Introduction to Data Distribution

DMX and Ethernet Networks

Who am I

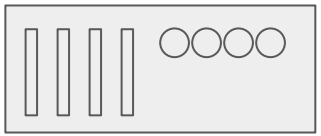
Chris Reising Software Engineer for Electronic Theatre Controls

Agenda

- Digital Multiplex (DMX)
- Ethernet Networks
- System Layouts
- Troubleshooting

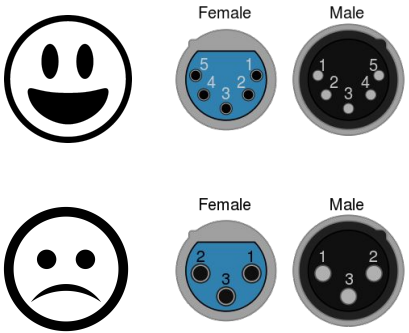
Disclaimer

There is a fine line between clever and reckless



One desk, one light…. Let the fun begin!

- Max Cable Length < 1000’
- Use Only Cable Approved for DMX



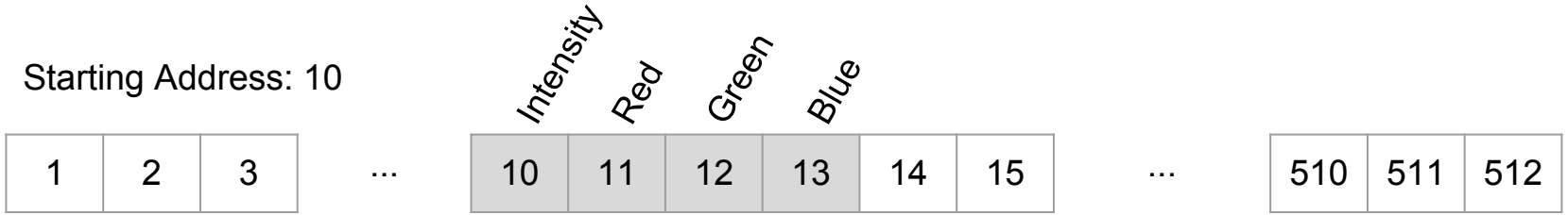
One desk, one light layout

Fixture Profile

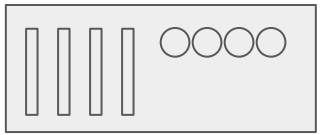
Channel	Purpose
1	Intensity
2	Red
3	Green
4	Blue

- One “DMX Cable” can carry 512 control channels (known as a DMX universe
- Most consoles support more than one universe
  - Universe 1: 1-512
  - Universe 2: 513-1024
  - … etc
- Common notation: Universe / Starting Address (e.g. 2/1 == 513)

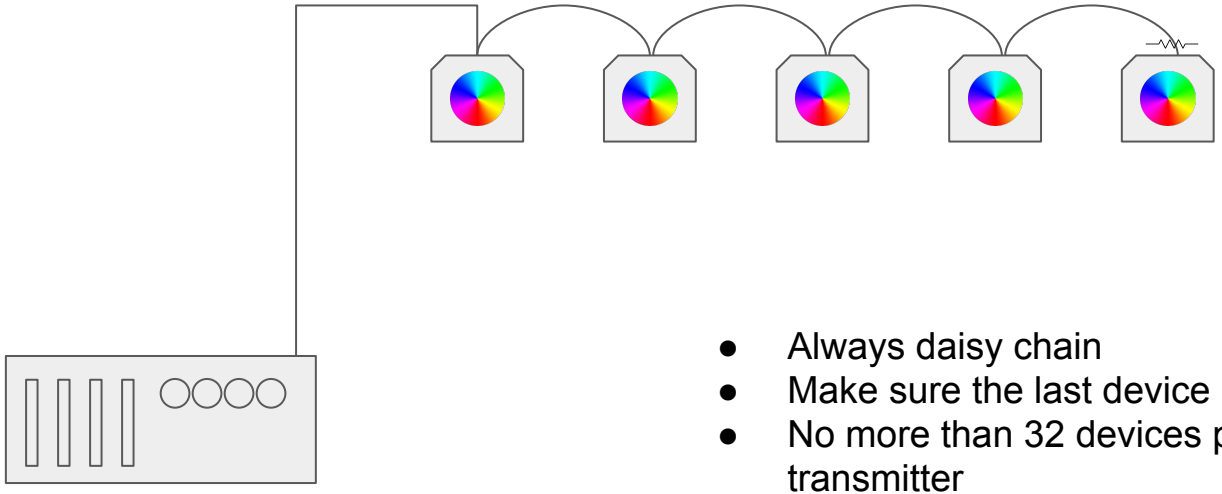
Starting Address: 10



What is a starting address?

