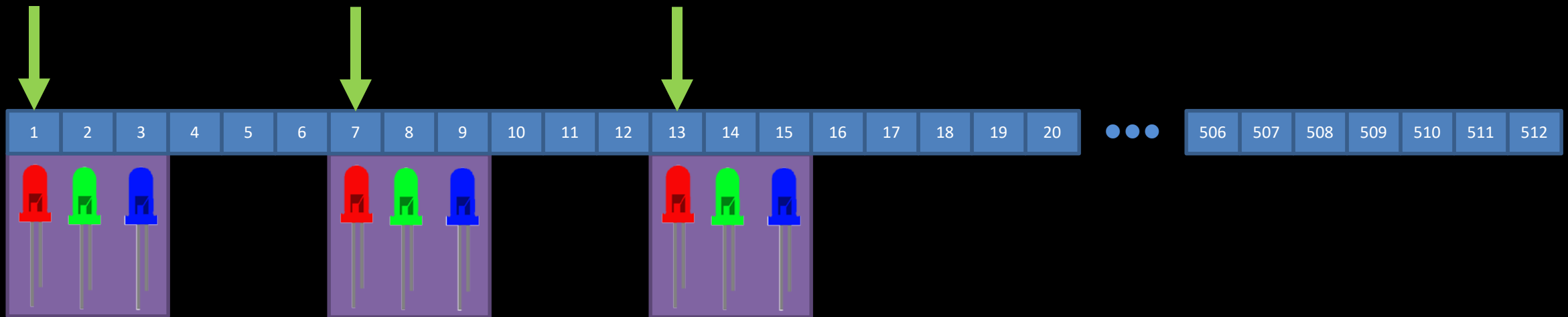
Beware of overlapping addresses – both fixtures will respond, and you will get undesired results.





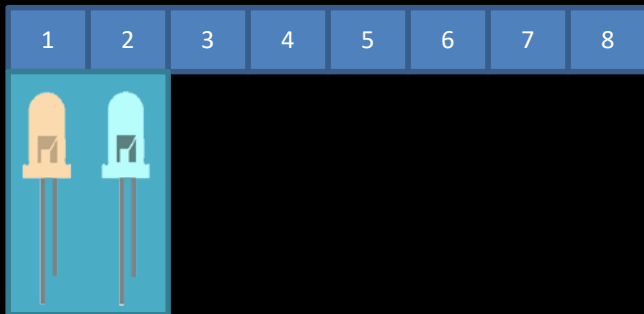
# DMX Start Address

Gaps in DMX addressing is acceptable, either for precaution (you may not know the footprint) or for logical reasons (all fixtures start at 1, 11, 21, etc.).



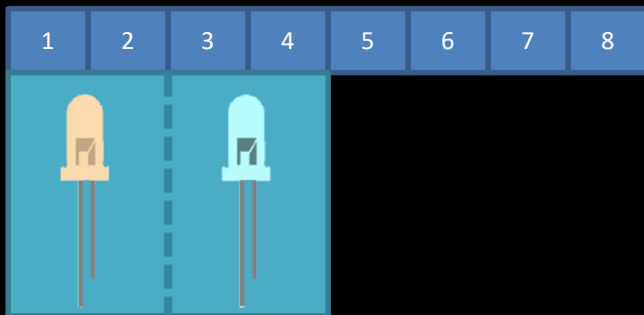
# 16-Bit Dimming

- A DMX address is 8-bit, meaning it has 256 steps of granularity.



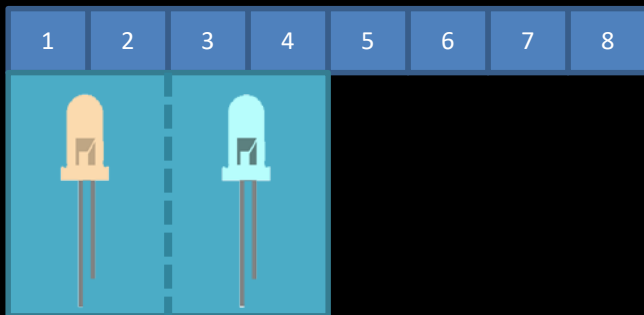
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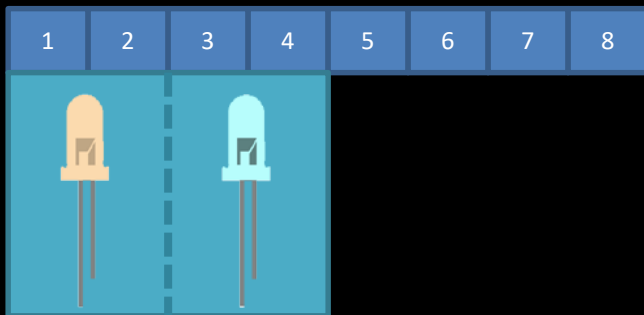
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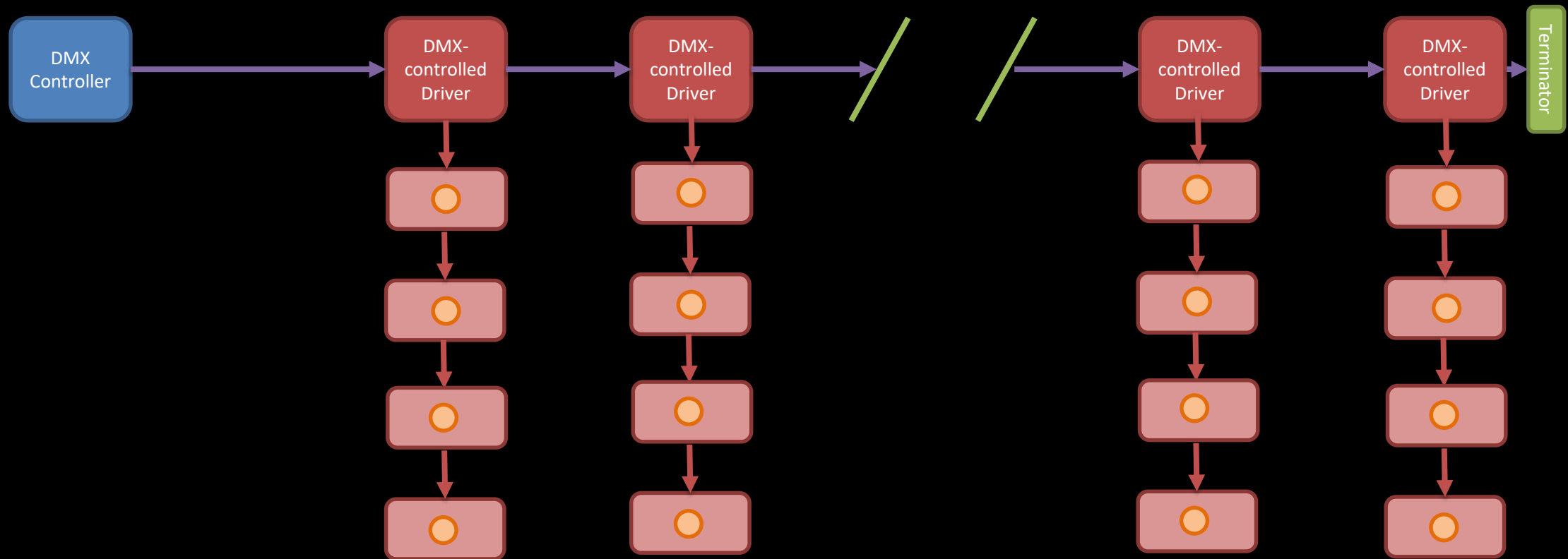
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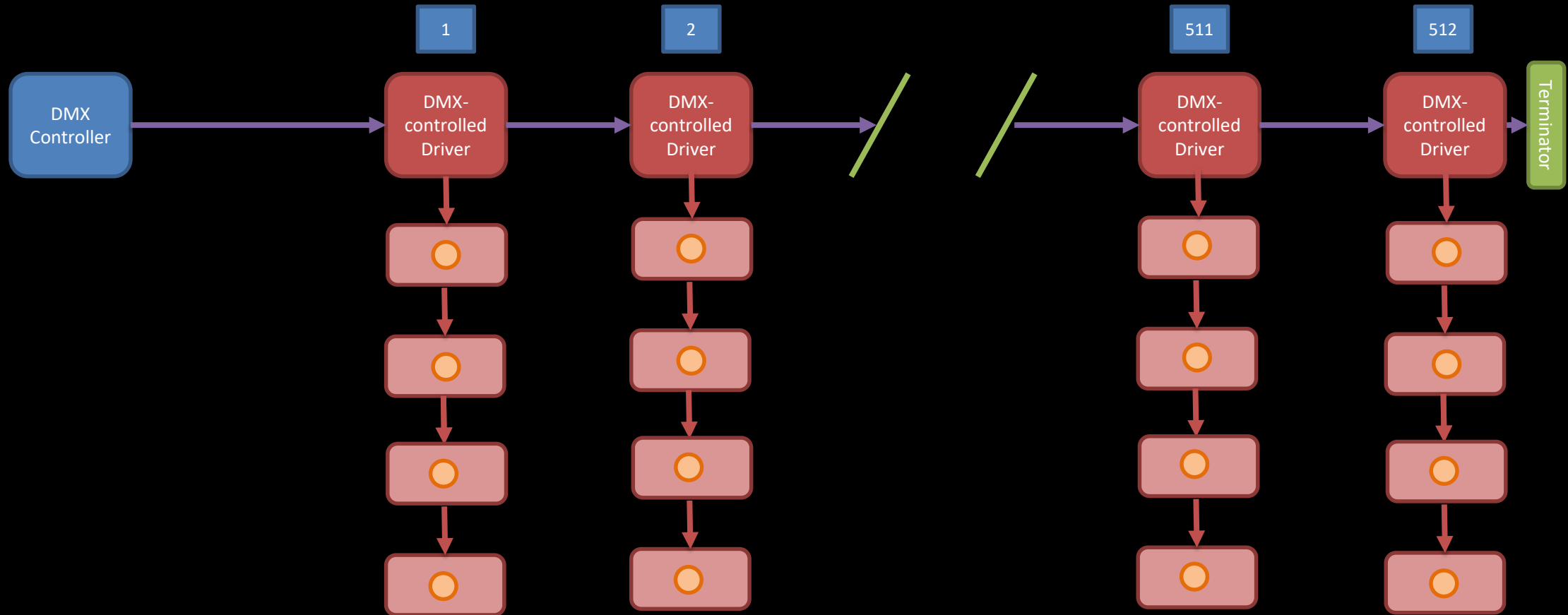


- Buyer beware: more steps doesn't automatically mean better dimming.

