“Live TS over IP - Live lessons learned”

Live network streaming - the problems we solved in the last 20 years.

VidTrans 2020

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Presentation Outline

- What is our main task?
- What do we need to do?
- What are the problem we are facing?
- Different network behavior
- Common problems review
- How to address the problems
- Alternative solutions
- ATSC 1.0 and 3.0 example
- Q&A

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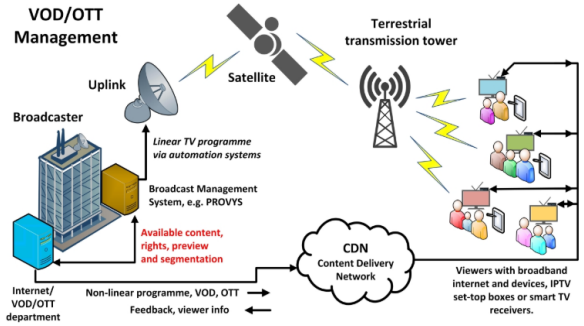
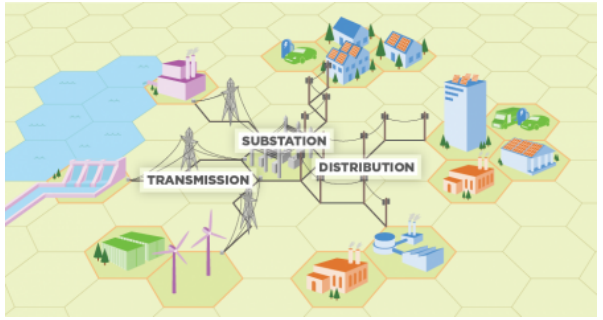
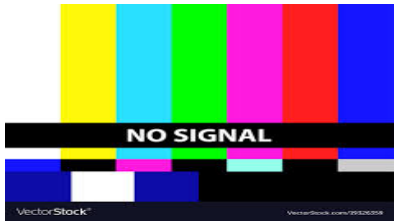
What is our main task?







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Continuity of service is our main task

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The basic Setup problem

- Planning
- Equipment
- Knowledge
- Measurement
- Network behavior

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Live TS over IP Problem Description

Switching Packet networks	• Packet jitter • Packet Loss • Reliability is mostly 99.99%
Bandwidth fluctuations	• Packet traffic patterns change • Network congestion • Link congestion caused by other users and applications
Solution must support	• Point-to-Point contribution • Point-to-Multipoint distribution • SPTS and MPTS

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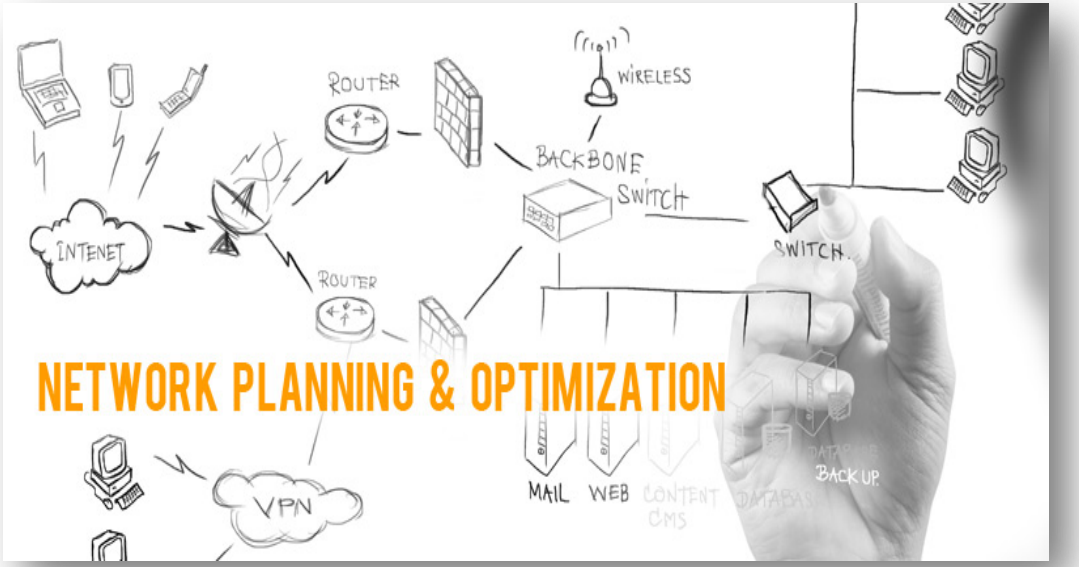
Planning

- Most often either the IT or broadcast team are responsible for the planning
- Lack of training and experience yield long install time, frustration, and management pressure
- Old methods are neither cost effective nor yield optimal results
- Using local experience may be 'good enough'
- Choosing the right technology is key for future expanse and stability
- Offloading the work to someone else may be the only quick and dirty solution



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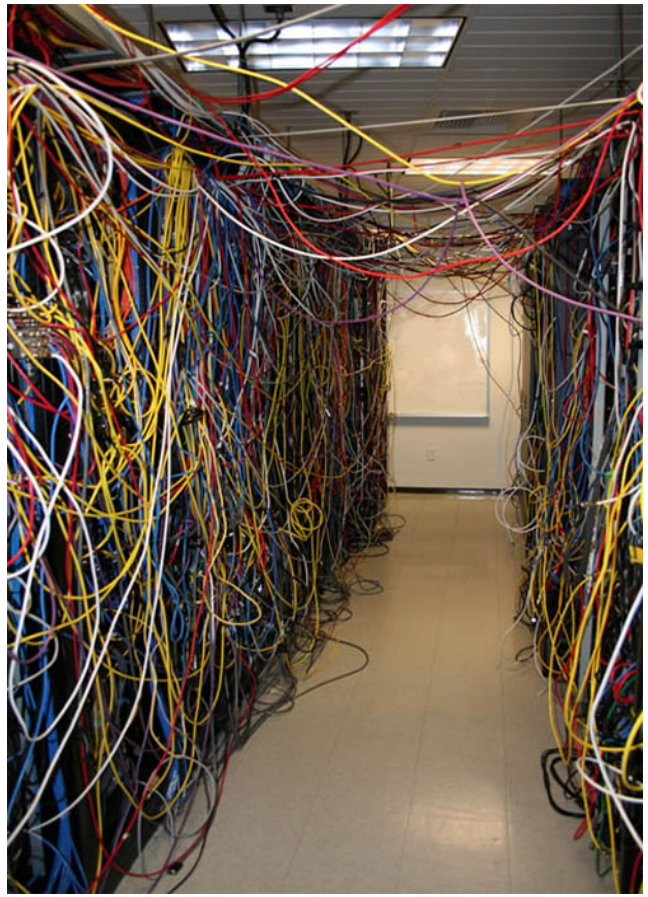
The Video Equipment problem