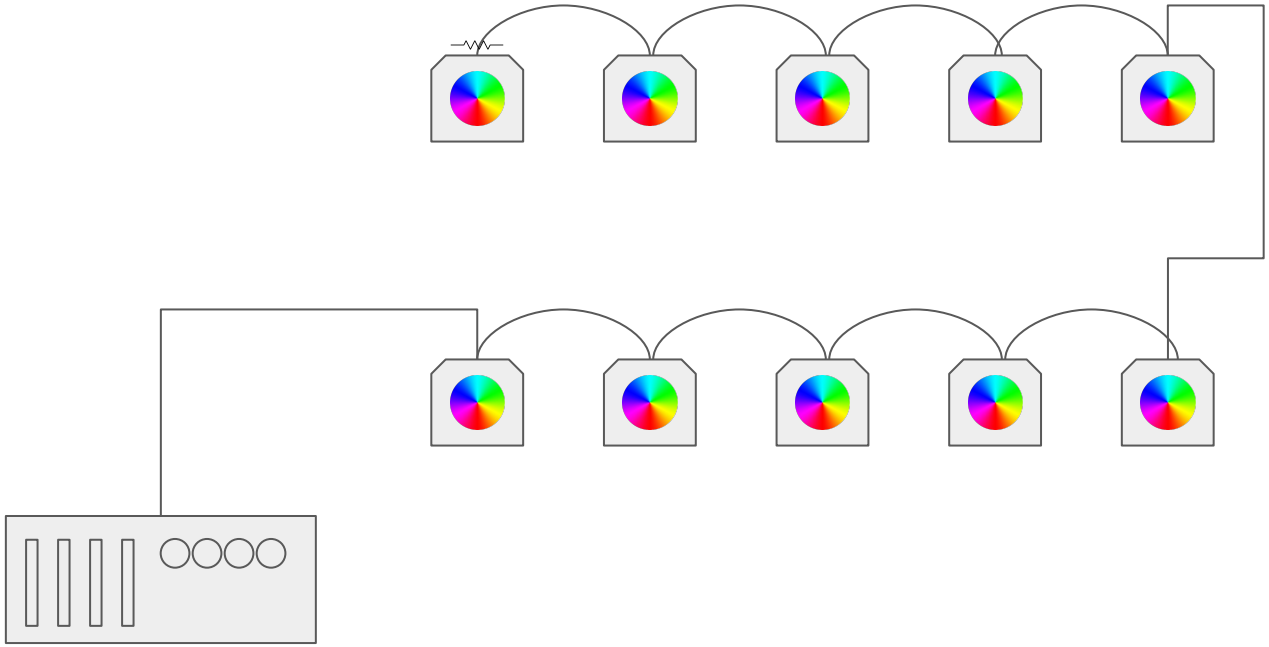


Congrats! You have more lights!



- Always daisy chain
- Make sure the last device is terminated
- No more than 32 devices per chain (includes transmitter
- The overall cable length from transmitter to the last device must be < 1000’
- Note: One transmitter (unless you have a merger)

Congrats! You have more lights!

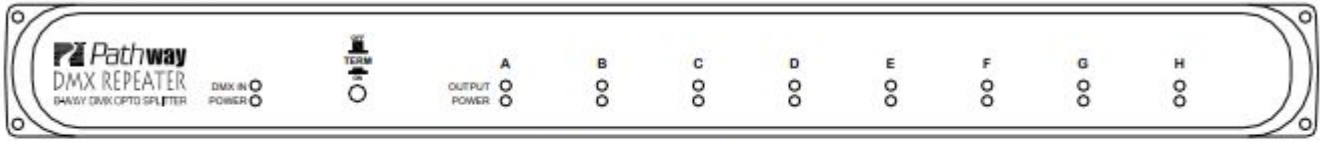


Let’s talk design

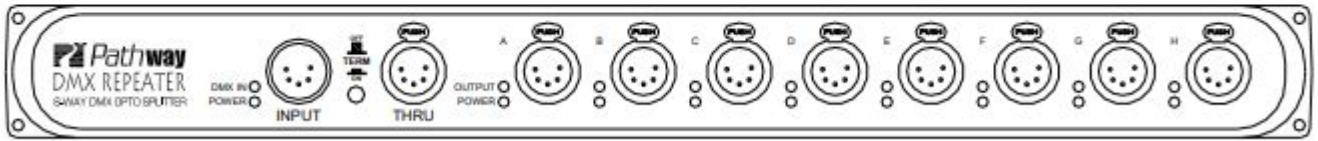
What you (should) gain from using an opto

- 32 devices per output
- 1000’ per output
- Isolation
- Makes layout easier
- Remember to terminate your last opto

