ATSC 3.0 Technical Overview

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ATSC 3.0 Basics

- Heartland Video Systems, Inc. has been involved in over 50 ATSC 3.0 market turn-ons including:

Los Angeles, CA
Houston, TX
Atlanta, GA
Hartford, CT
Detroit, MI

- We are pleased to be members of ATSC for the last 2.5 years.

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ATSC 3.0 General Review

- Benefits of ATSC 3.0
- Signal Signing
- Consumer Electronics

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ATSC 3.0 Benefits

- OTA/OTT Hybrid Services & Repair
- Mobile
- Supports 4K/UHD & 1080p + HDR
- High Quality Audio, Enhanced Dialog, Dolby Atmos & 7.1+2 Audio
- Targeted Ad/Content
- Easy Datacasting
- Offers Signal Signing & Encryption
- Significantly Improved Emergency Alerting (AEA&I)

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Status and more about Signal Signing

- EONTI/DigiCert– Stations must contract with them and they will issue the certificates
- The Lighthouse owner needs to buy a cert for CDT and SMT. Possibly one for App Distribution as well
- Any App author needs to buy a cert for their app.
- Status-Sunrise was Feb 14, 2022. Broadcasters can start using certificates now.
- High Noon will come later, TBD.

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Status update on Consumer Devices

- Samsung-Good A/V, captions, ESG, DRM and Certs
- Sony-Good A/V, captions, ESG, DRM and Certs
- LG-Good A/V, captions, ESG, DRM and Certs
- Set Top Boxes-Vbox, ZapperBox, HDHomeRun

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ATSC 3.0 Chain Review

- BOM
- Budgetary Estimates
- Encoder / Packager
- ROUTE / MMT Signaling Server
- Broadcast Gateway

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Bill of Materials

- HEVC & AC4 Encoder plus DASH Packager
- ROUTE and/or MMT Server
- Broadcast Gateway/Scheduler
- Stratum 1 NTP and GPS & Networking/Switches
- IP STL with around 35 Mb/s minimum capacity
- ATSC 3.0 IP and RF Analysis
- ATSC 3.0 IP and RF IRD
- Consumer TV
- IP Interconnect between stations (VideoFlow or LTN)

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Budgetary Estimate-ATSC 3.0

- Encoder/packager $40-50k (depends on Mfg and ch count)
- ROUTE/Gateway $65k-90k (depends on Mfg and ch count)
- Monitoring Equipment $65k (Analyzer, IRDs, and consumer TV)
- Misc Equipment $15k (Nielsen, GPS, NTP, etc.)
- IP STL $70k (SAF Microwave for example)
- VideoFlow $15k per site roughly

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Budgetary Estimate-ATSC 1.0

- Redundant Encoder Refresh $55k
- PSIP Refresh $15k
- Monitoring Equipment $10k
- VideoFlow $15k per site roughly