- Most devices have an IP data port
- Most devices are not tuned for long haul streaming
- All devices are great for point to point local streaming
- SMPTE 2022-7 is supposed to resolve long haul streaming
- Long haul is usually conducted over private or leases line circuits
- A third party is responsible for the long haul connection
- Network problems are solved by the third party
- We have to trust the third party, they are the specialist



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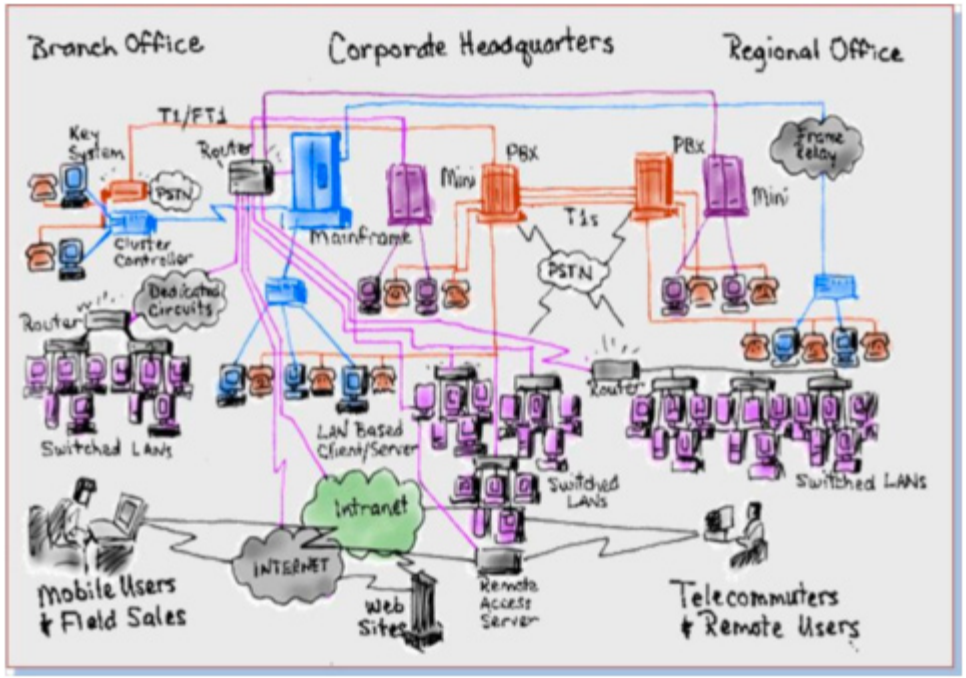
The Knowledge problem ; IT

- IT normally support Firewall, local LAN, office SW, VoIP, Cloud, VM, Container and VPN
- Main concern : ‘all quiet in the western front’
- With recent TV Station groups M&A we find different IT groups, and different local network topologies.
- No central control and observation
- Simple and costly solution is always the easy escape



And IT people don’t speak Video

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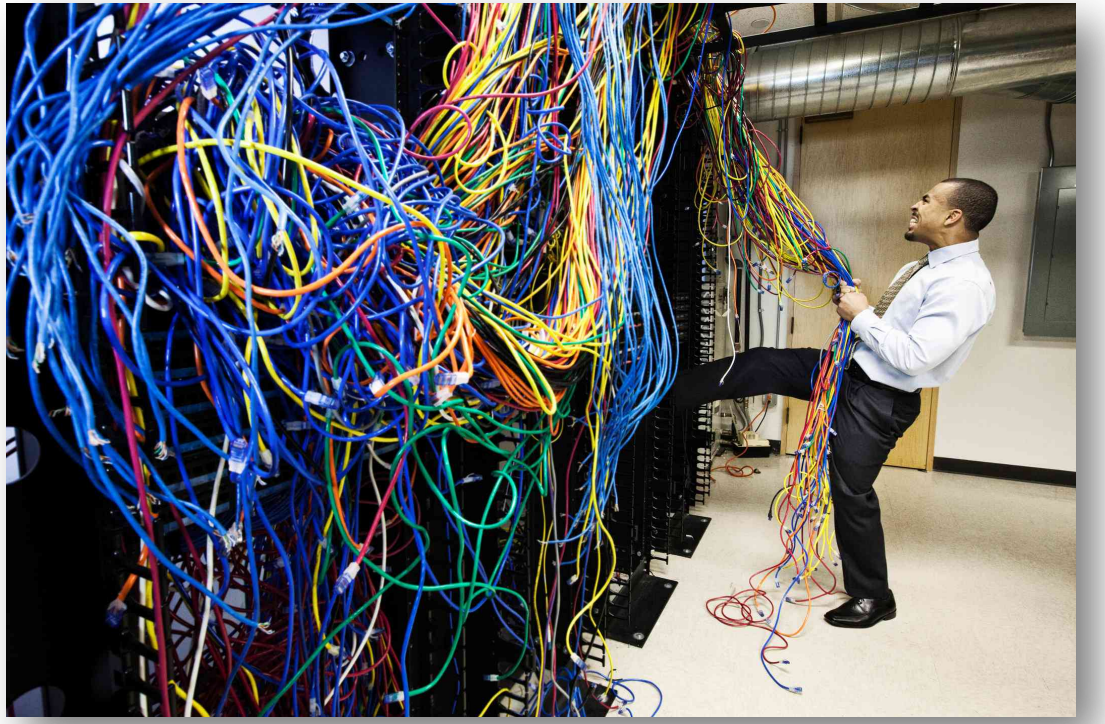
The Knowledge problem – Broadcast

- Most broadcast engineers are trained for LAN traffic
- They are familiar with the Encoder and Decoder RJ-45 port
- Firewall, Cybersecurity, Port forwarding, and DHCP are not part of the encoder and decoder configuration
- File transfer, quality of service, SLA, and congestion are the responsibility of some one else
- IT is responsible to design both local and long haul connections
- The Internet is dirty
- What is this new cloud thing that management wants?