FRONT PANEL

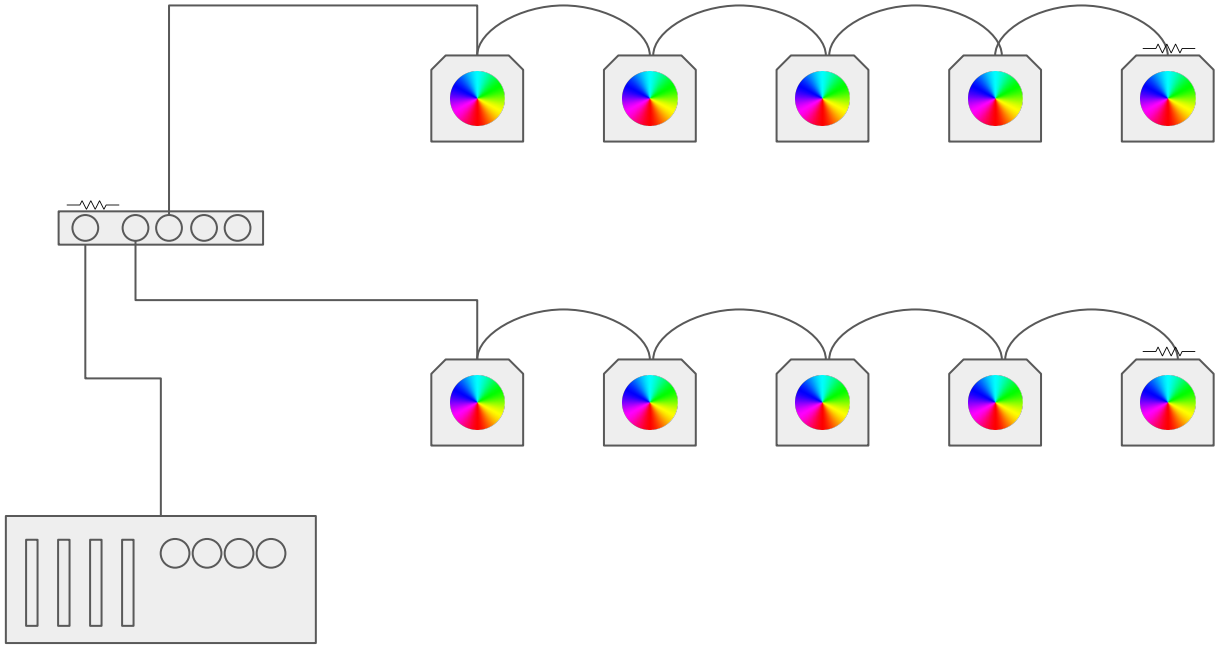


MODEL 9014, 9015, 9017



MODEL 9016

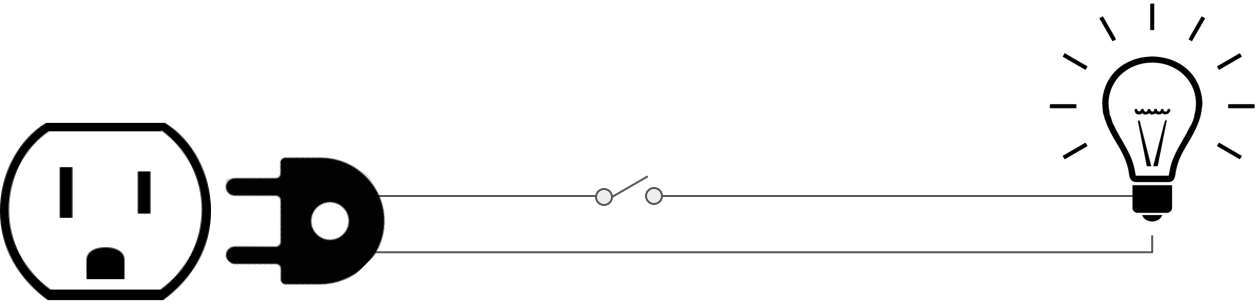
Meet the Opto Splitter



Let’s talk design (continued)

Troubleshooting DMX

- Just walk through the system from one end to the other
- Be practical (avoid rabbit holes)



Tips on Troubleshooting

- Most fixtures either have LEDs by the DMX port or some indicator on their LCD screen
  - In general, input are solid when they have data and blink slowly if they do not
  - Some outputs (like opto splitters) will blink at the same rate as the data it is transmitting
  - When in doubt, check the manual
- There are a number of handheld tools out there that let you read and transmit DMX values

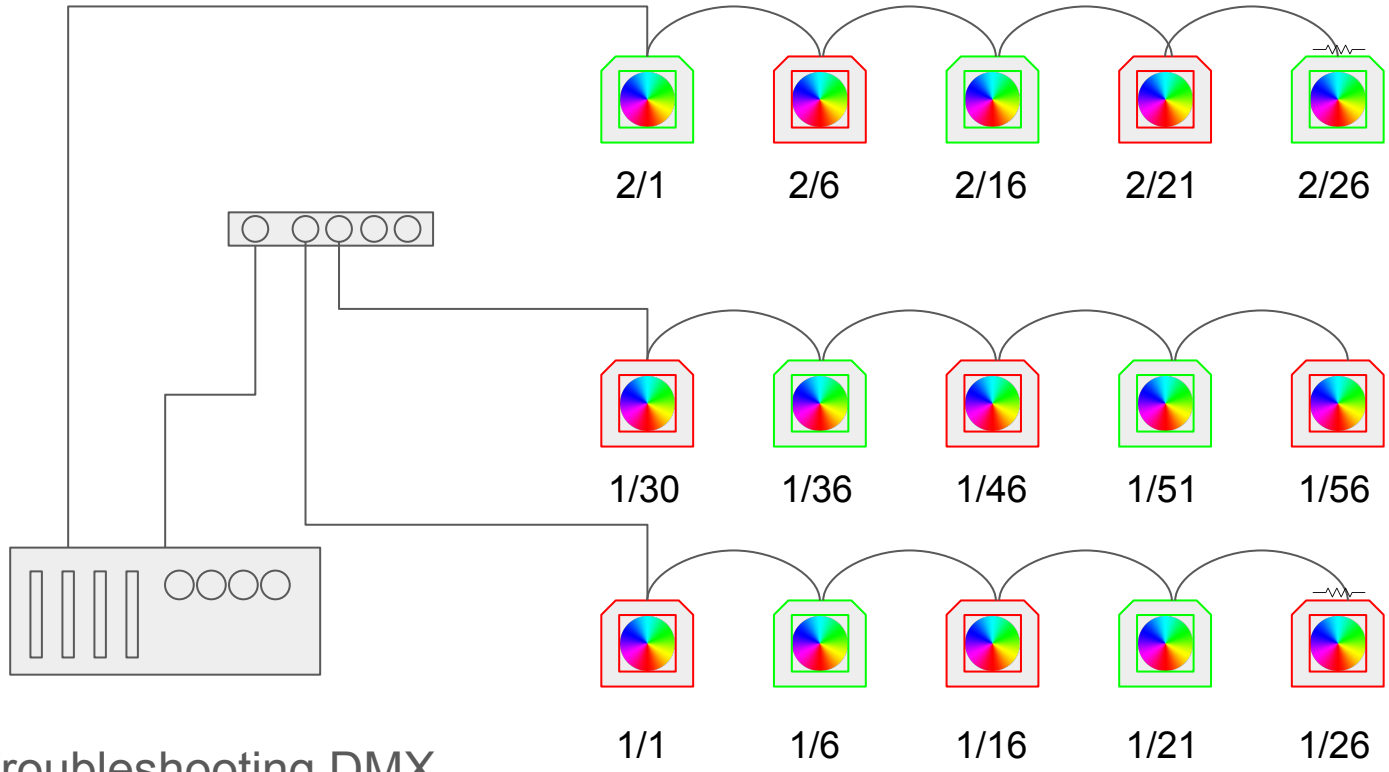
Swisson

Goddard Design

Doug Fleenor Design

Methods for confirming you have data

Red devices need 5 channels
Green devices need 10



Troubleshooting DMX

Remote Device Management (RDM)

(More of a good to know)

ETC Concert Device Editor

- DMX is just used to transmit levels. RDM adds monitoring and configuration
- Not all devices support RDM (this includes opto splitters!)
- How to access RDM:
  - Some consoles
  - A USB to DMX/RDM interface
  - Network Gateways (more on this later)

USB to DMX/RDM Interface

Monitoring and Configuring Devices

Advanced / Good to Know DMX Topics

Example: a moving light is moving from position A to position B over a period of 15 seconds.

- A DMX channel only has 8 bits, so there are only 256 “steps” available for a fade.
- Let’s pretend this changes the pan from a value of 20 to 25% (51 - 64). This results in one “step” every ~1.2 seconds. The move will not look smooth.
- Solution: Combine two channels for 16 bit resolution. We now have 65536 steps!
- In our example above we go from 5 steps to move from A to B to 3176 (one step ever 4ms).