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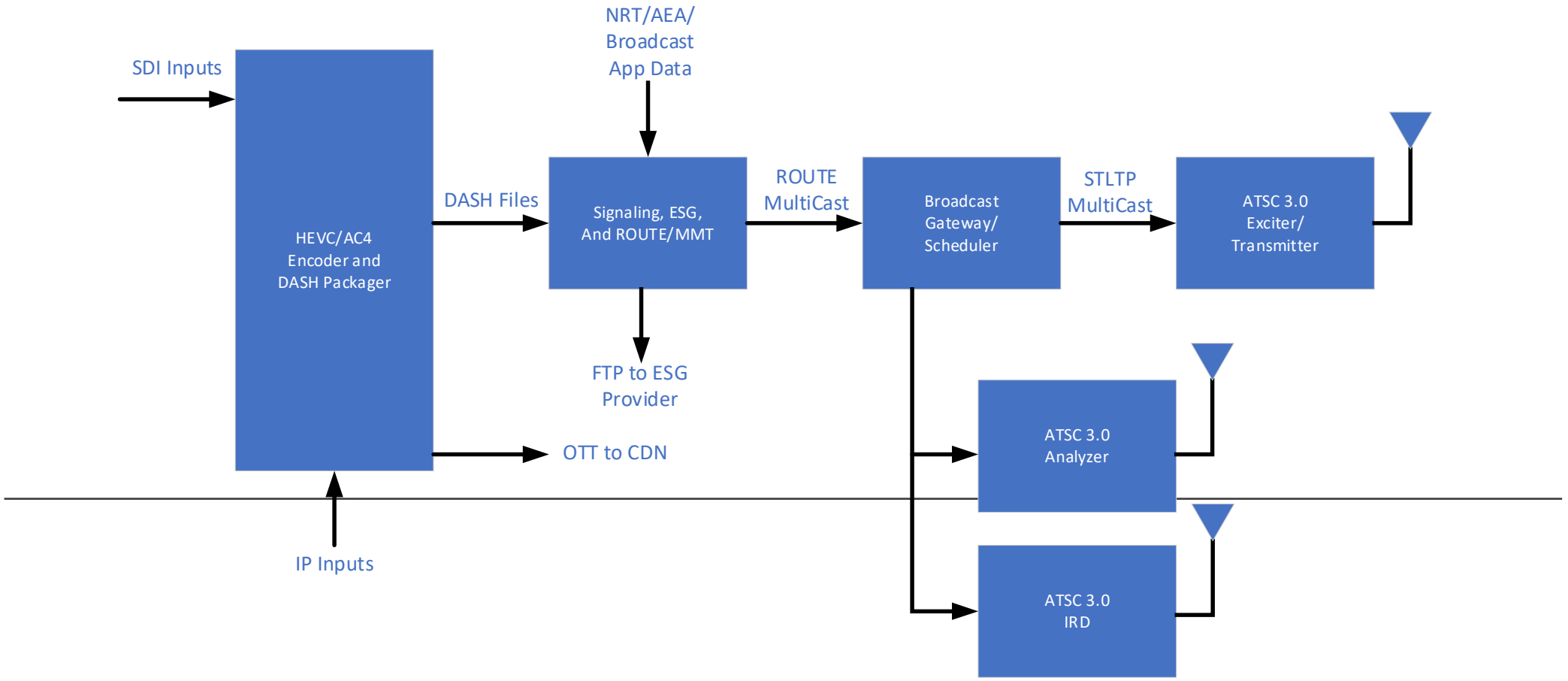
Block Diagram



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Encoder/Packager

- HEVC & AC4
  - 1080p at 4-5 Mb/s
  - UHD at 16-20 Mb/s
  - 480p at 1 Mb/s
  - Internal AC4 encoder up to 5.1
  - AC4 allows Dolby Atmos & 7.1, but that must be done before the encoder
  - AC4 also allows for enhanced dialog and multiple languages by replacing the center channel.
- DASH Packaging
  - DRM
  - IMSC1 Captions
  - OTT

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ROUTE/MMT Server

- DASH to ROUTE conversion
  - DASH is a file transfer and must use unicast rules from encoder to ROUTE server
  - ROUTE is multicast
  - One ROUTE Multicast per A/V service
- ESG Generation
  - Must be able to go out to external FTP (TitanTV, GraceNote, Protrack, etc)
  - For a Lighthouse model, partner guide data must be aggregated.
- Signaling Generation
- Broadcast App Insertion
  - Broadband or Broadcast
- AEA-Advanced Emergency Alerting.
  - Must use a Broadcast App for TV to show this
- Referenced NRT Data
- Signal Signing

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Gateway

- ROUTE to STLTP Conversion
- Unreferenced Data Insertion
- ModCod/Exciter Settings
- LDM-Layered Division Multiplexing
  - Advantage is that it can allow more bandwidth in a defined modulation and code rate scheme for PLP-0. You have to give up a certain amount of C/N in PLP-1 though. Typically, 1 to 2 dB.