And we want IT and Broadcast people to understand each other

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Wrong Measurements – Wrong Decisions

- Wrong Tools
  - Ping and RTT are too slow to detect live streaming issues
  - Ping plotter/Trace route bad information
    - ICMP/ping interval is every 1sec
  - SpeedTest
    - Based on TCP/HTTP upload/download test
  - *Results change based on network pattern*

- Right Tools
  - Netcat (win/Linux) – transmits a stream at your desired rate for several minutes and observe reception
  - Iperf (win/Linux) - trasnmits a stream at your desired rate for several minutes and observe bandwidth, jitter, RTT and packet loss
    - *Tuned to UDP and 1320 byte MTU*

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Network behavior

- Organization need to recognize the small satellites of the network they want to use.
- SLA is just a start
  - Call center response time
  - MTTR (Mean time to repair)
  - MTTD (Mean Time to Detect)
  - Jitter reports
  - Packet loss reports
  - Backup/alternate paths
  - Oversubscription

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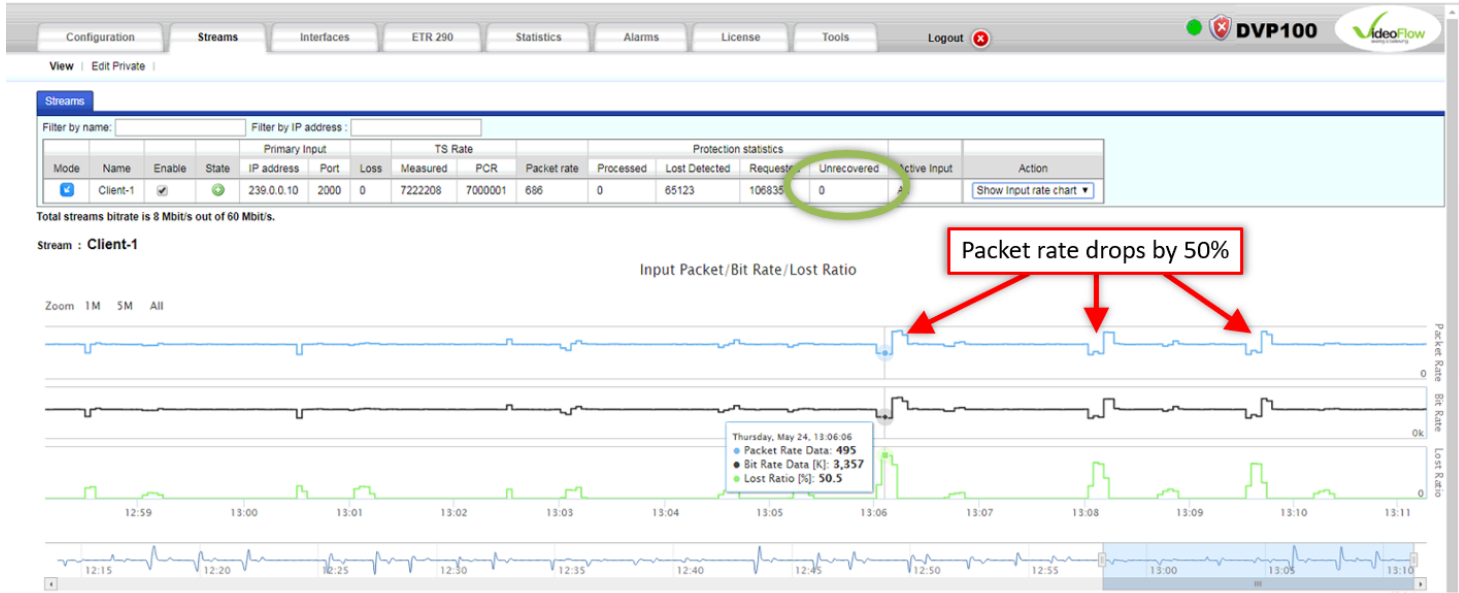
Docsis network example

Latency and Packet Loss Issues with my Internet

- I've been having issues with dropped frames while I stream and latency issues when I game online. My connection never disconnects and my speed is fine. Every 30 seconds or so my latency will spike from a regular 30ms to about 250-300ms for a second or two. If I stream on Twitch or Youtube I constantly drop frames and the video feed looks choppy.
- I've ran ping and traceroute tests on my command prompt and they all point to packet loss issues. I've had 3 techs come out to my building and only one said that he detected any packet loss. They've swapped my modem, replaced cables and checked the outside line for tap/splitter problems but I continue to have issues.
- I called to have my service canceled because I was charged $50 when the tech found "no problems" and they offered to upgrade my service for free and remove the charge. When the tech came to install the new service, he was sub-contracted by 'xxxxxxxx' and only installed the new modem and refused to check out my issues.
- The problem continues and I feel like my pleas are falling on deaf ears. I'm at my wits end and just want someone to confirm what is causing this problem.
- Is there anything I can do?



https://forums.timewarnercable.com/t5/Connectivity/Latency-and-Packet-Loss-Issues-with-my-Internet/td-p/153303