Figure 1 – 8-bit DMX

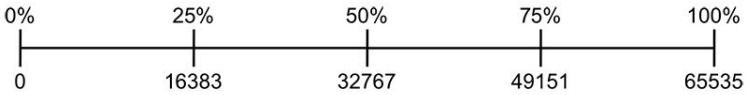


Figure 2 – 16-bit DMX

Source: http://plsn.com/articles/feeding-the-machines/bits-and-bobs-8-bit-vs-16-bit-dmx-control/

Good to know: attributes that require a higher resolution

- Ethernet cables meet the spec’s required for DMX
- Don’t mix up with port transmitting Ethernet! (No, I don’t know what will happen)
- More common in permanent installs
- Most Ethernet cables are not shielded

RJ-45 Terminator

RJ-45 to 5 pin XLR Adapter

Opto with RJ-45 Connectors

Good to know: It is ok to use Ethernet cables to transmit DMX

- Some units have “timing” channels for smooth fades

- Most devices that output DMX have the ability to control the speed of the output

- Consider daisy chaining by type when layout out a system (there are times when this could be beneficial)

More good to knows

Ethernet Networks

But Chris, doesn’t DMX solve all the world’s problems?

1 Channel

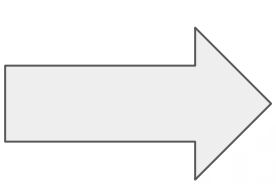
A Couple Channels

Hipsters

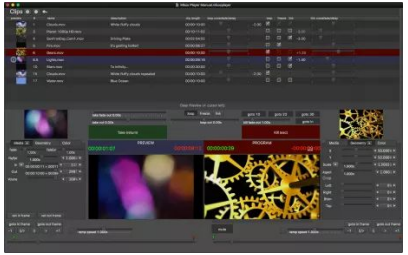
> 3000 Channels (photo: Light Tech LLC)

Grunge is in

~24 Channels



52 Channels



> 400 Channels

3 DMX Universes

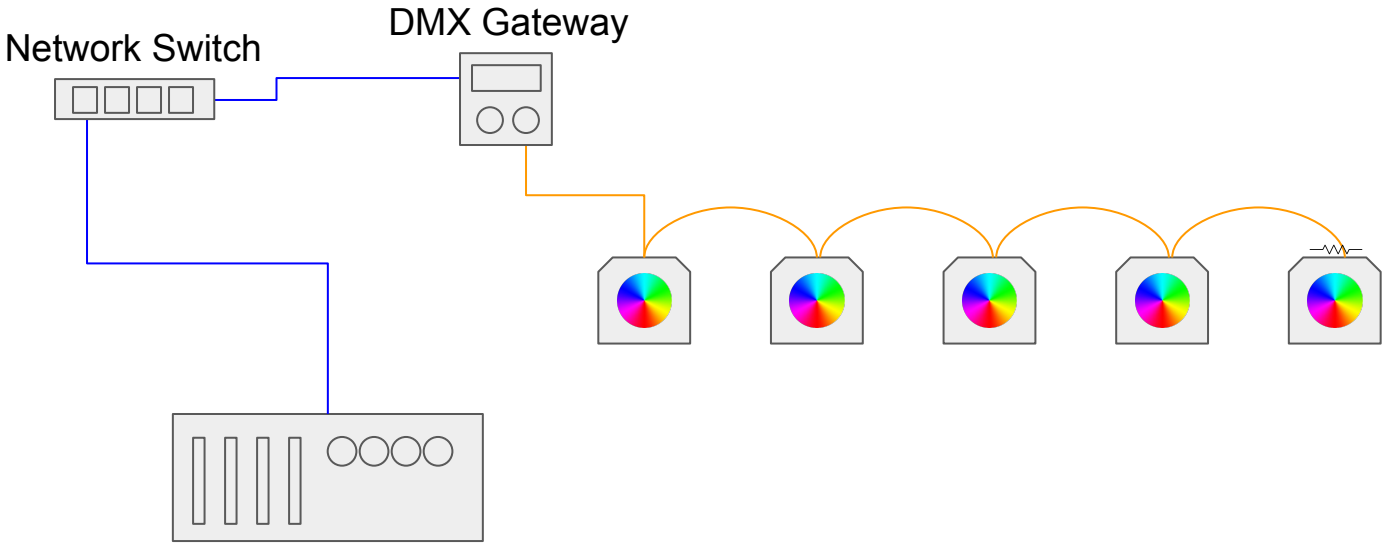
1 Channel

24,576 Outputs (48 Universes)

Up to 15 Channels

Then and now

- Supports up to 63,999 universes
- Allows for multiple sources
- Max network cable length 100 meters per segment (device to switch)