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Market Connectivity

- Lighthouse Model
- Station Interconnectivity

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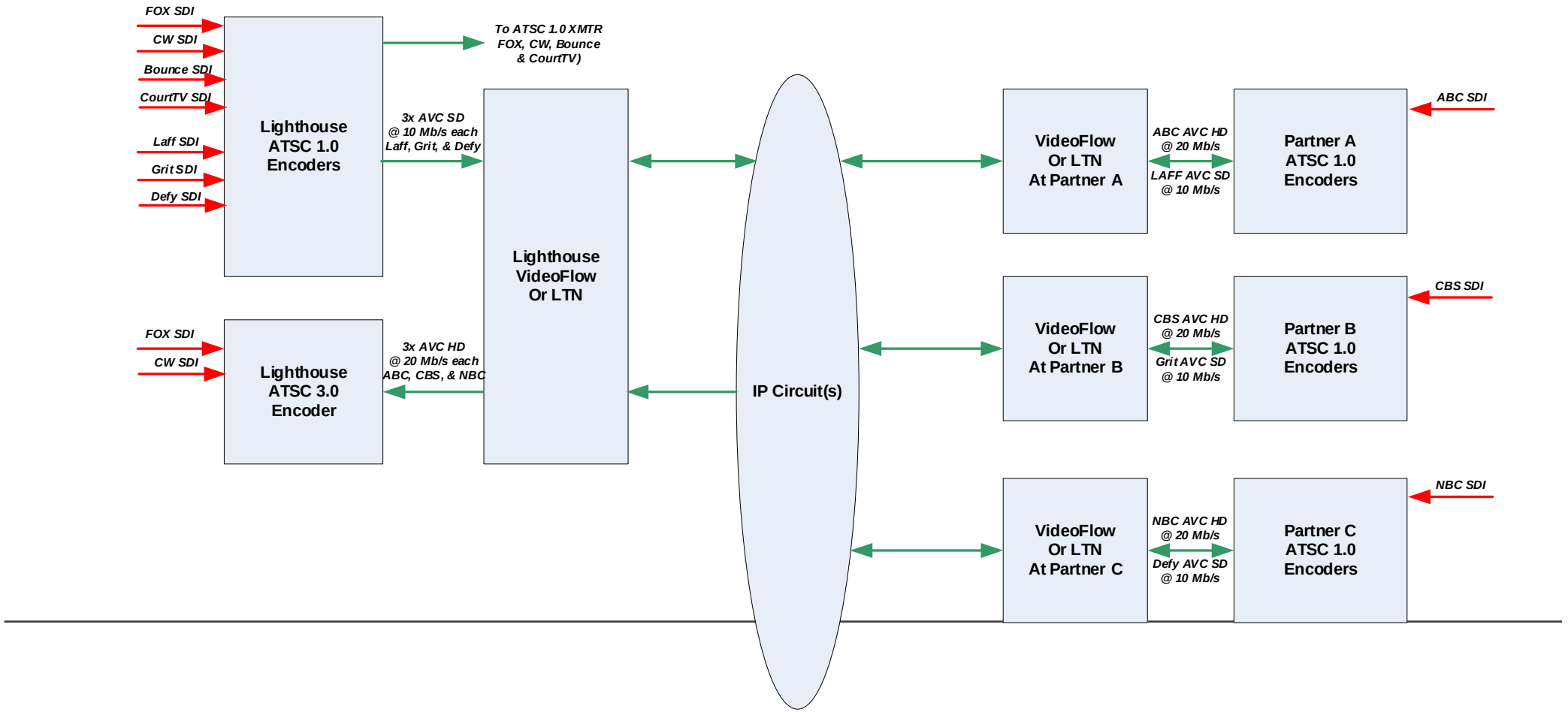
ATSC 3.0 Market Interconnect



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Lighthouse & Partners

- The Lighthouse is the station turning off their ATSC 1.0 and moving to 3.0
- They must distribute all their legacy ATSC 1.0 services to others in the market
- The partners will generally all take at least one service to air on their ATSC 1.0 transmitter.
- In return, they send their primary HD to the 3.0 Lighthouse for transmission.

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Station Interconnectivity

- LTN
  - Managed Services
  - OpEx
- VideoFlow
  - CapEx
- Microwave
- Fiber

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ATSC 3.0 IP Overview

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Basic IP Rules

- There are four major parts to an IP scheme we deal with
- **IP address**-divided between network and host portions
- **Subnet Mask**-determines the size of the network (how many hosts or unique equipment IP addresses you have available)
- **Gateway**-connects local devices to other networks.
- **DNS**-translates domain names to IP addresses.

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Basic IP Rules

MULTICAST ADDRESSES START AT 224.0.0.0 AND GO THRU 239.255.255.255

Class	Default Subnet Mask	Address Range	Number of Hosts
A	255.0.0.0	1.0.0.0 - 126.255.255.255	16 Million
B	255.255.0.0	128.0.0.0 - 191.255.255.255	65000
C	255.255.255.0	192.0.0.0 - 223.255.255.255	254

IPXO

Basic IP Rules

- Unicast (one to one) always needs TX and RX NIC's to be within the same subnet
- Multicast (one to many) doesn't, but it is good practice to adhere to the same subnet rule
- NIC's on the same physical device should always be in different subnets.