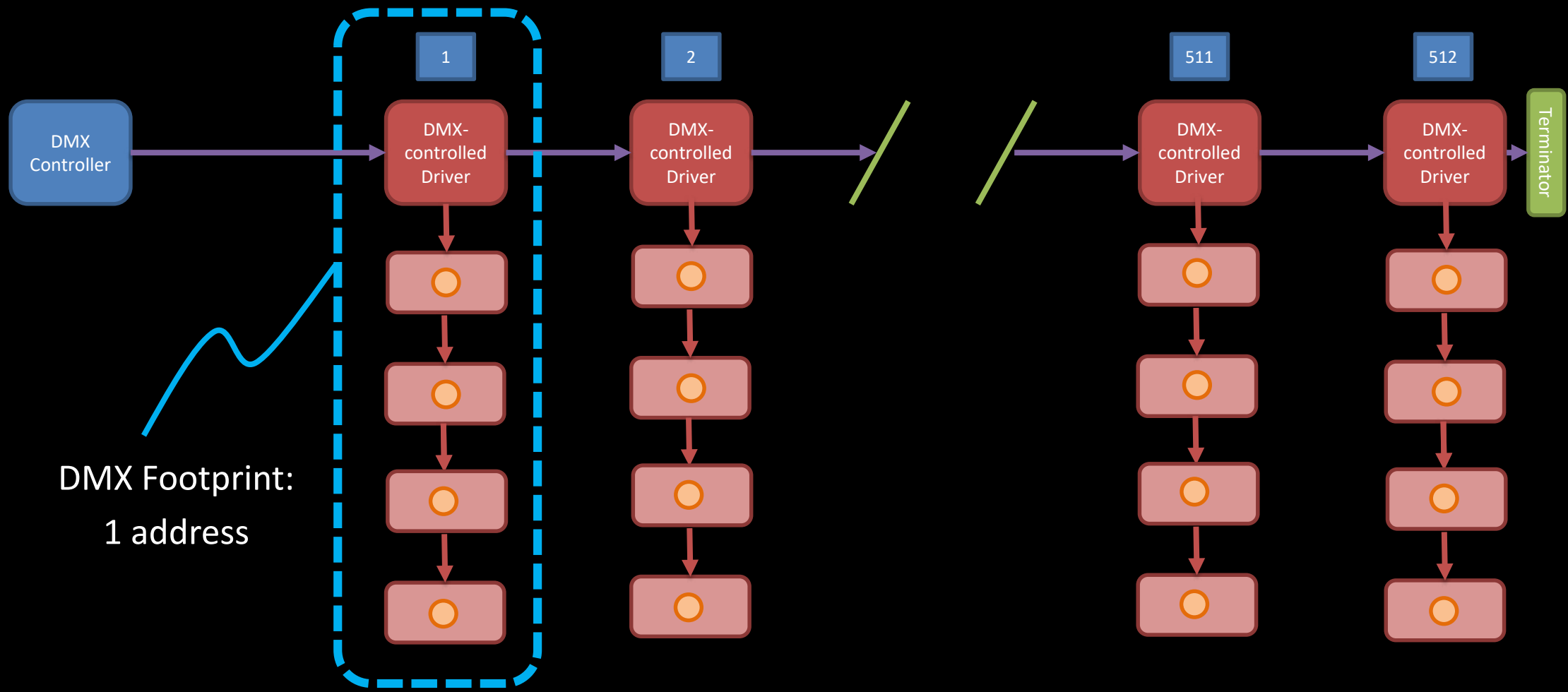
# Drivers with Multiple Fixtures – Combined Control



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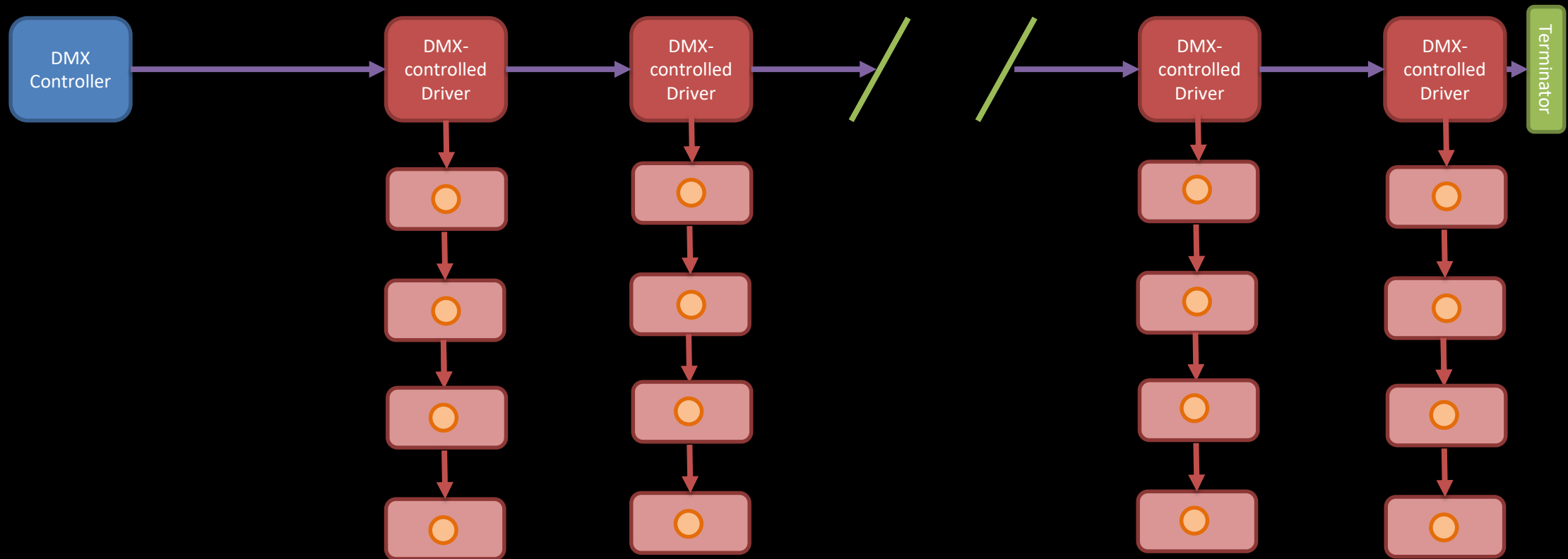


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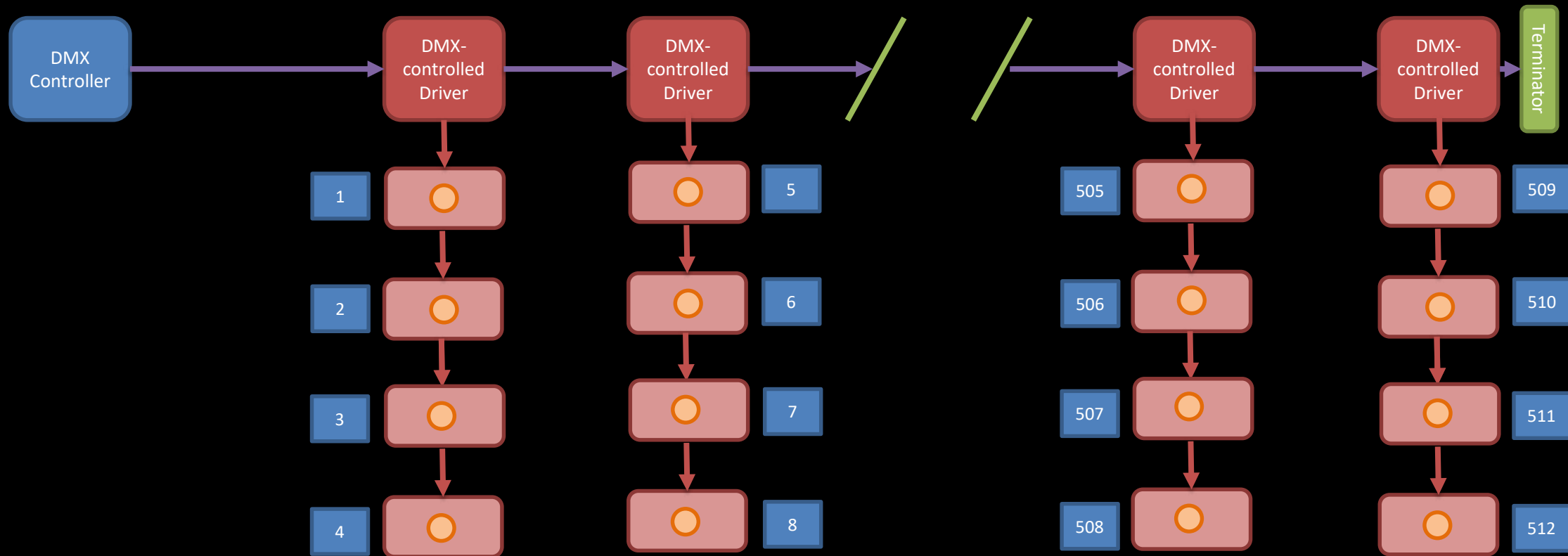




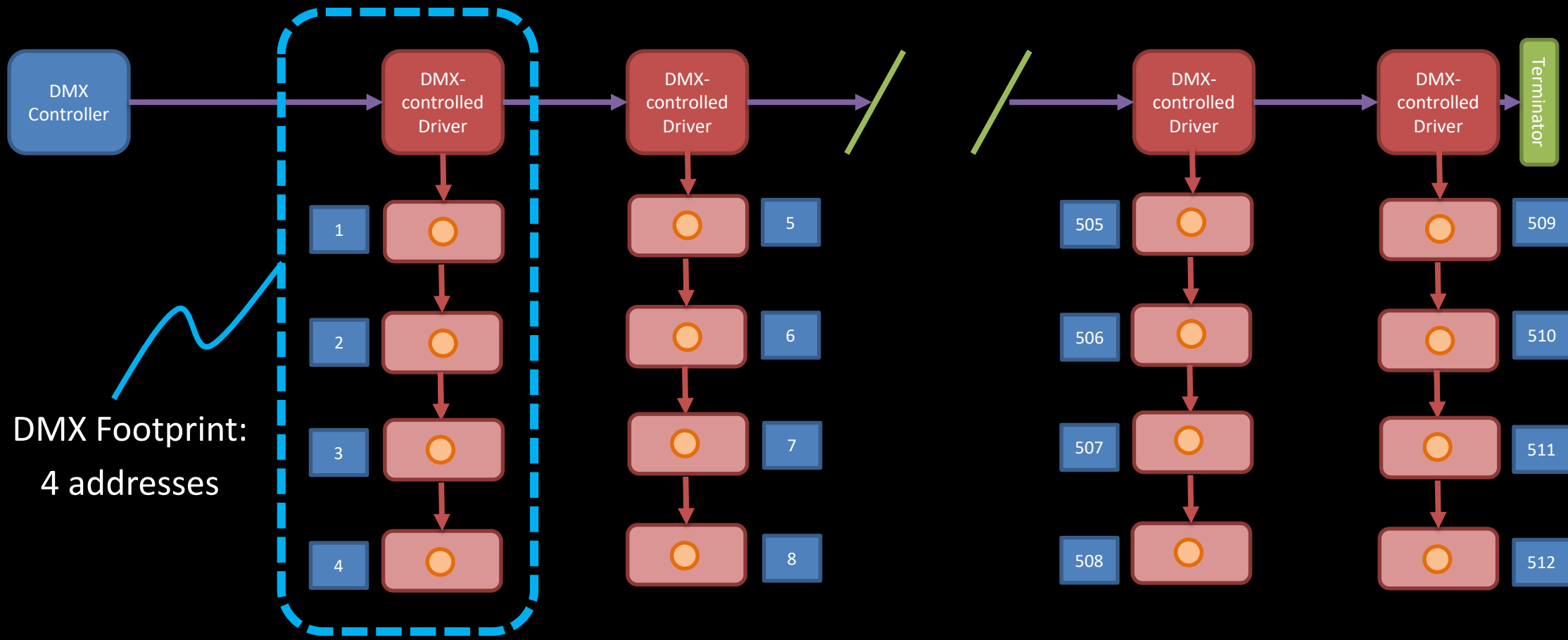
# Drivers with Multiple Fixtures – Discrete Control