sACN: How Ethernet Networks and DMX Integrate

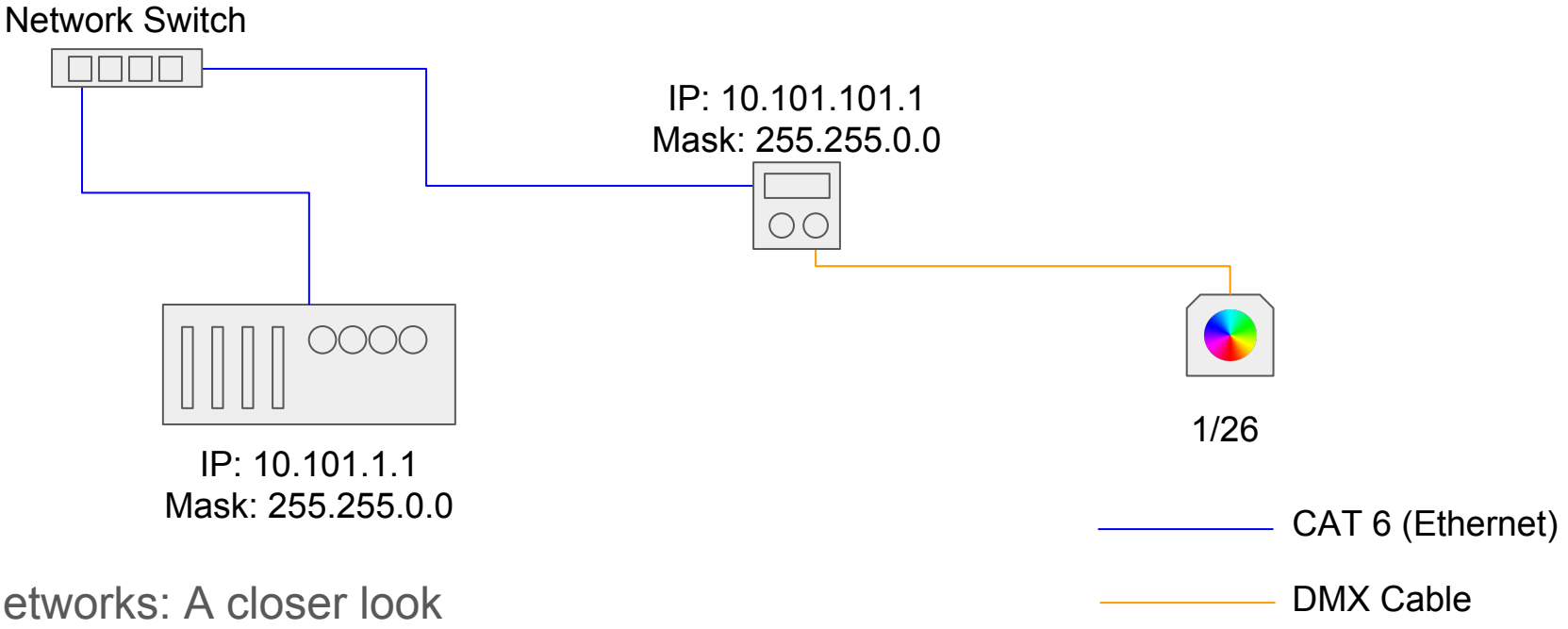
- Converts sACN (the ethernet protocol) to and from DMX
- Port modes are configurable. They can be used as inputs or outputs
- The port’s universeare also configurable.

Meet the DMX Gateway

- Not unique to the lighting world
- Generally comes in two flavors: managed and unmanaged
- Some lighting manufacturers make switches for our industry
- Some switch offer Power Over Ethernet (POE)
- Some consoles have switches built in (i.e. have multiple network ports)

Meet the Network Switch

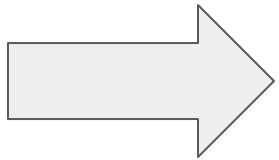
- Each device generating or receiving data needs an IP Address and a subnet mask unless…
- Your network has a DHCP server (which will issue addresses for you)