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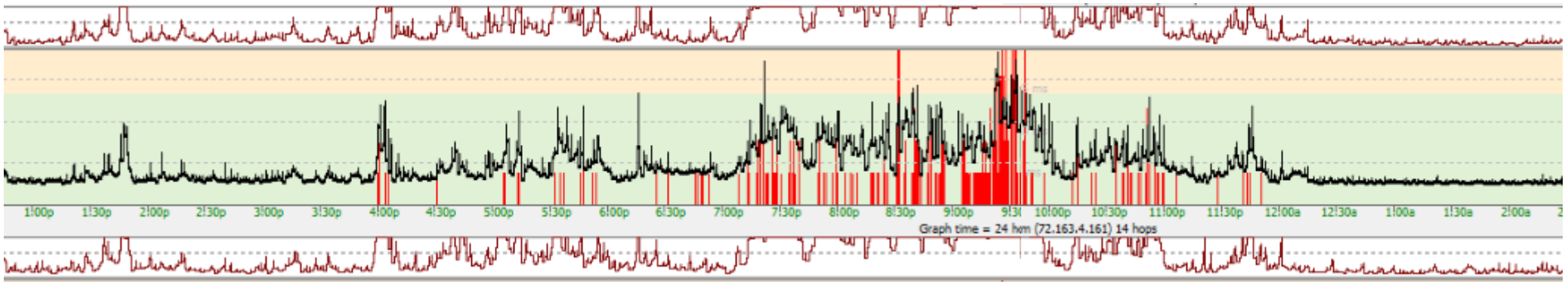
Internet jitter and packet loss patterns



- The Internet misbehaves between 4PM to 11:30PM
- Latency spikes from 50 ms - 70 ms to 250 ms
- Packet loss can spike from a normal 1% to 7% and the burst to 30%
- OTT video consumption, Facebook, Social video are the key contributors

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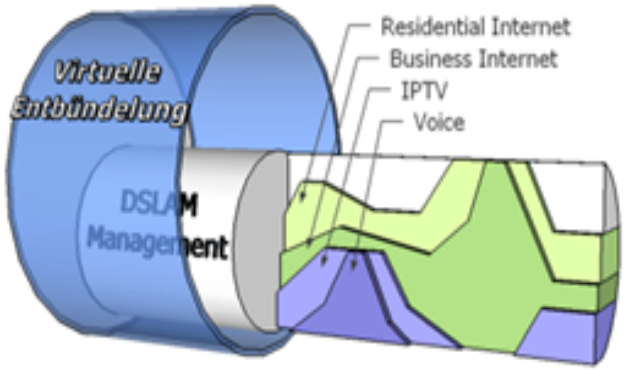
Network quality assessment

- Leased line circuits
- SDN and SD-WAN
- MPLS
- DIA
- Broadband Internet



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Leased line circuits

- A great solution for point to point streaming.
- Availability of 99.999% and low delay
- Most often two Lease lines are in use in A + B configuration to achieve robustness and failure assurance
- Problems start when multiple groups and sites are using the same network
- Temporary oversubscription, can cause congestion at the service provider that yield packet loss and latency variation (jitter)
- Proper QOS and bandwidth allocation per application is mandatory to achieve 99.999% SLA
- Cybersecurity concern level is low
- Can carry multicast
- High monthly cost

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SDN and SDWAN

- SDN (Software Defined Network) and SD-WAN are the new hype words of IT and equipment manufactures.
- With SDN/SD-WAN the network links and resources are virtualized regardless of the underlined connection technology.
- The SD-WAN can be across multiple sites and create virtual network with multiple different services (Internet access, VoIP, PBX, File transfer, Backup and Live Video Streaming).
- SD-WAN SLA is based on the underlined connection service provider
- Most SD-WANs will run on a mix of Internet and leased circuits infrastructures
- SD-WAN can provide in-depth analysis and reporting to better understand how the network is being used and how it is performing.
- SD-WAN can change routes/paths on-the-fly causing sudden latency and packet loss spikes
- SD-WAN does not assure packet loss or fix latency of the underline link
- Can carry Multicast
- Mid level Cybersecurity risk

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MPLS

- Multi-protocol label switching (MPLS) network is a well managed network with resource allocation mechanism on top of the IP protocol
- Each packet is labeled and monitored in its flight through the network, allowing high QOS and SLA.
- The benefits of MPLS are scalability, performance, better bandwidth utilization, reduced network congestion, and a better end-user experience.
- MPLS is a service that must be purchased from a carrier and it is very expensive
- MPLS is optimized for TCP and not UDP
- Field deployments show that MPLS services tend to collide with other services causing latency spikes and bursts of packet loss
- Low Cybersecurity risk

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DIA

- Dedicated Internet Access means that your contracted bandwidth is exclusively yours
- DIA connection is normally a symmetrical connection
- DIA contracts often include SLA for latency and availability (99.99%)
- DIA is considered as MPLS over public Internet
- Medium to High level of Cybersecurity risk
- Considered to have more Jitter and packet loss as it run over Internet
- Possible service fluctuation due to Internet backbone
- Some DIA networks support Multicast

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Open Internet

- Best effort network
- Asymmetrical upload/download speeds
- The stability has improved over the last 5 years
- Main problem is the first mile sensitivity
- Jitter and packet loss change over the course of the day with picks at 6 pm that can reach 15%
- Static IP is optional, but critical to assure streaming service
- Unicast or multicast over VPN
- High level of Cybersecurity risk

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Misbehaving networks

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Common Problems

- Lower actual bandwidth than the one you paid for
- Burst of packet loss
- ARQ retransmission
- Going SMPTE 2022-1/2 over WAN
- Going SMPTE 2022-7 over WAN
- Bandwidth fluctuations

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Less bandwidth than stated

- The ‘miss understandings’
  - The bandwidth is for pick/max burst throughput, e.g. short burst of traffic and not continuous
  - The client would order bandwidth A and got B << A
  - The Service provider shares the physical link with others, and those paid more
  - Service provider changes IP address every few hours or days with a short service interruption
  - Service provider performs maintenance every few days for an hours or so
  - Service provider’s MTU is lower than 1300 Bytes

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Burst of Packet loss

- No network is perfect
- The normal Internet is 80% salt and pepper noise and 20% burst loss
- Burst loss may occur on path change, Congestion flow control
- Last mile is more prone to burst loss