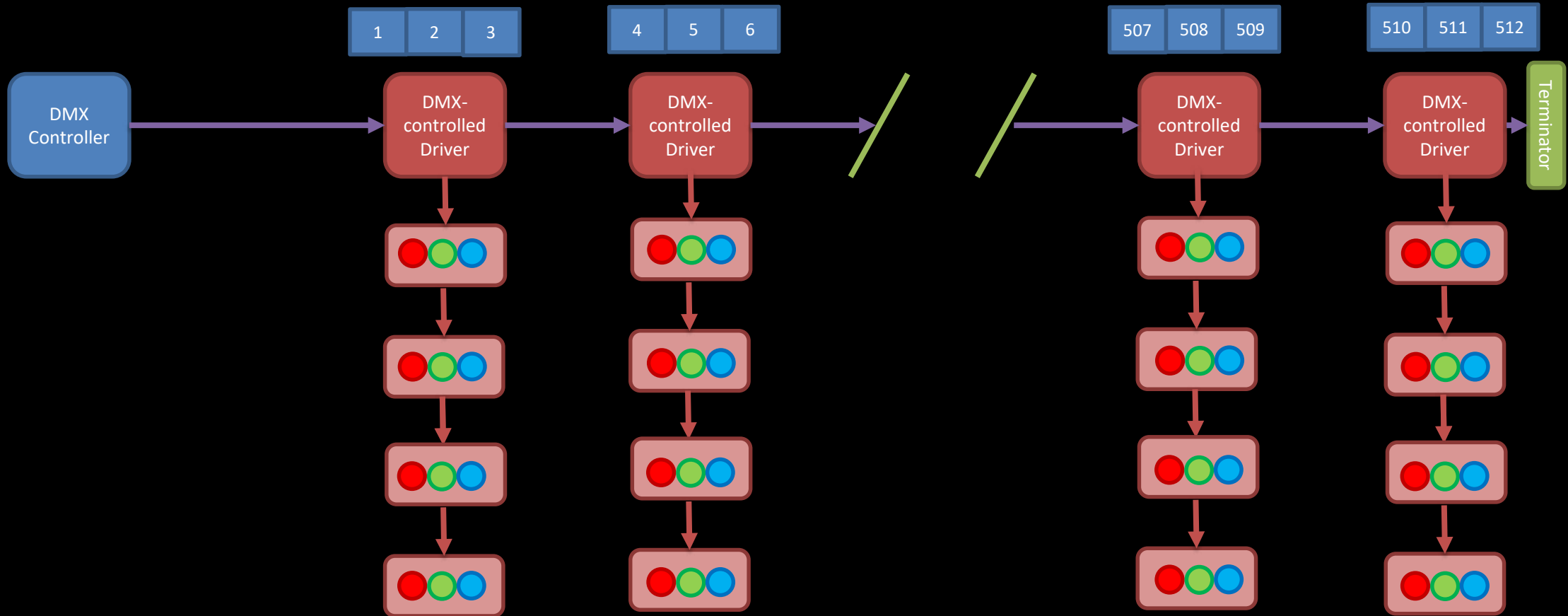
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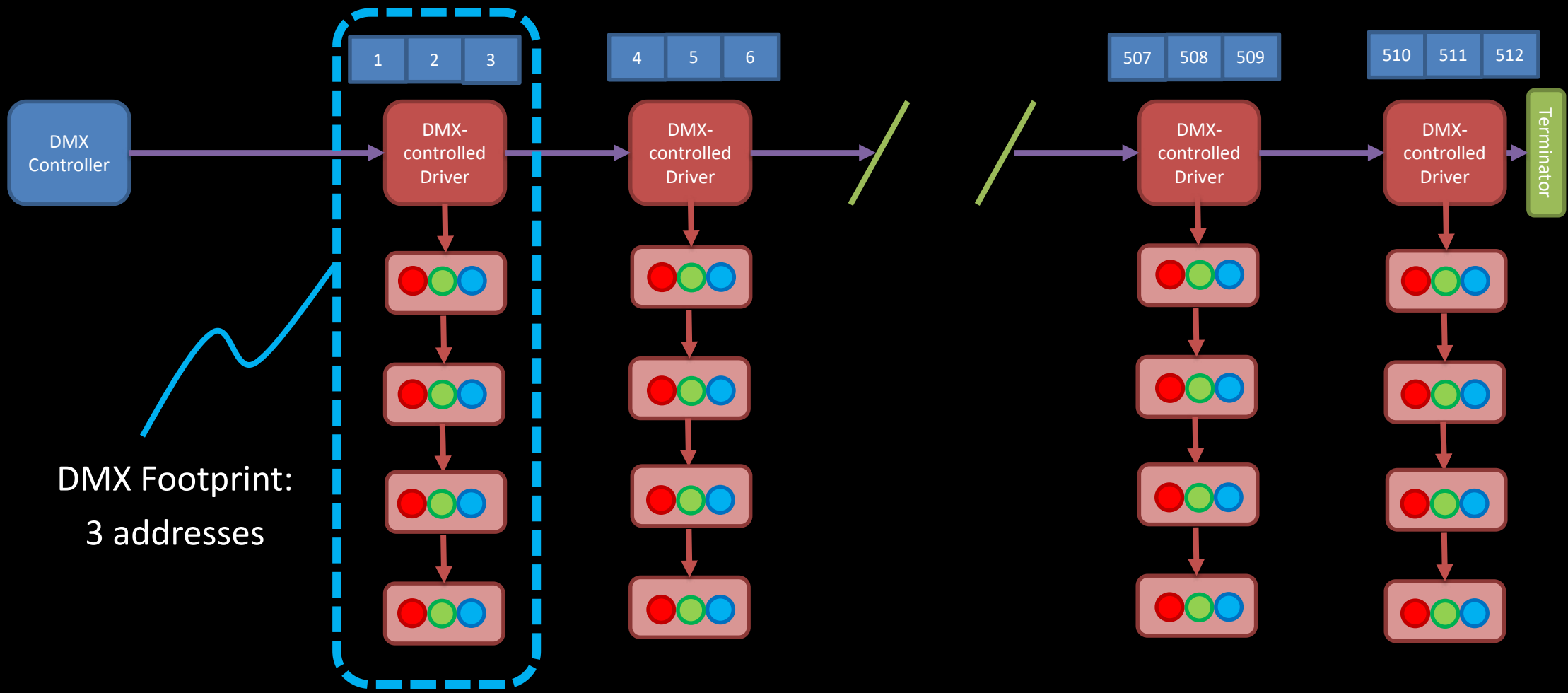
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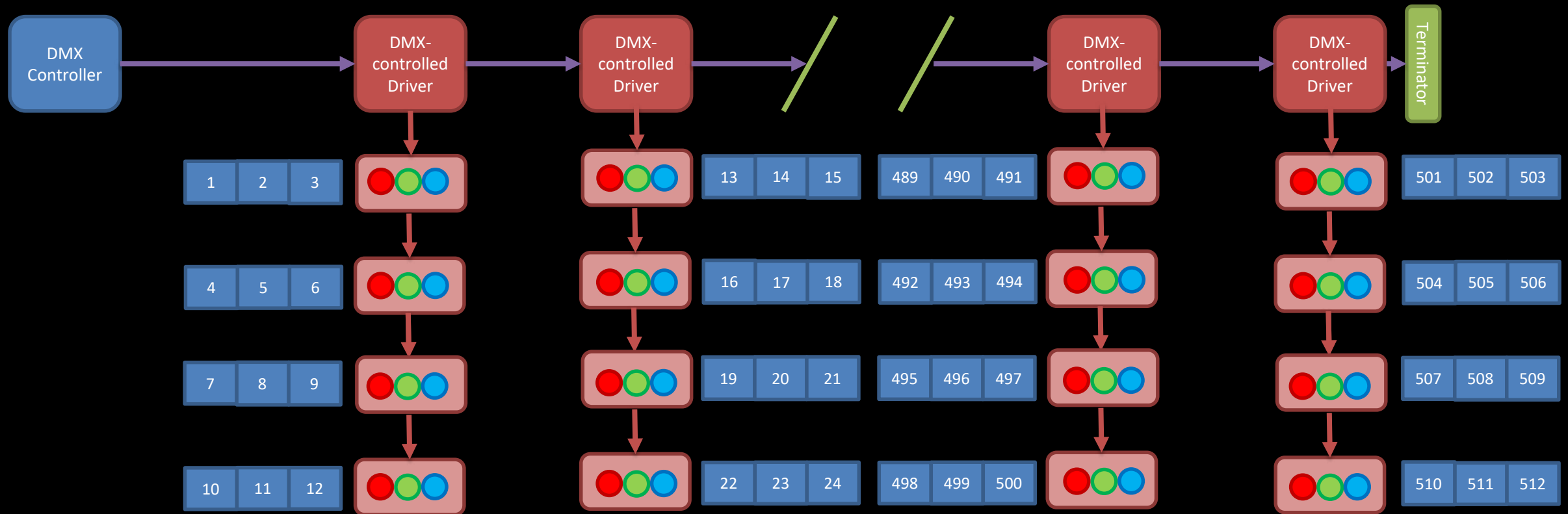
# Drivers with Color Changing Fixtures - Combined