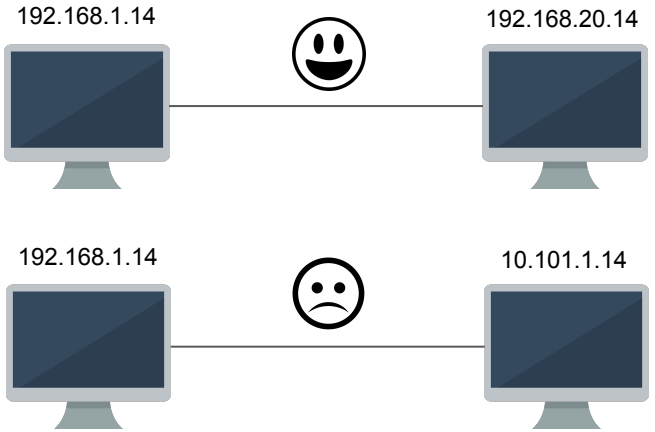


Networks: A closer look

IP:	192	168	X	X
Subnet Mask:	255	255	0	0

A mask of 255.255.0.0 indicates that the first two octet must match

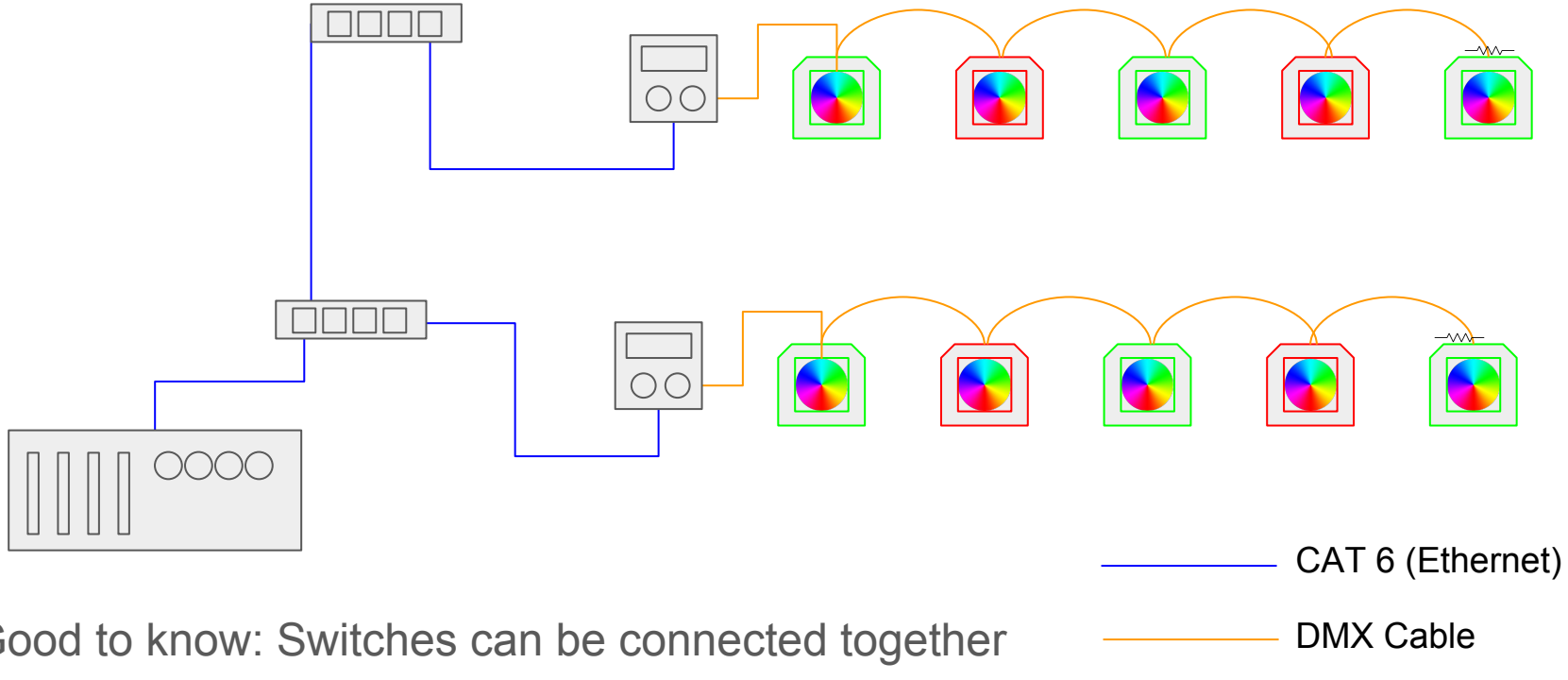




- IP Addresses on a local networks normally use 10.X.X.X or 192.168.X.X. (ETC uses 10.X.X.X)
- The range of each octet is [0, 255]. Example: 10.0.0.0 - 10.255.255.255. Avoid using the lowest and highest address.
- 192.168.X.X networks normally have a subnet mask of 255.255.0.0.
- 10.X.X.X networks normally have a subnet mask of 255.0.0.0.
- Each device's address must be unique.
- DHCP Server (address servers) will assign all of this for you.

IP Addresses: the basics

- There is no theoretical limit on connecting switches to switches, but there are some practical concerns (bandwidth, points of failure, etc)
- Consult your manual regarding which ports should be used



Good to know: Switches can be connected together

Tools and Troubleshooting

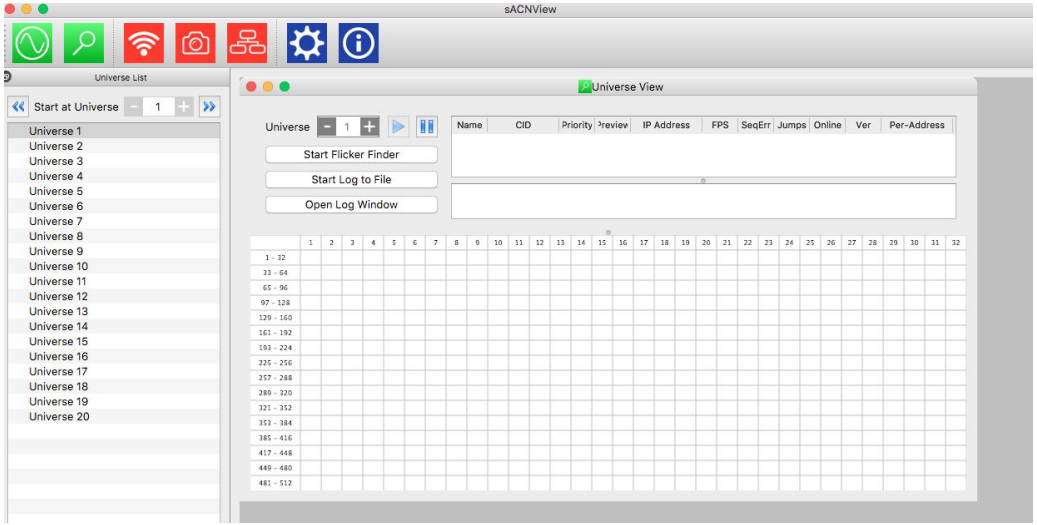
```
en1: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
        ether 10:40:f3:b1:e6:5a
        inet6 fe80::4d7:b8e:4052:30d5%en1 prefixlen 64 secured scopeid 0x7
        inet 192.168.1.151 netmask 0xffffff00 broadcast 192.168.1.255
        nd6 options=201<PERFORMNUD,DAD>
        media: autoselect
        status: active
```

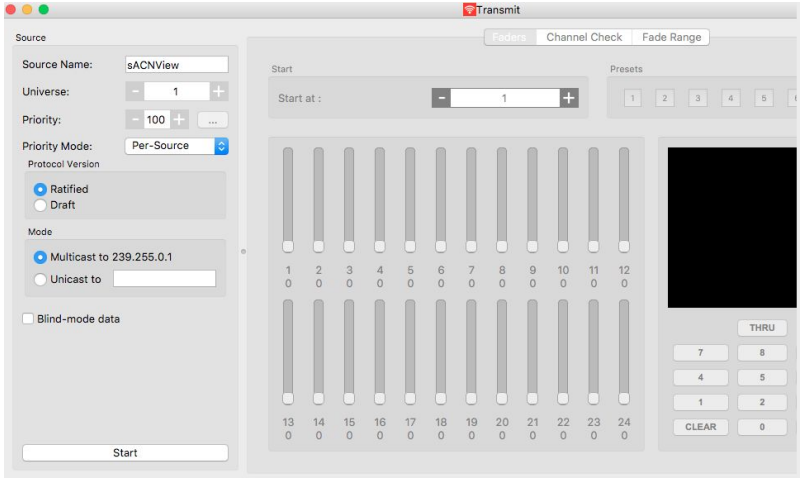
To view your IP settings: *ifconfig* on Mac or Linux / *ipconfig* on Windows

```
ChristohersMBP4:~ creising$
ChristohersMBP4:~ creising$ ping 192.168.1.1
PING 192.168.1.1 (192.168.1.1): 56 data bytes
64 bytes from 192.168.1.1: icmp_seq=0 ttl=64 time=0.949 ms
64 bytes from 192.168.1.1: icmp_seq=1 ttl=64 time=2.064 ms
64 bytes from 192.168.1.1: icmp_seq=2 ttl=64 time=1.143 ms
^C
```