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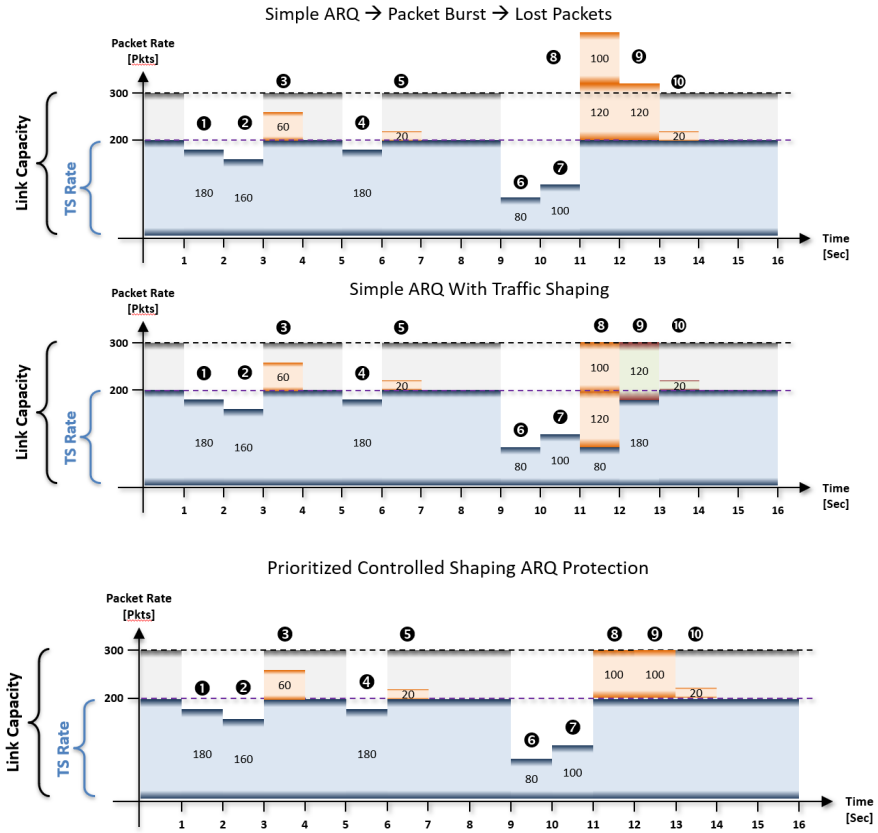
ARQ retransmission causes more damage

- Links have a bandwidth constrain
- When the ARQ retransmission is not controlled (Limited) it will take bandwidth from the stream. This will increase packet loss to the point the link will be occupied with retransmitted packets and pause
- Some solution are using traffic shaping – that contains both the stream and ARQ and flood the link
- Prioritization and ARQ shaping is required so that the Stream will ALWAYS take first priority and then the ARQ.



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Going SMPTE 2022-1/2

- SMPTE 2022-1/2 is a great solution for LAN environments.
- Going SMPTE 2022 over a non perfect WAN network is a recipe for a disaster
- Reports and studies show that is can only overcome 3% packet loss.
- The additional overhead for SMPTE 2022 (in 2D mode) can create extra packet loss as it creates up to 25% overhead in some cases
- SMPTE 2022 should be only used in LANs where packet loss is low or if there is NO other alternative

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SMPTE2 022-7 over WAN

- SMPTE 2022-7 is a great step forward to provide redundancy between different Links.
- For proper delivery over WAN, a user must assure the use of totally different networks to benefit from the SMPTE 2022-7.
- Many times the two paths are running on top of the same carrier and may loss of the same packets.
- Augmenting the SMPTE 2022-7 with ARQ yielded very good results

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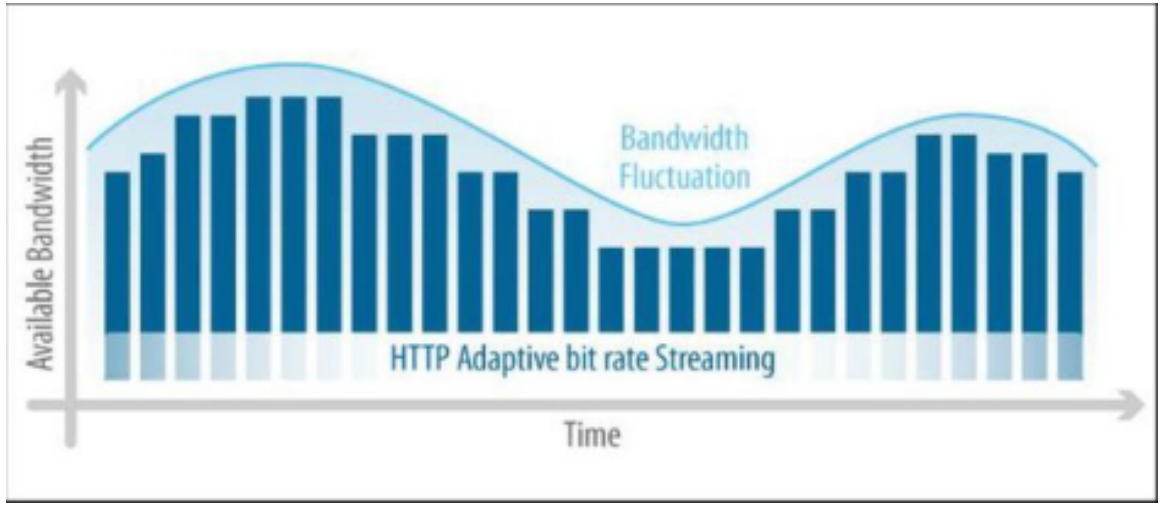
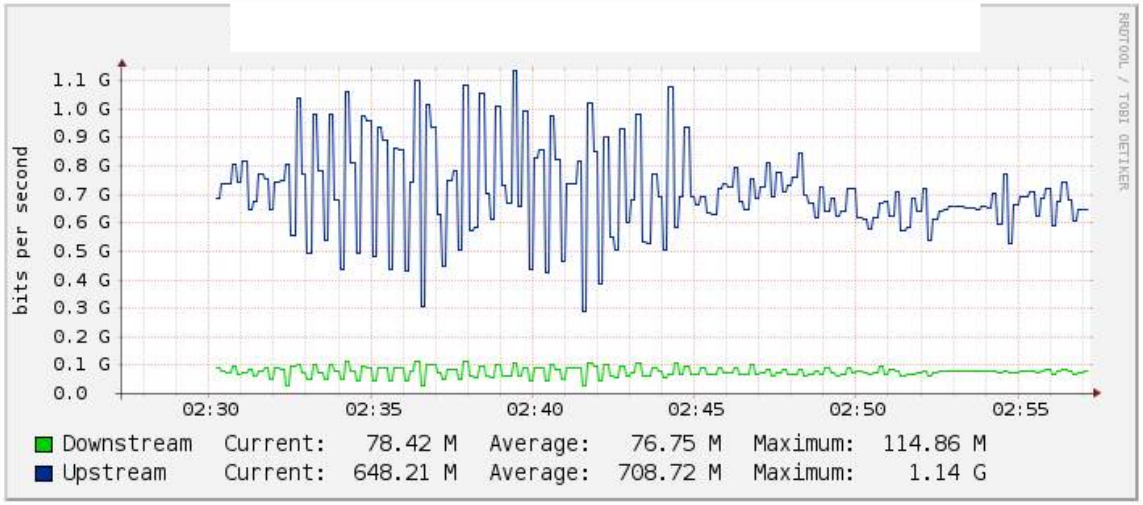
Bandwidth fluctuation