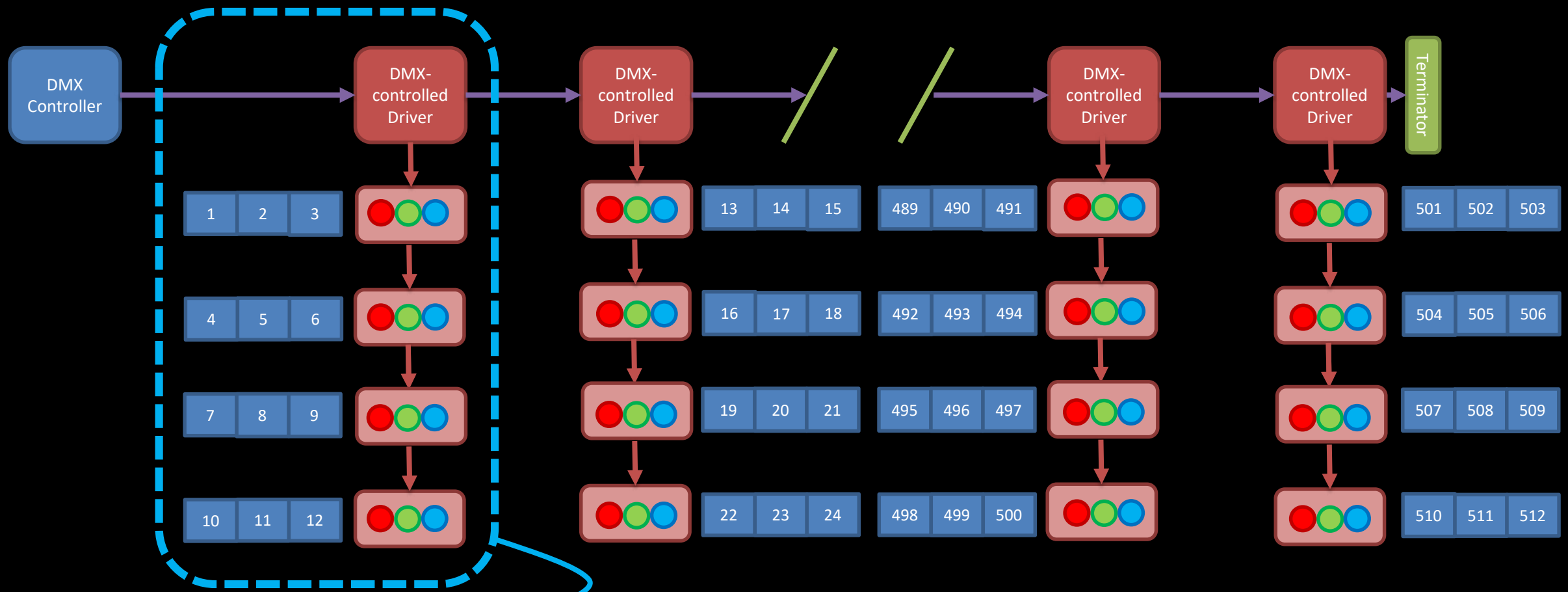
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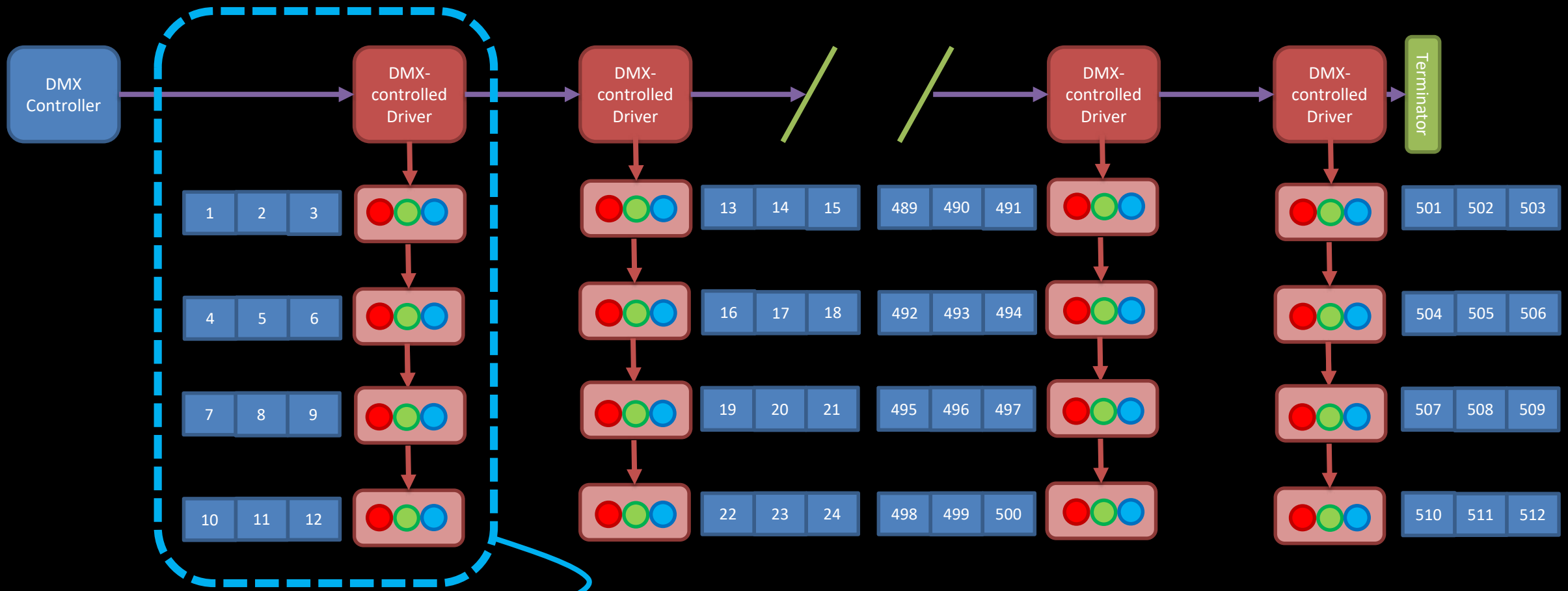


# Drivers with Color Changing Fixtures - Discrete



DMX Footprint:  
12 addresses

# Drivers with Color Changing Fixtures - Discrete



DMX Footprint:  
12 addresses

Only 42 Drivers on a universe,  
before the count exceeds 512



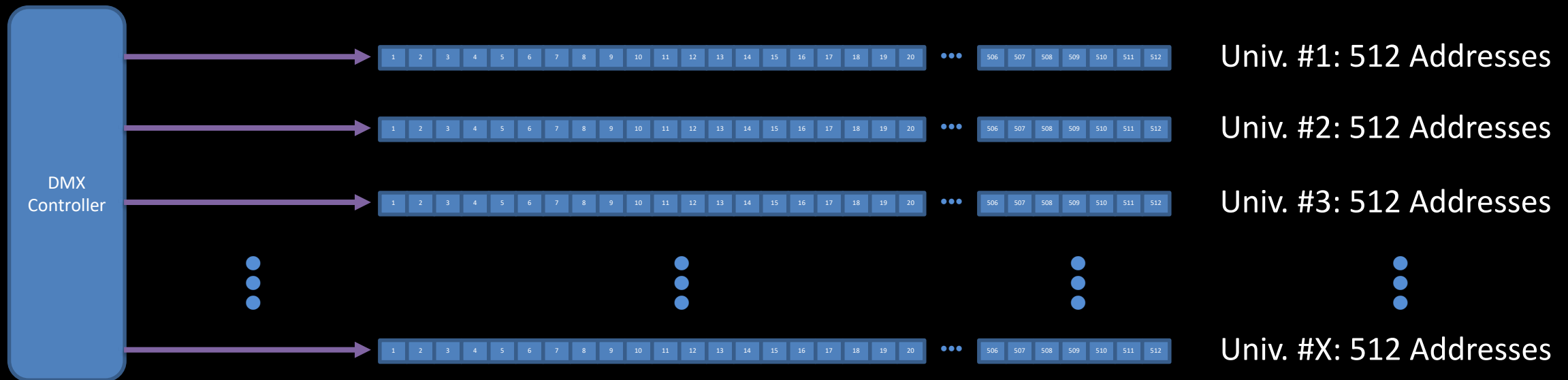
# Exceeding 512 Addresses

- Many, many projects exceed 512 addresses, and that is ok! You just need more universes!



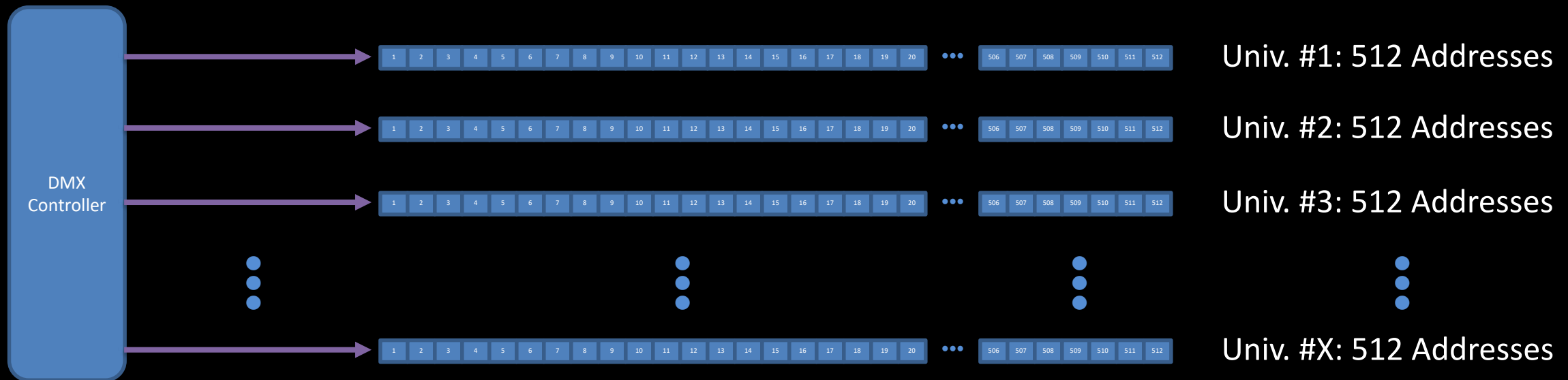
# Exceeding 512 Addresses

Use a Controller with the capability to output the Universe count you need



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- You don't need to fill every address, Universes can be organizational.

# Point / Counterpoint



# The Rules of DMX

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- A data line cannot exceed 500m (1640 ft).
- All data lines must be terminated at/after the last fixture.

# Data Cable Must Be DMX Compliant

- The DMX specification calls for Shielded Twisted Pair (STP) cable:
  - “120 ohm 1- or 2-twisted pair shielded cable suitable for use with EIA-485 (120 ohm) electronics”
  - The shielding prevents electromagnetic interference with the digital signal
  - A common cable specified is Belden 9729
- The DMX specification calls for 5-pin XLR connectors

Ruggedized, but expensive – designed for repeated coupling and decoupling.



# Data Cable Must Be DMX Compliant

- In 2000, ESTA researched and approved DMX over Category cable, with RJ45 terminations.
- Shielding is still required
  - STP Category cable (Cat5 or better)
  - UTP Category cable in conduit



# Data Cable Must Be DMX Compliant

## DMX-over-CatX considerations:

- Color of cable & patch points
  - DMX is not Ethernet, and components can be damaged by things like PoE. Having a specific jacket color with matching patch points will allow easier identification of DMX-over-CatX lines.
- Category cable types and terminations
  - You should ensure your Category cable choice is clear in documentation, and is what is installed. Different Category cables have different gauges of wire – if (for example) Cat5 is on the drawings and Cat6 is pulled, the termination kits the installer ordered may not fit, resulting in delays and additional cost.



# Daisy-Chain Topology

Daisy-chaining only (DMX fixtures typically have in & out ports)