To see if a device is reachable: ping <the IP address> (e.g. *ping 192.168.1.1)*

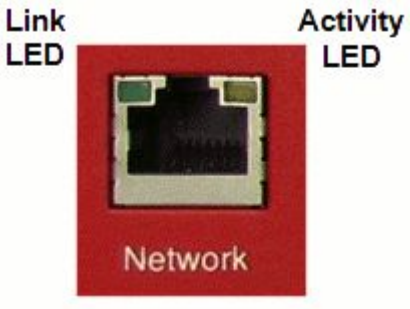
Helpful Commands for Troubleshooting





- Allows you view sACN values
- You can also transmit values
- Free and open source (supports both Mac and Windows)

sACN Viewer (http://www.sacnview.org/)

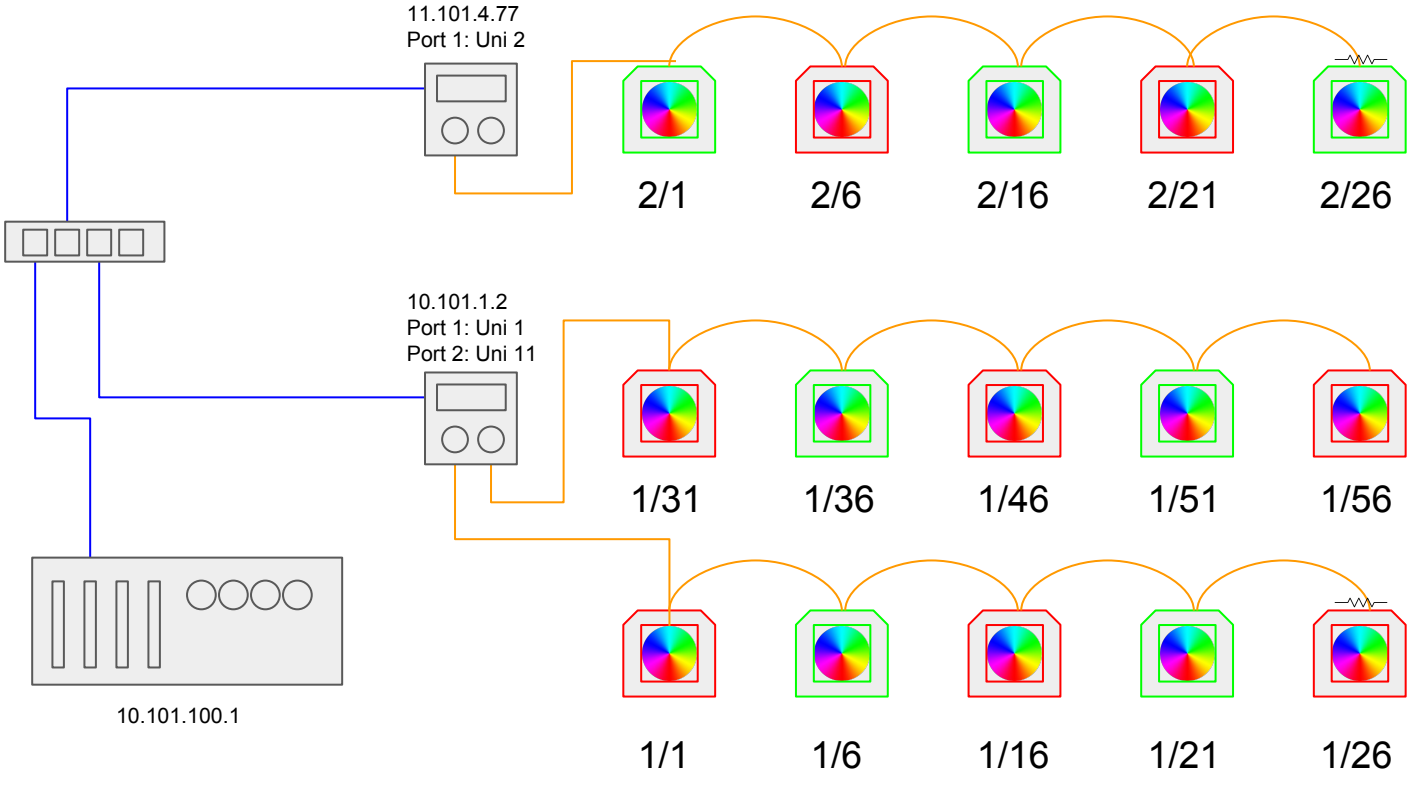


- The link light should be solid. Indicates the network interface (NIC) is connected to something
- The activity light should blink. Indicates data is flowing
- This does NOT guarantee your NIC settings are correct.

- Basic cable tester might be useful

Troubleshooting cable issues

Mask is 255.0.0.0



Troubleshooting a System

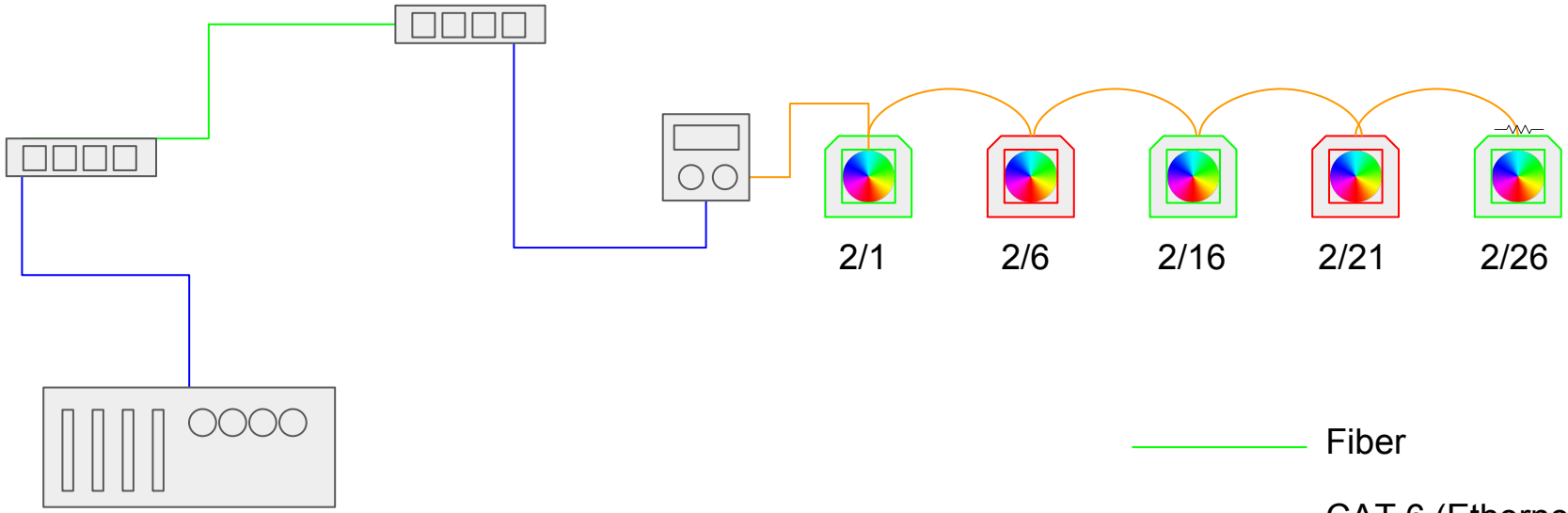
CAT 6 (Ethernet)