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What should one do?

- Choose the right technology and vendor partner
- Teach your IT people the video language
- Teach your Video people the IT language
- Create a safe environment where IT, Video, and vendors can plan, discuss and execute what its best for your organization
- Test and verify your LAN and video links before every Project
- Look around, new technologies and streamline solutions are coming each year. A solution that was good 5 years ago can be replaced by lower cost and more effective one.

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TS over IP essentials (my rules of thumb)

- Analyze your network before you begin
- Jitter reduction
- ARQ for error removal
- Prioritize Stream over ARQ
- Limit the ARQ so that it won’t flood the connection
  - Stop ARQ if is causes more bad then good
- Use multi path
  - Use dynamic load share to reduce load on your networks
  - Provision to max but allow less traffic to reduce load and interference
  - Couple high SLA Links coupled with low SLA Links to save cost
  - Use prioritized service delivery
- Use Adaptive delivery
- Use Authentication is more important than encryption

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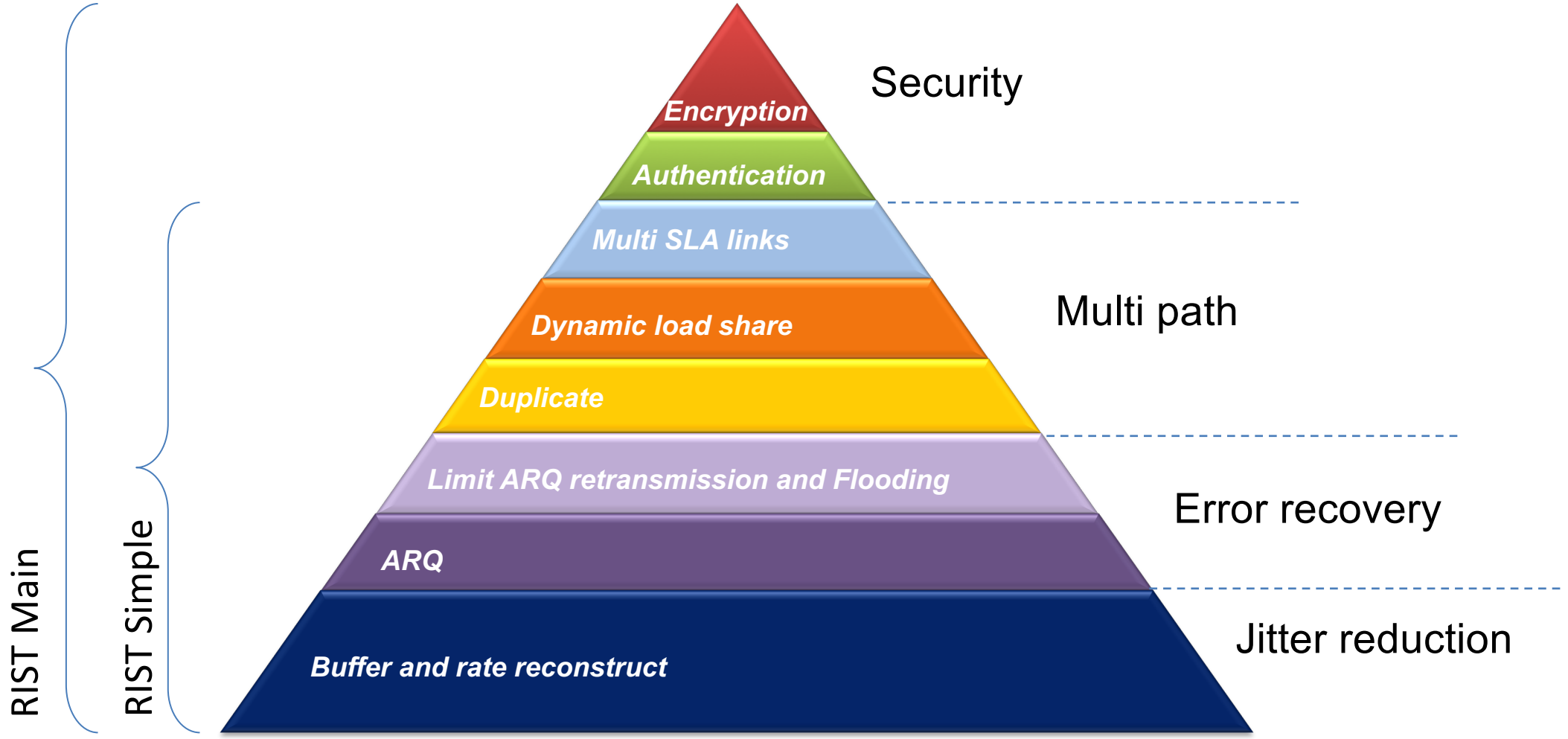
The foundation of reliable streaming



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Operational efficiency

- The introduction of low cost IP opens new capabilities:
  - Reliable streaming
  - Hitless recovery
  - Remote monitoring
  - Confidence monitoring
  - Disaster Recovery
  - Secure access to remote sites
  - Low cost backup