- no stars, no spurs, no splices, no wire nuts



# Point / Counterpoint

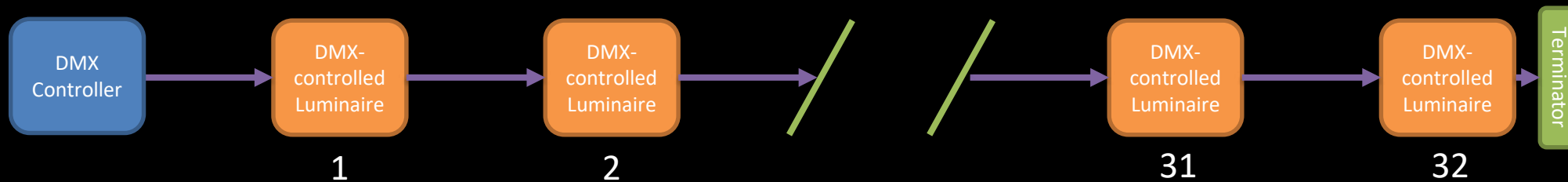


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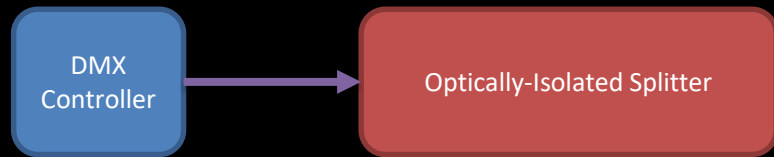
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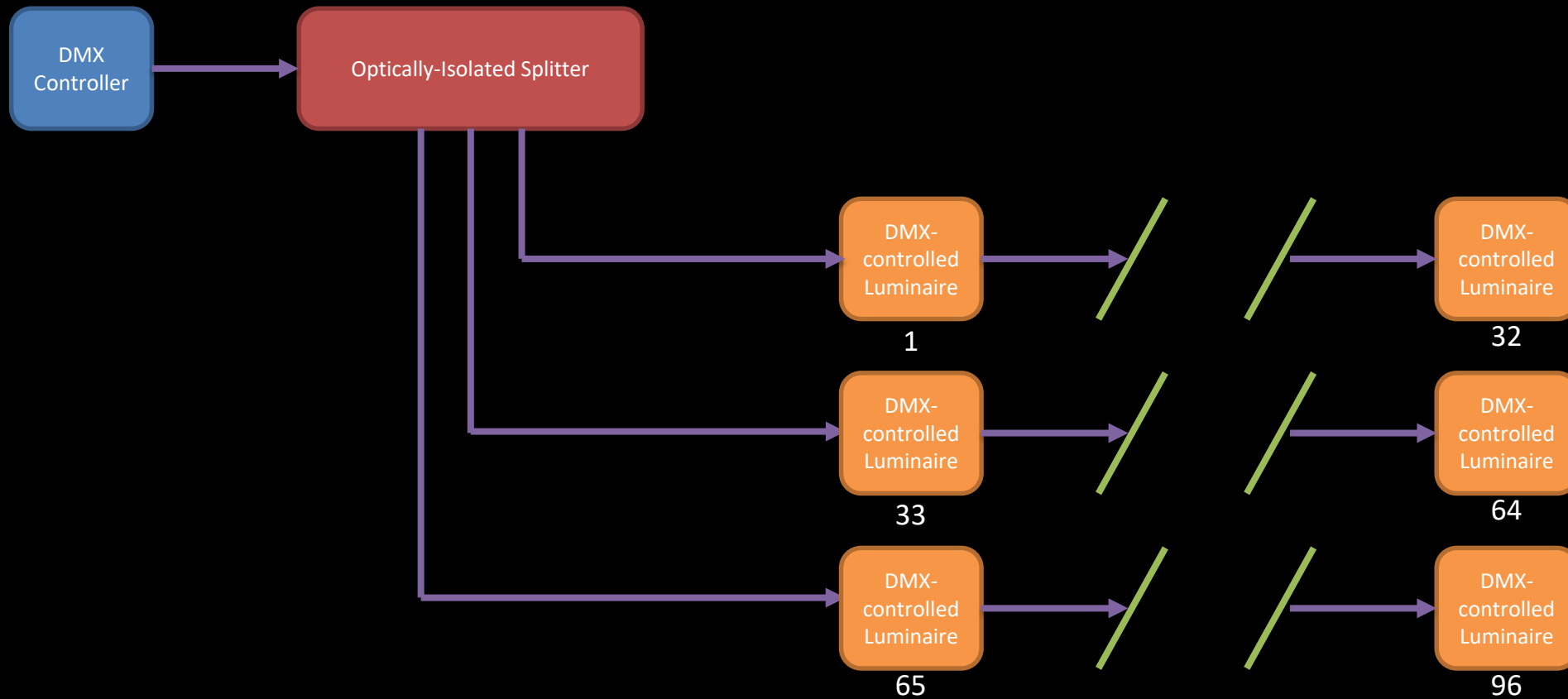
# 32 Fixtures can be connected to a Data Line



# Opto-Iso Splitters/Repeaters



# Opto-Iso Splitters/Repeaters

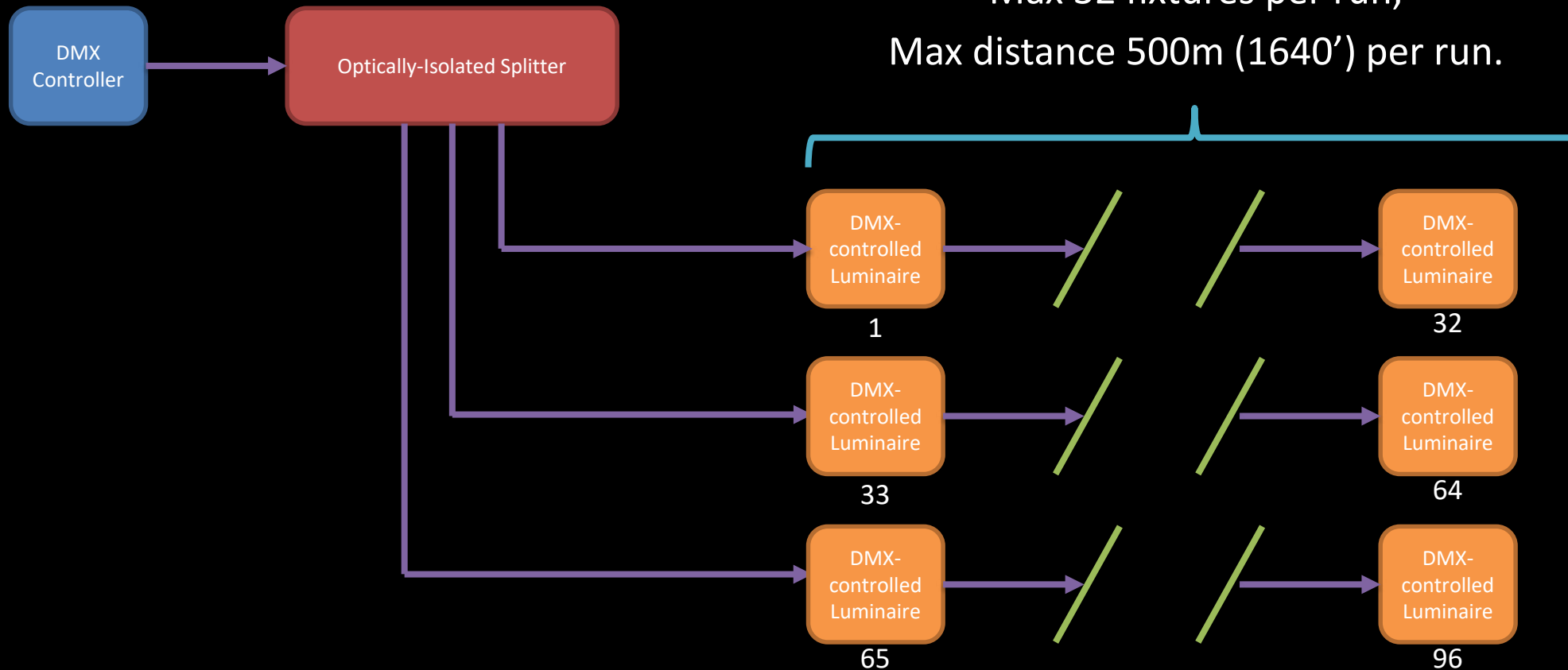


# Opto-Iso Splitters/Repeaters

All share 512 addresses.

Max 32 fixtures per run,

Max distance 500m (1640') per run.

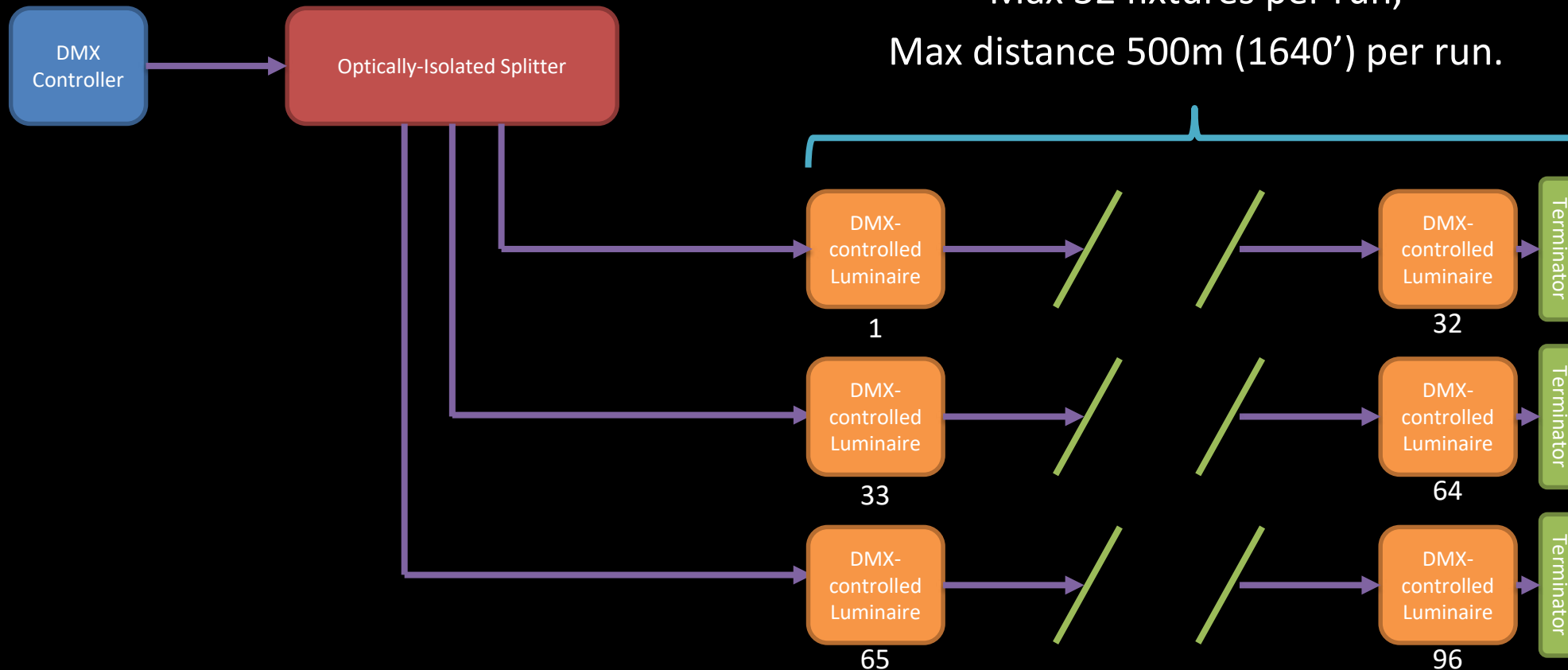


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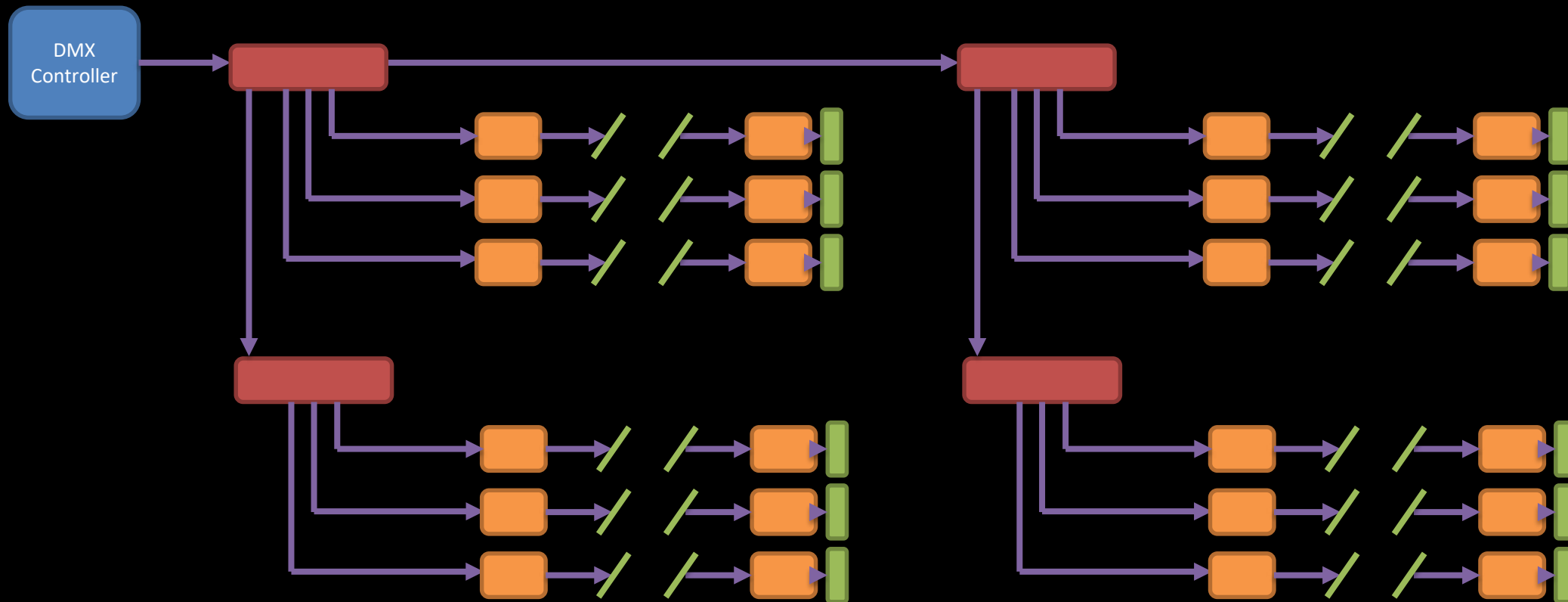
Max 32 fixtures per run,

Max distance 500m (1640') per run.