Basic IP Rules

- I try to use the same 4th octet on all NICs of a common piece of equipment.
- Control NIC is 192.168.12.50/24
- TSoIP NIC is 192.168.13.50/24
- ROUTE NIC is 192.168.14.50/24
- STLTP NIC is 192.168.15.50/24
- It helps me keep track of the addresses better than using random numbers.

Subnet Mask

- Subnet masks are written like this: 255.255.255.0 or /24 (called CIDR notation)
- To understand the /24, you have to convert the decimal 255 to binary. That is 1111 1111. You just count the ones and ignore the zeros. 255=8 bits and you have three 255's. For a total of 24 bits.
- Another example of a more complex subnet is 255.255.255.192. To find the CIDR notation, you already know the 255.255.255 part is 24. 192 decimal in binary is 1100 0000 or 2 more bits. 24 + 2=26, so the notation is /26.

Subnet Mask

- For a /24 subnet, equipment will communicate if their IP addresses have the same first three octets and the 4th is different.
- 255 indicates you need to match it and the 0 means it needs to be different.
- Example: 192.168.12.50 and 192.168.12.100 will work if the subnet mask was 255.255.255.0.
- 192.168.12.50 and 192.168.13.50 wont work with the same subnet mask of 255.255.255.0. Here, the third octet doesn't match

Networking Options

- One option is to incorporate the multicast IP schemes into the existing data switches
- Another option is to use dedicated switches that never touch the existing networks to carry the multicast IP data
- We find that this is split roughly 50/50 between our customers.
- Those with a strong and involved IT dept usually want to incorporate this into the existing network.
- We find there is no real drawback to having an isolated switch for just ATSC 3.0 traffic.