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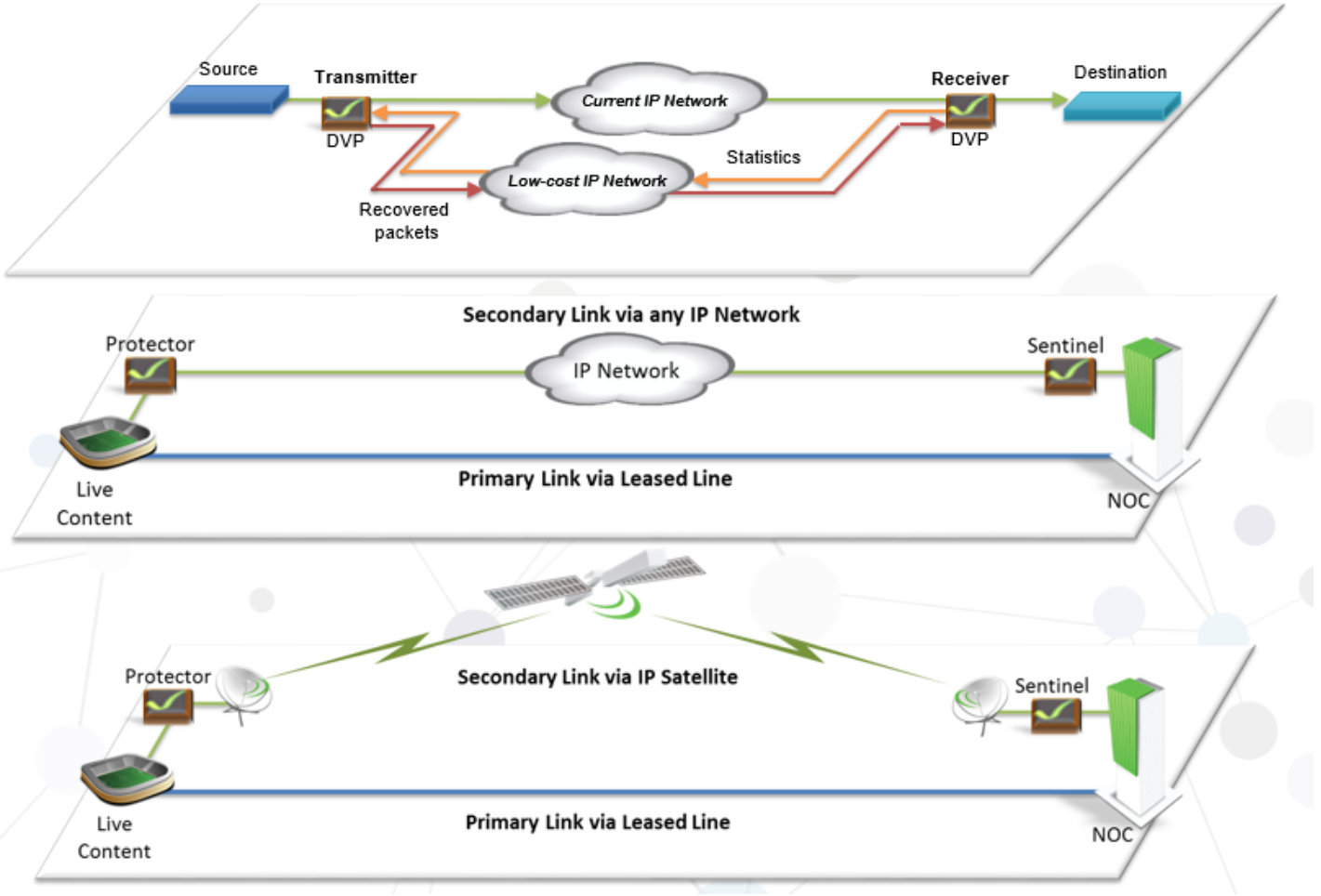
Alternative solutions

- We found that the key for successful continuity of service is to dynamic load share between several ISPs:
  - MPLS and DIA
  - DIA and Internet
  - Ku and Internet
  - Ka and internet
  - DIA and LTE
- Each medium carries a portion of the stream
- Service based QOS is achievable



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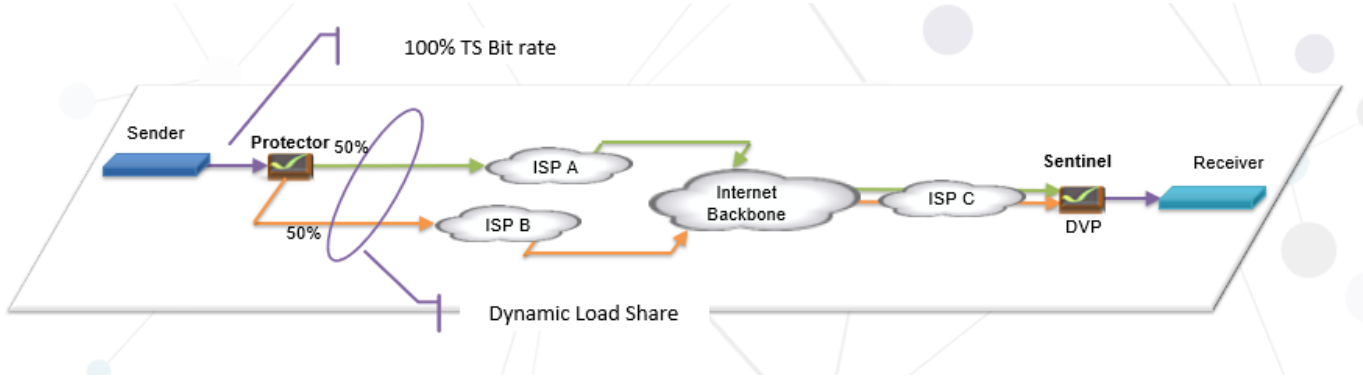
Bonding ISP's and connection

- Solves the issue of not having enough bandwidth from one ISP
- Bonding several ISP's with Dynamic Load share solve the problem
- In one example we bonded two ADSL carries, each with 1.5mbit upload speed to carry 2.5Mbit with each one carrying 1.25