# Opto-Iso Splitters/Repeaters – Scaling Up



# Point / Counterpoint



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# Data Line Maximum Distance

Sometimes you need to exceed the 500m (1640 ft) distance allowed by DMX.

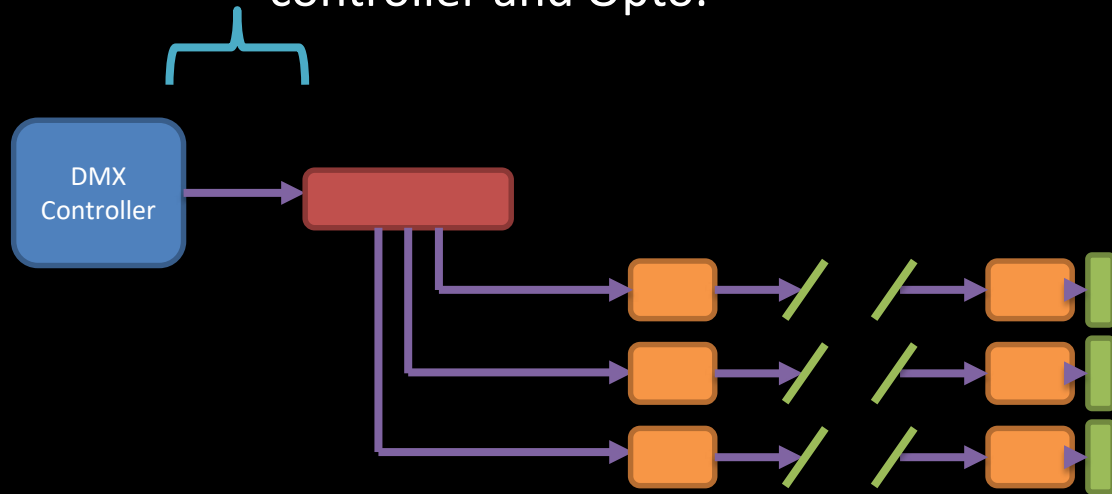
# Data Line Maximum Distance

Sometimes you need to exceed the 500m (1640 ft) distance allowed by DMX.

- Remember our friend, the Opto-Iso splitter/repeater?
  - Because it regenerates the DMX signal, you get 500m from each output.

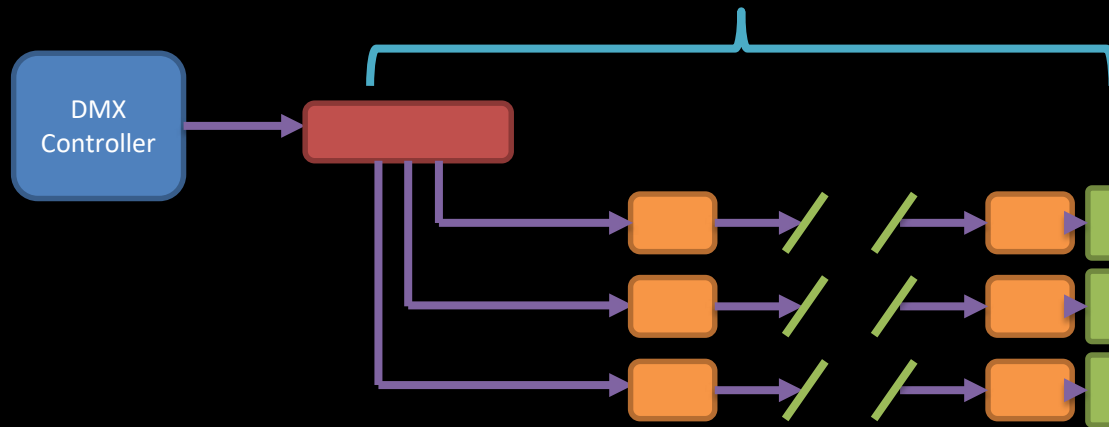
# Data Line Maximum Distance

Max distance 500m (1640') between controller and Opto.



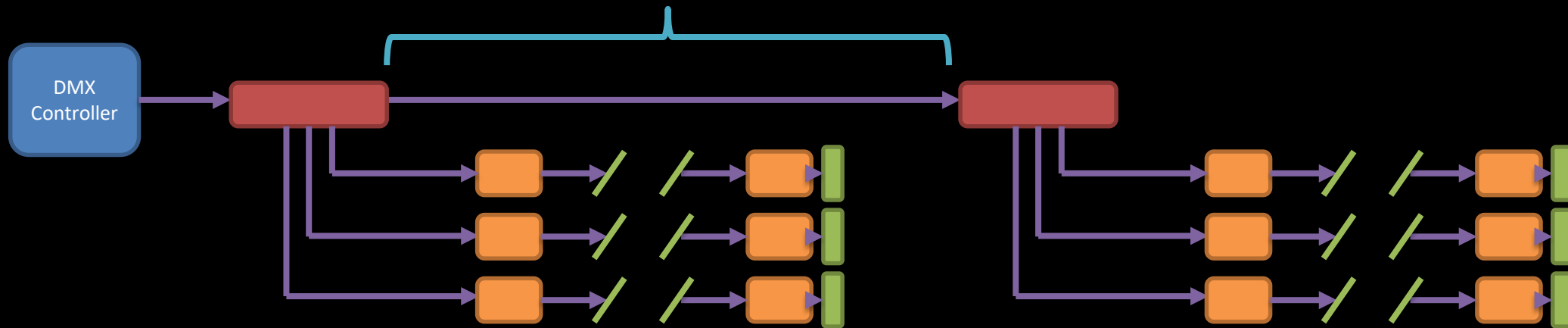
# Data Line Maximum Distance

Max distance 500m (1640') between  
Opto and the terminator on each data line.



# Data Line Maximum Distance

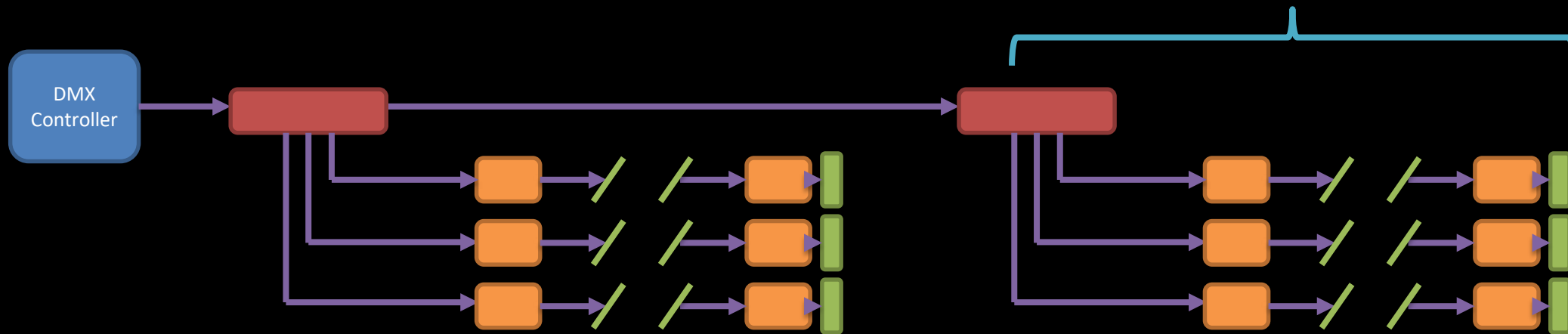
Max distance 500m (1640') between Opto output and the input of another Opto.





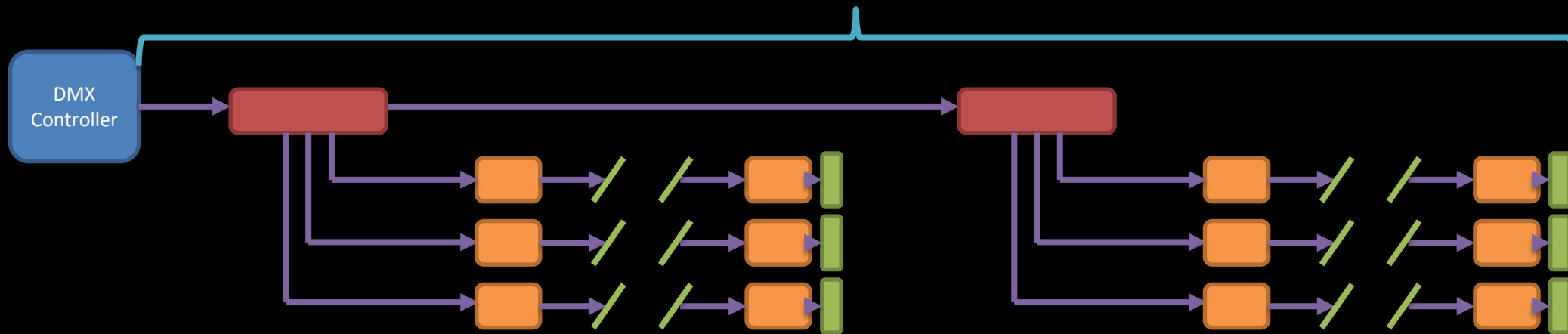
# Data Line Maximum Distance

Each Opto output can now go another 500m (1640') before needing to be terminated.



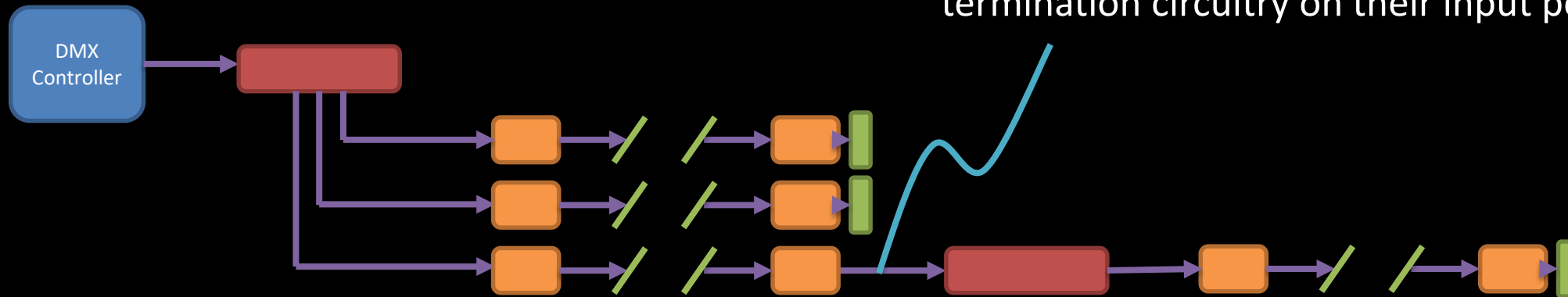
# Data Line Maximum Distance

With just two Optos, we are already looking at 1500m  
(4920' – almost a mile) between the controller and the furthest fixture.