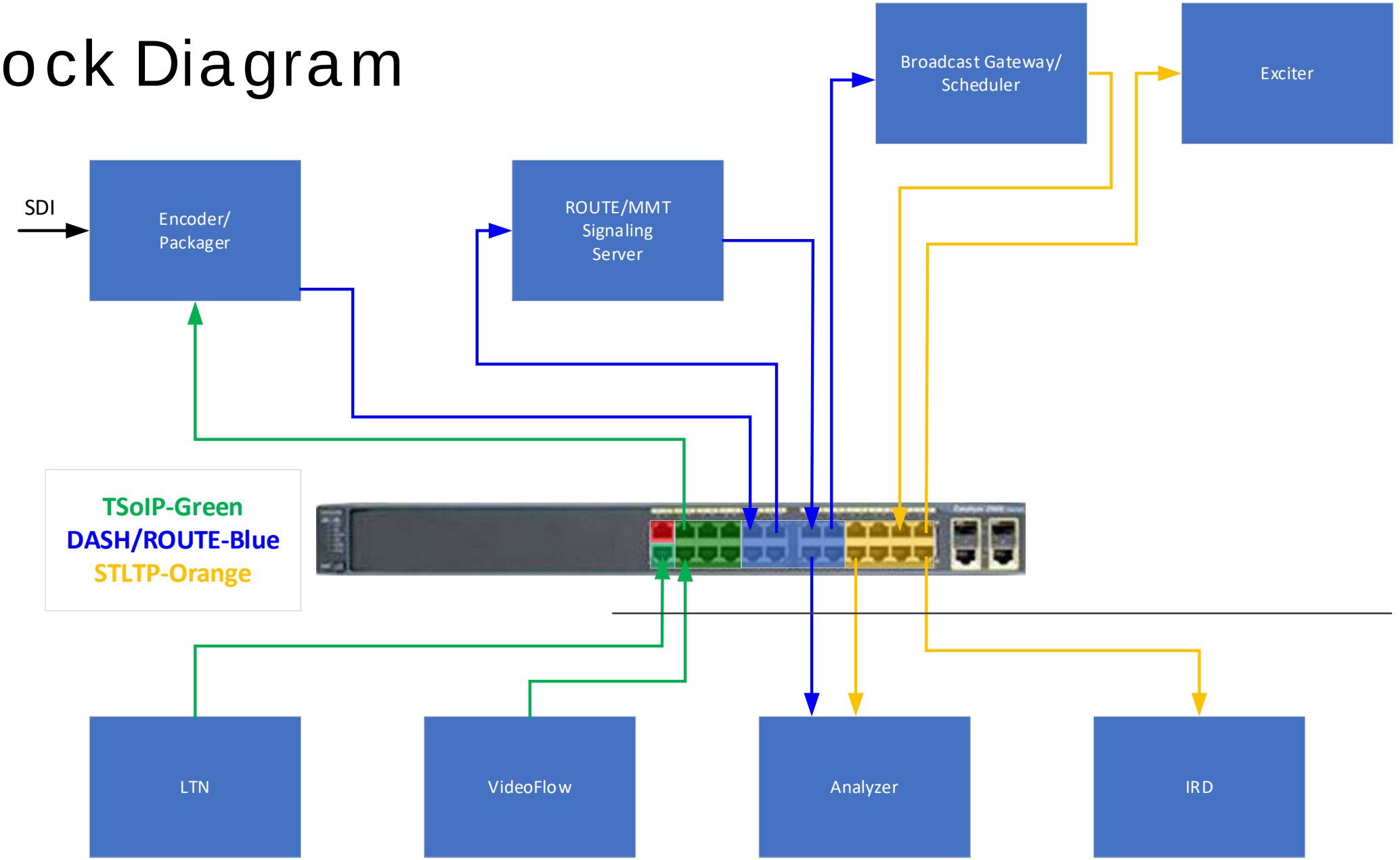
IP Scheme

- VLANs: Typically we will make a VLAN for ROUTE, STLTP, and TSoIP
- VLANs act like isolated switches, traffic cant pass between VLANs.

Example IP Scheme

- Control VLAN is 49
- TSoIP VLAN is 50
- ROUTE VLAN is 51
- STLTP VLAN is 52

Block Diagram



TSoIP VLAN

- In a Lighthouse model, where partners are sending HD services to the Lighthouse encoder, there is typically an IP handoff via LTN or Videoflow.
- This IP transport will be an AVC and AC3 encoded HD service at 20 Mb/s.
- Both LTN and VideoFlow will use some kind of template for IP addressing
- This helps keep track of what is on a certain multicast address without too much trouble