DMX Cable

Advanced / Good to Know Ethernet Topics

Red devices need 5 channels
Green devices need 10

- Be sure to do your research.
- Fiber has different types of connects
- The cable itself needs to be compatible with the fiber transceiver



Good to know: Fiber can be used for long runs

- The left one is a managed switch. Or is it the one on the right...
- The takeaway: managed switches expose configuration options (often through a web UI or a command line interface). Unmanaged switches are “plugin and play”
- To my knowledge, most “consumer grade” switches are unmanaged.
- If you have a managed switch, you might want to contact tech services. If left enabled, certain settings could interfere with your lighting protocols.

Managed vs Unmanaged Switch

- The left one is a switch…. Or is it a hub….
- The takeaway: a hub broadcasts an incoming message to all port ports. A switch only sends it to the port that has the device that is the message's final destination
- It is becoming increasingly difficult to find hubs

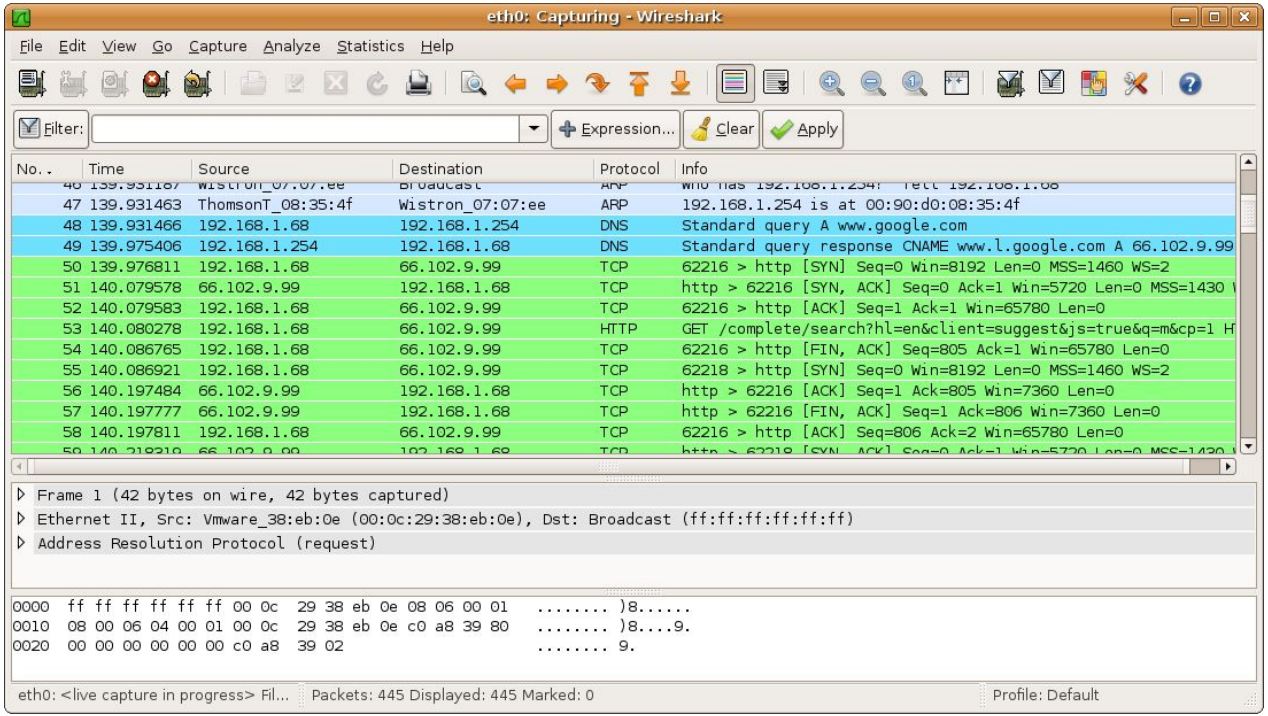
Hub vs. Switch (Ugh)

- ArtNet:
  - Developed by Artistic License
  - Predates sACN
  - Also used to stream control levels
  - Supports network management and RDM

- ACN
  - NOT sACN (worst naming ever)
  - Ethernet based configuration protcol
  - Did not take off like wildfire
- RDMNet
  - Not yet released
  - Gets RDM data onto the network

Other ethernet based protocols

- Generally not something you would used everyday...
- Allows you to capture network traffic
- There are dissectors for the different protocols used in the lighting world



Viewing ethernet traffic with Wireshark

Additional Resources

- https://www.etcconnect.com/Support/Articles/DMX-512-Info.aspx
- http://www.dfd.com/info.html
- https://www.pathwayconnect.com/index.php/support/reference-articles
- https://art-net.org.uk/
- https://opendmx.net/index.php/DMX512-A
- http://www.rdmprotocol.org/
-