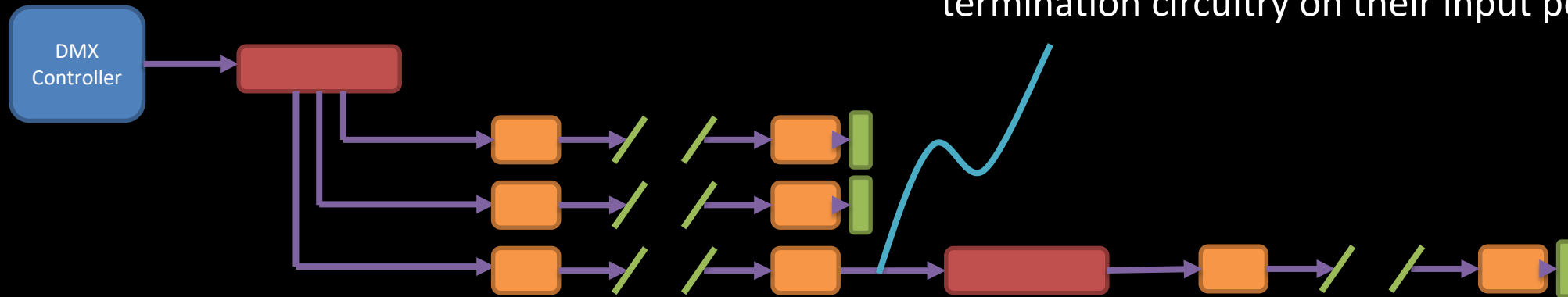
# Data Line Maximum Distance

Extend a data line linearly by adding an Opto inline to regenerate the DMX signal. No terminator is needed on the first data line because most Optos have termination circuitry on their input port.



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BONUS: In a linear approach like this, DMX is much better suited for long-distance instantaneous changes versus TCP/IP networking – for things like lit boulevards, themed environments, building facades, etc. We can discuss in Q&A if that is of interest.

# Point / Counterpoint



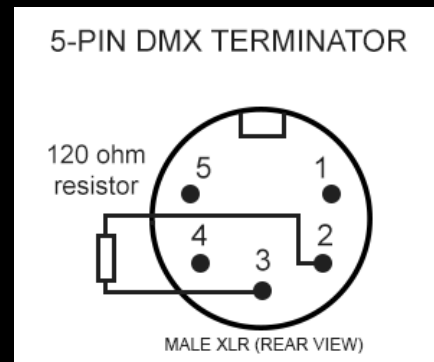
# The Rules of DMX

## Five Simple Rules:

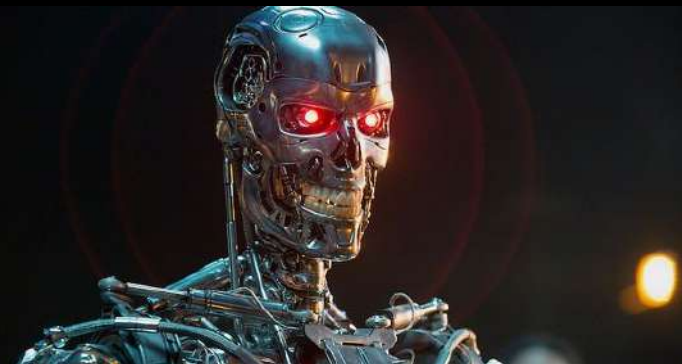
- Fixtures cannot exceed the use of 512 individual control addresses.
- Data cable must be DMX compliant, and daisy-chained between devices.
- 32 fixtures can be connected to a single data line.
- A data line cannot exceed 500m (1640 ft).
- All data lines must be terminated at/after the last fixture.

# Terminators

- DMX is a digital circuit. Because of the daisy-chain nature of the data bus, the end of the circuit needs to be closed by a 120-ohm resistor.
- Lack of a terminator can cause data loss and reflection issues, and can cause lights to flicker or not respond. RDM will not function.
- Every data line needs to be terminated.



This terminator....



...not this one.

*...one more rule*

(if you intend to utilize RDM)



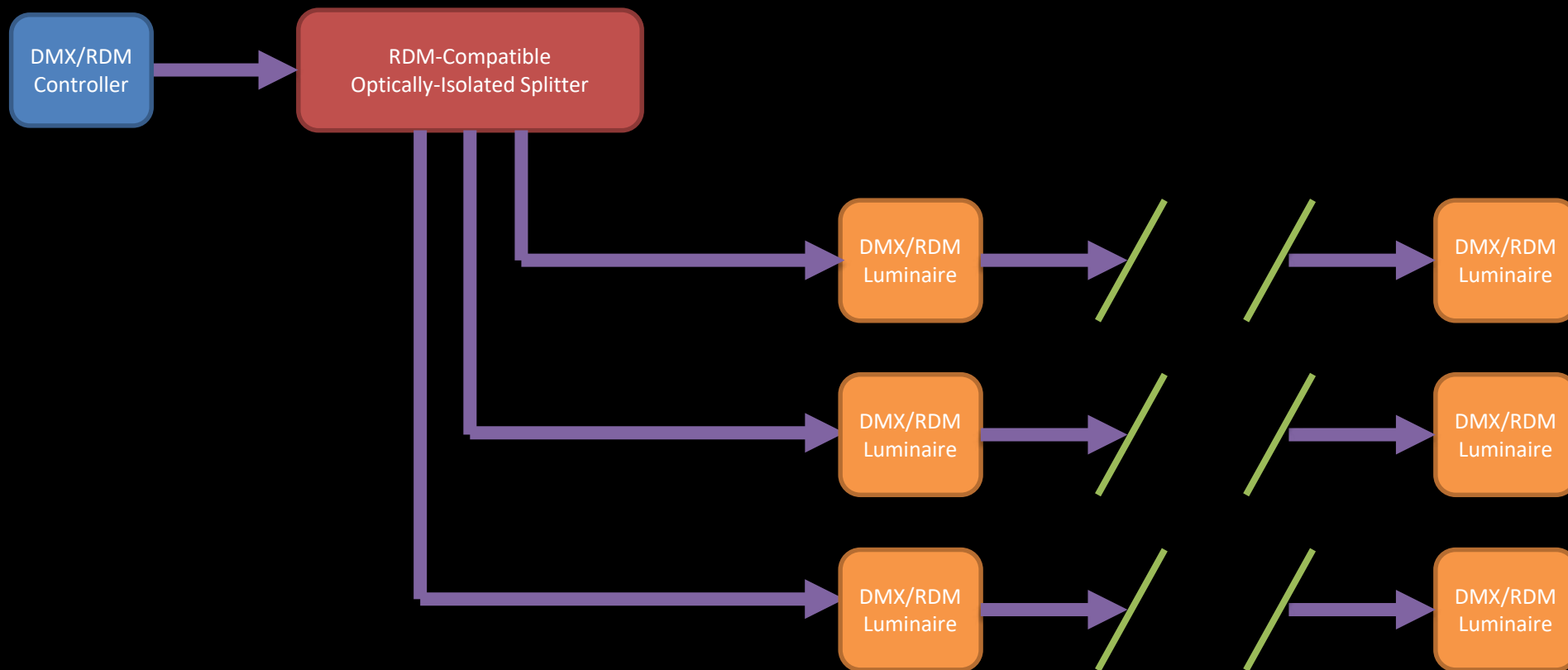
# Specifying for RDM on a DMX System

RDM is very useful for commissioning, but also for health reporting from the fixtures.

- **ALL** components must be RDM-capable, because RDM is bi-directional – DMX is not.

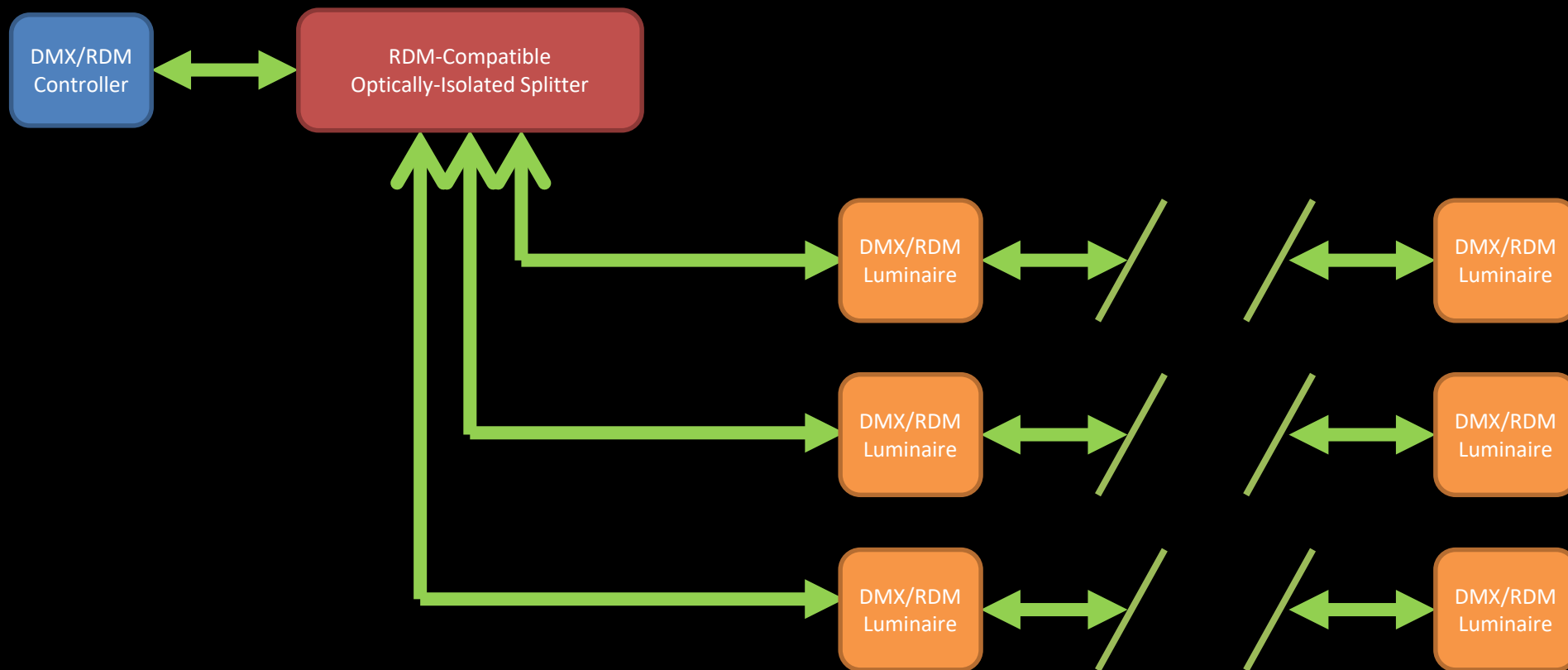
# Specifying for RDM on a DMX System

DMX is uni-directional – components don't need circuitry to feed data back to the controller