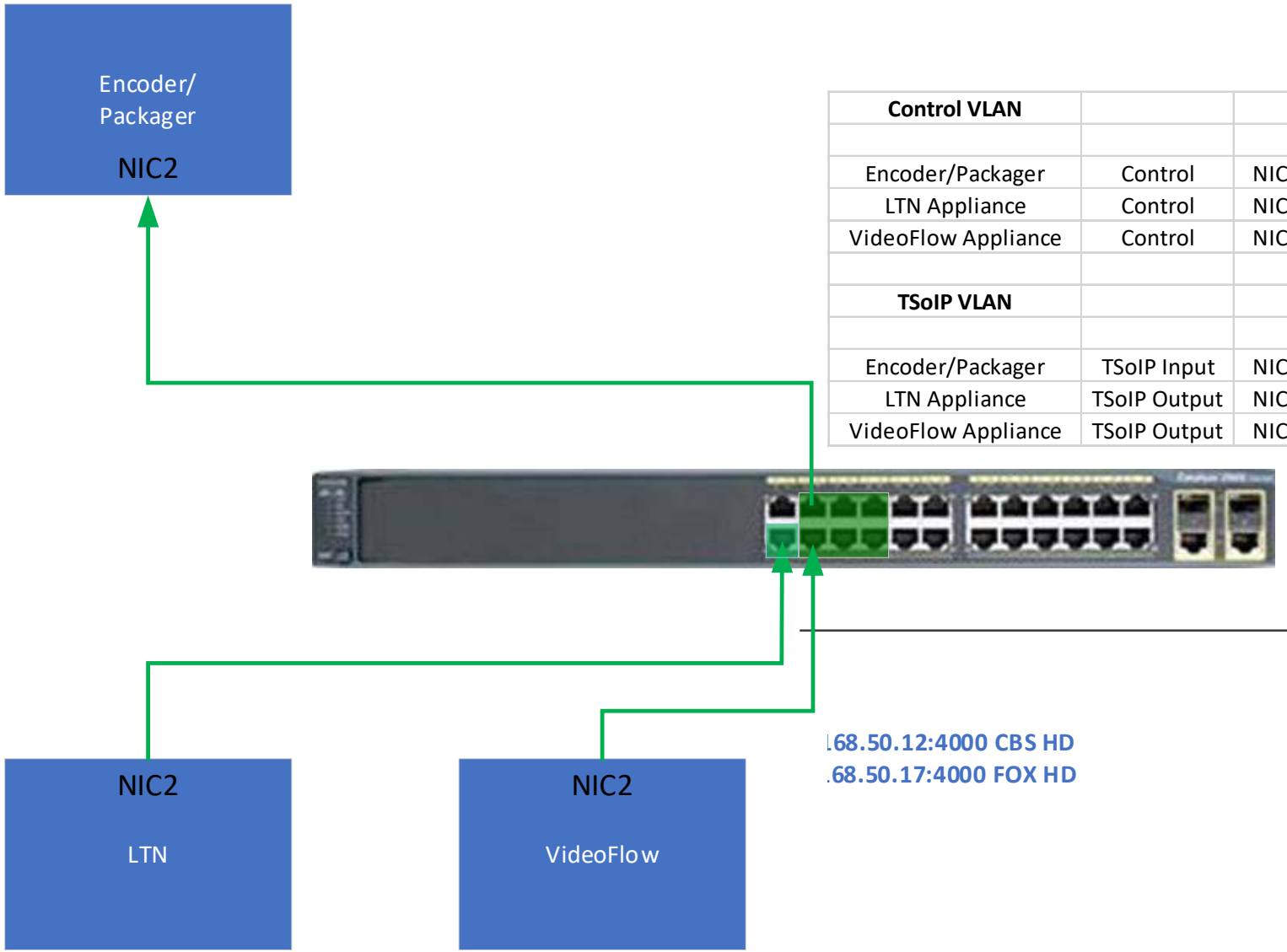
TSoIP VLAN

- The VideoFlow/LTN output NIC and Encoder input NIC should be in the same subnet.
- Example: VideoFlow Output NIC is 192.168.50.11/24. LTN Output NIC is 192.168.50.12/24. Encoder Input NIC is 192.168.50.10/24

TSoIP VLAN Troubleshooting

- Because this is multicast and any device can receive it, it makes testing easy
- Connect an analyzer to the TSoIP VLAN and try to receive it.
- If you don't get the TSoIP multicast, ping between devices. Its most likely a physical connection issue.

TSoIP VLAN



Control VLAN					
Encoder/Packager	Control	NIC1	192.168.49.10	255.255.255.0	192.168.49.1
LTN Appliance	Control	NIC1	192.168.49.11	255.255.255.0	192.168.49.1
VideoFlow Appliance	Control	NIC1	192.168.49.12	255.255.255.0	192.168.49.1
TSoIP VLAN					
Encoder/Packager	TSoIP Input	NIC2	192.168.50.10	255.255.255.0	
LTN Appliance	TSoIP Output	NIC2	192.168.50.11	255.255.255.0	
VideoFlow Appliance	TSoIP Output	NIC2	192.168.50.12	255.255.255.0	

ROUTE VLAN

- Encoder DASH Output is a file transfer (not multicast). The Encoder output NIC and ROUTE/Signaling Server input NIC must be in the same subnet.
- Example:

Encoder Output NIC is 192.168.51.10/24.
ROUTE/Signaling Server Input NIC is192.168.51.13/24

- Example:

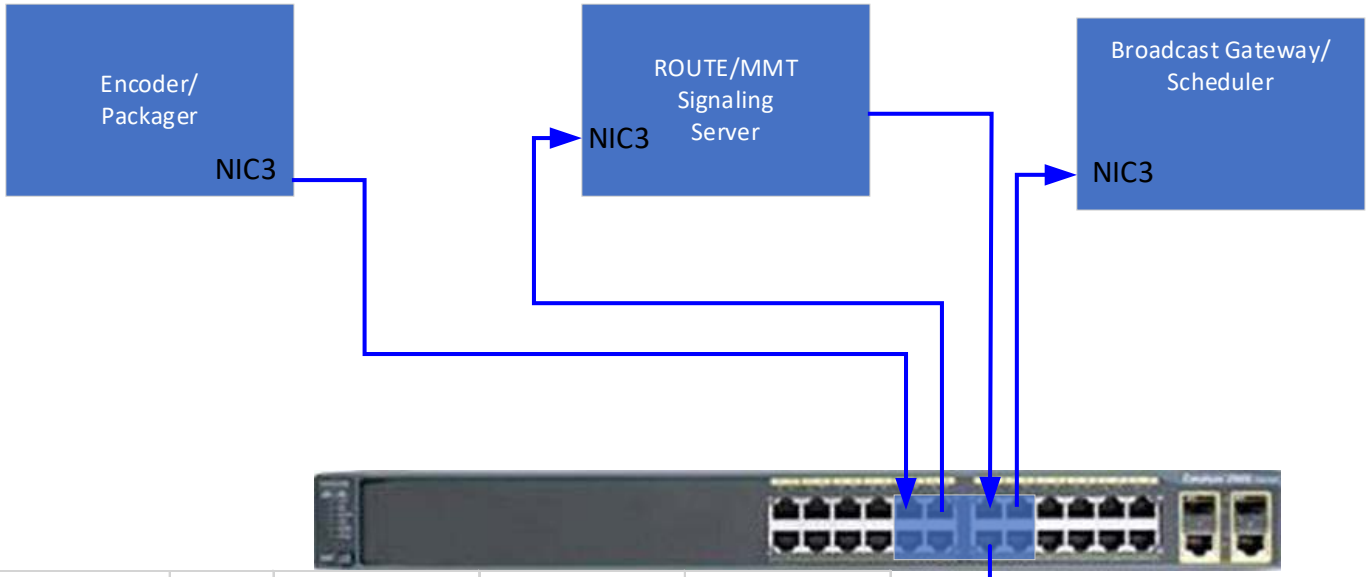
ROUTE I/O NIC is 192.168.51.13/24.

Gateway Input NIC is 192.168.51.14/24.

ROUTE VLAN Troubleshooting

- If you are not publishing, ping between encoder and Signaling Server
- If that is good, then check Publishing parameters
- Check destination IP, UDP Port #, and publishing path. Syntax matters.

ROUTE VLAN



Control VLAN					
Encoder/Packager	Control	NIC1	192.168.49.10	255.255.255.0	192.168.49.1
Signaling Server	Control	NIC1	192.168.49.13	255.255.255.0	192.168.49.1
Broadcast Gateway	Control	NIC1	192.168.49.14	255.255.255.0	192.168.49.1
Analyzer	Control	NIC1	192.168.49.15	255.255.255.0	192.168.49.1
ROUTE VLAN					
Encoder/Packager	DASH Output	NIC3	192.168.51.10	255.255.255.0	
Signaling Server	ROUTE I/O	NIC3	192.168.51.13	255.255.255.0	
Broadcast Gateway	ROUTE Input	NIC3	192.168.51.14	255.255.255.0	
Analyzer	ROUTE Input	NIC3	192.168.51.15	255.255.255.0	

STLTP VLAN

- The Gateway output NIC and Exciter input NIC should be in the same subnet.
- Example:

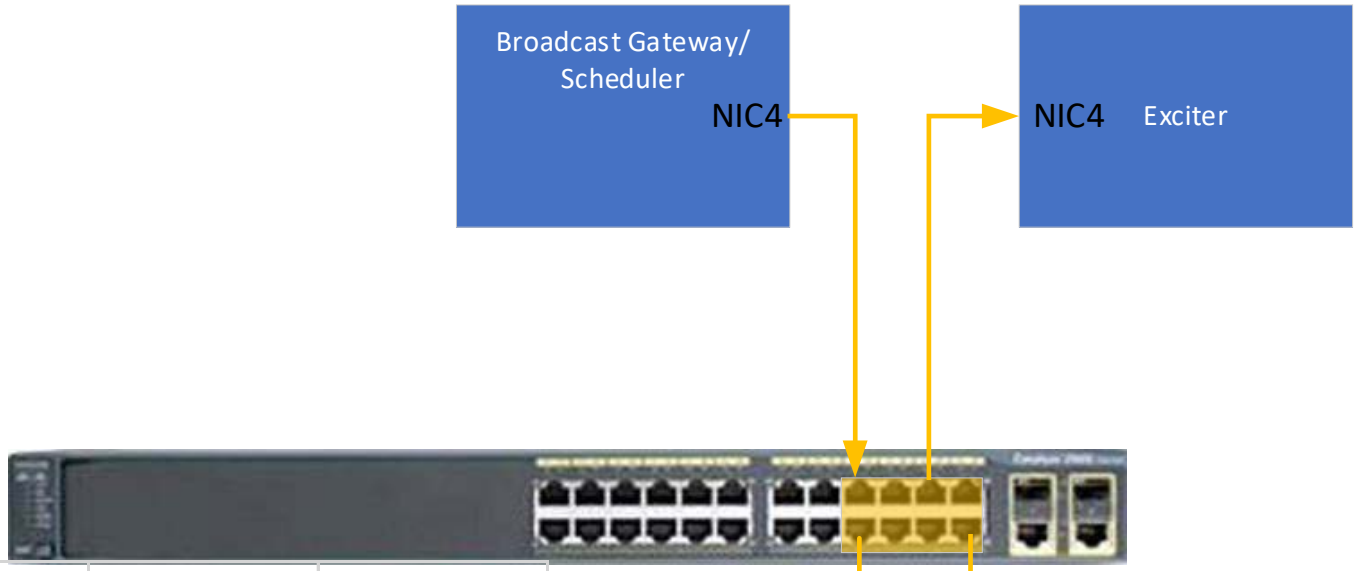
Gateway Output NIC is 192.168.52.14/24.

Exciter Input NIC is 192.168.52.15/24

STLTP VLAN Troubleshooting

- Because the Broadcast Gateway feeds the exciter via some STL usually, that is the first thing to look at.
- You should still be able to ping between Broadcast Gateway and Exciter
- Make sure the STL has the necessary bandwidth to carry the signal (35 Mb/s is a good max number to allocate)
- Its nice to have some equipment at the transmitter site so you can monitor both the studio and transmitter ends

STLTP VLAN



Control VLAN					
Broadcast Gateway	Control	NIC1	192.168.49.14	255.255.255.0	192.168.49.1
Analyzer	Control	NIC1	192.168.49.15	255.255.255.0	192.168.49.1
IRD	Control	NIC1	192.168.49.16	255.255.255.0	192.168.49.1
Exciter	Control	NIC1	192.168.49.17	255.255.255.0	192.168.49.1
STLTP VLAN					
Broadcast Gateway	STLTP Output	NIC4	192.168.52.14	255.255.255.0	
Analyzer	STLTP Input	NIC4	192.168.52.15	255.255.255.0	
IRD	STLTP Input	NIC4	192.168.52.16	255.255.255.0	
Exciter	STLTP Input	NIC4	192.168.52.17	255.255.255.0	

ROUTE & STLTP Multicast Rule

- All IP packets, other than LLS IP packets, shall carry a Destination IP address either (a) allocated and reserved by a mechanism guaranteeing that the destination addresses in use are unique in a geographic region, or (b) in the range of 239.255.0.0 to 239.255.255.255, where the bits in the third octet shall correspond to a value of SLT.Service@majorChannelNo registered to the broadcaster for use in the Service Area of the broadcast transmission…

ROUTE Multicast Rule

- We use a number of different schemes to accomplish this. They are always a derivative of 239.255.<major channel>.<minor channel>:8 <major channel><minor channel>. Ex: If your virtual channel is 20.1, then the ROUTE address would be 239.255.20.1:8201.
- ESG is typically 239.<major channel>.0.255:8000 or 239.20.0.255:8000.
- Some groups have station octets as part of their IP scheme and these are incorporated into the addressing if applicable.

STLTP Multicast Rule

- 239.0.<major channel>.<minor channel>:8 <major channel><minor channel>
- Example, if your Lighthouse virtual channel is 20.1, then the STLTP would be 239.0.20.1:8201

ROUTE & STLTP Multicast Scheme

Channel	DASH Path	ROUTE Out Path	STLTP IP Address
ABC HD 20.1	http://192.168.51.13:8080/uploads/ABC/manifest.mpd	239.255.20.1:8201	239.0.20.1:8201
NBC HD 10.1	http://192.168.51.13:8080/uploads/NBC/manifest.mpd	239.255.10.1:8101	
CBS HD 17.1	http://192.168.51.13:8080/uploads/CBS/manifest.mpd	239.255.17.1:8171	
FOX HD 52.1	http://192.168.51.13:8080/uploads/FOX/manifest.mpd	239.255.52.1:8521	
Preamble		224.0.23.60:4937	
ESG		239.20.0.255:8000	

Reference Materials

- ATSC 3.0 Station Lighthouse Manual from Pearl
- ATSC 3.0 Standards (https://www.atsc.org/atsc-documents/type/3-0-standards/)

Questions