# Specifying for RDM on a DMX System

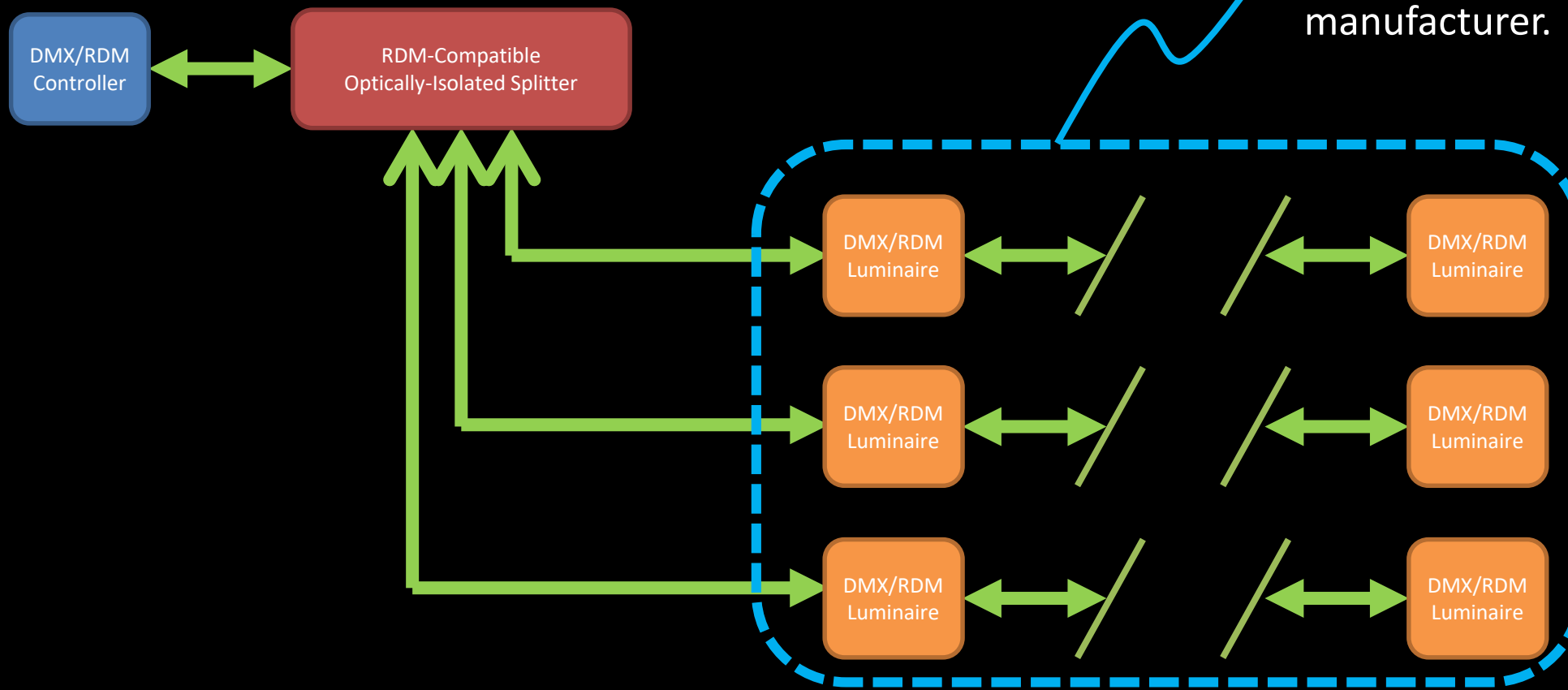
RDM is bi-directional – components need to be DMX/RDM compatible to process RDM messages



# Specifying for RDM on a DMX System

If you expect RDM to function:

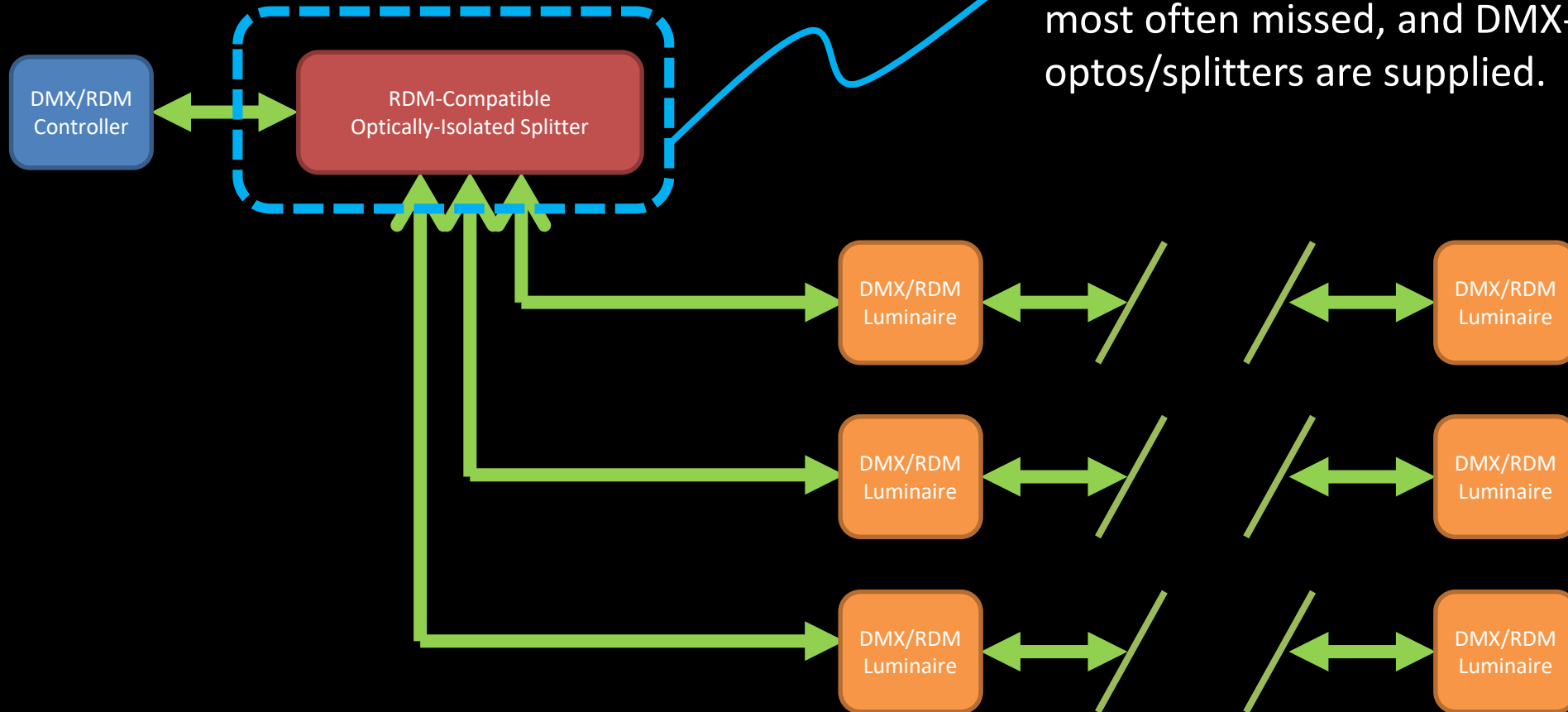
Fixtures must be RDM-capable. Different features are available – check with the manufacturer.



# Specifying for RDM on a DMX System

If you expect RDM to function:

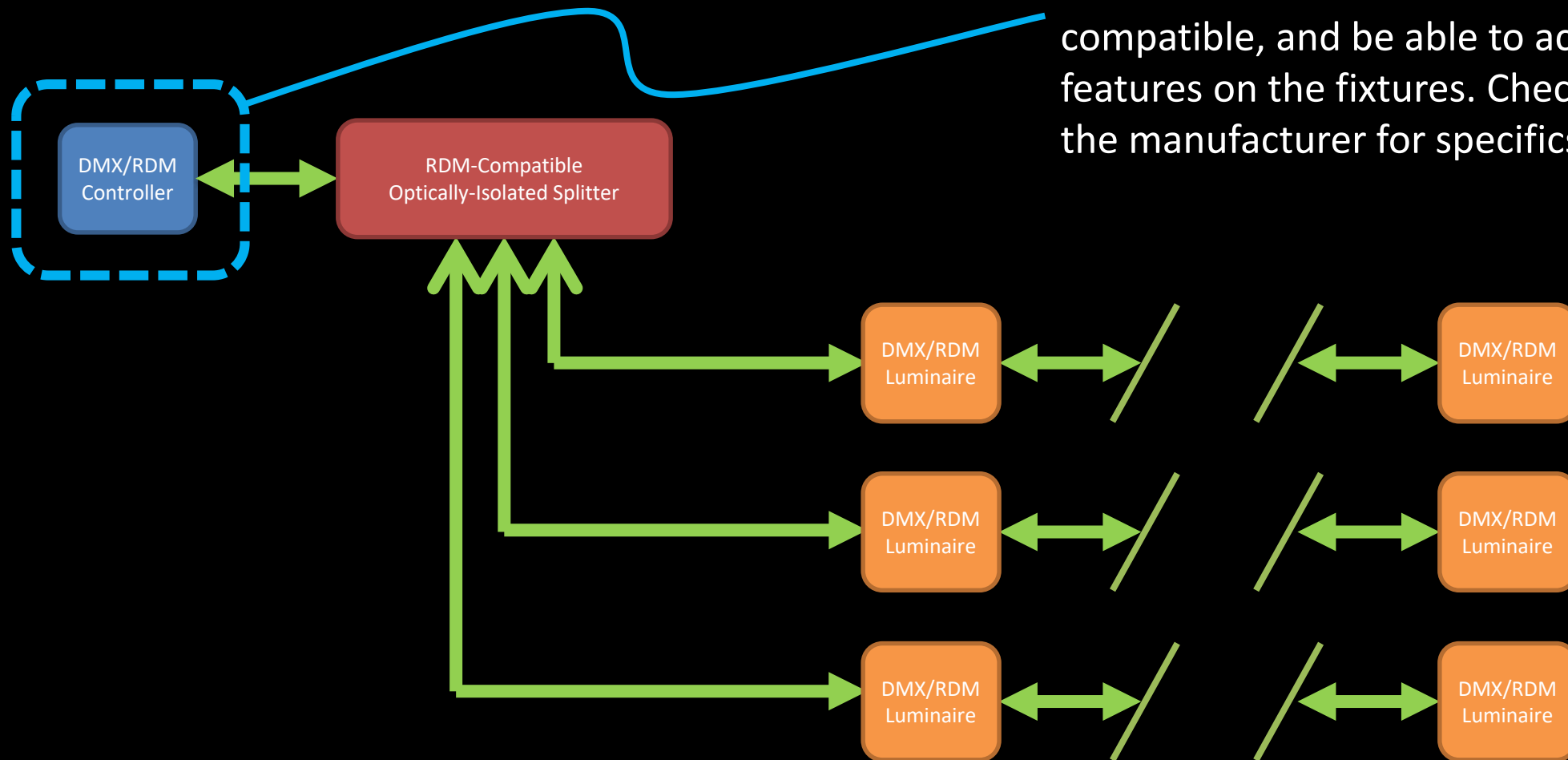
ALL optos/splitters must be RDM-compatible. These components are the most often missed, and DMX-only optos/splitters are supplied.



# Specifying for RDM on a DMX System

If you expect RDM to function:

The controller must be RDM-compatible, and be able to access the features on the fixtures. Check with the manufacturer for specifics.



# Point / Counterpoint



# Design & Specification Considerations

## Design Documentation

- Control Intent Narrative
- Control Zoning Schedules
- Sequence of Operations
- General Conditions/CSI Sections
- Component Cuts
- Single Line/Riser Diagrams



# Back to the Rules of DMX

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*design  
considerations*



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*RS-485 electrical  
considerations*

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# Why the 32 fixture limit matters



- As we mentioned, the ability to scale up a DMX system can suddenly make 512 addresses seem like less than enough if your installation is both visually complicated, and geographically wide-spread

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# What To Do With 512 addresses

DMX can be used to modify:

- Multiple Color Channels (RGBWW)
- Physical Direction (Pan & Tilt)
- Intensity (.01% - 100%)
- Dimming curves to support visual logic



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This concludes The American Institute of Architects Continuing  
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# Live Q&A!