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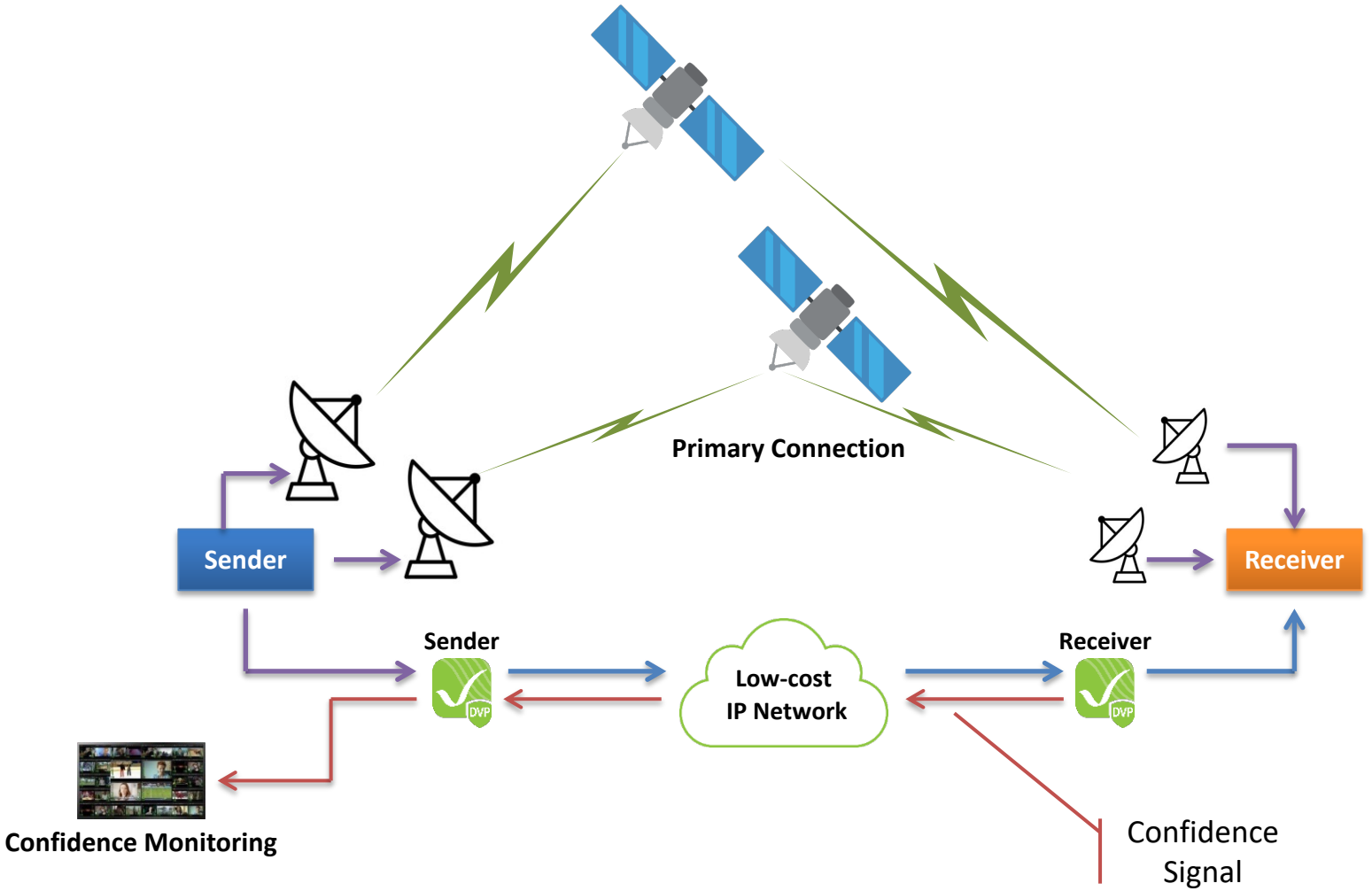
Satellite Bonding

- Solved the issue of carrying more bandwidth available on a single Satellite.
- In this example two Ku Satellites were bonded to deliver a 44 Mb/s over dual Ku links.
- Additional Error recovery was provided via internet
- Internet was used for confidence monitoring



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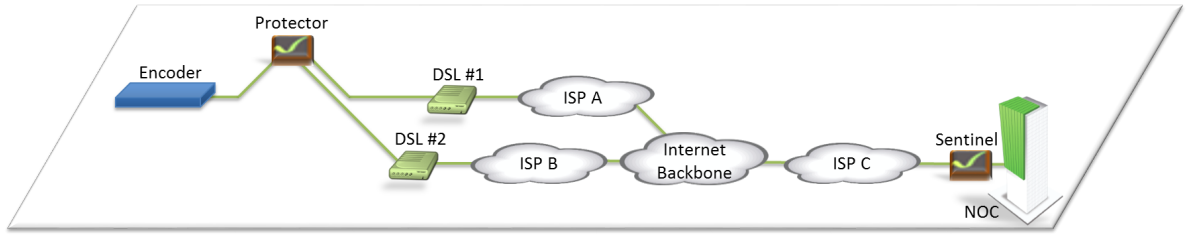
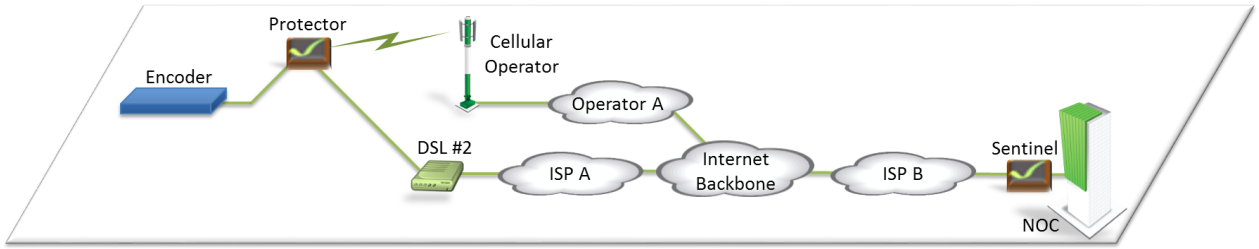
Improving Network reliability

- Improving network reliability by adding a low cost link (Internet or Data LTE).
- The additional Link can carry ARQ or low priority services
- In many cases this improved the original solution to become a 99.999%
- Sometimes a mobile LTE modem can do wonders





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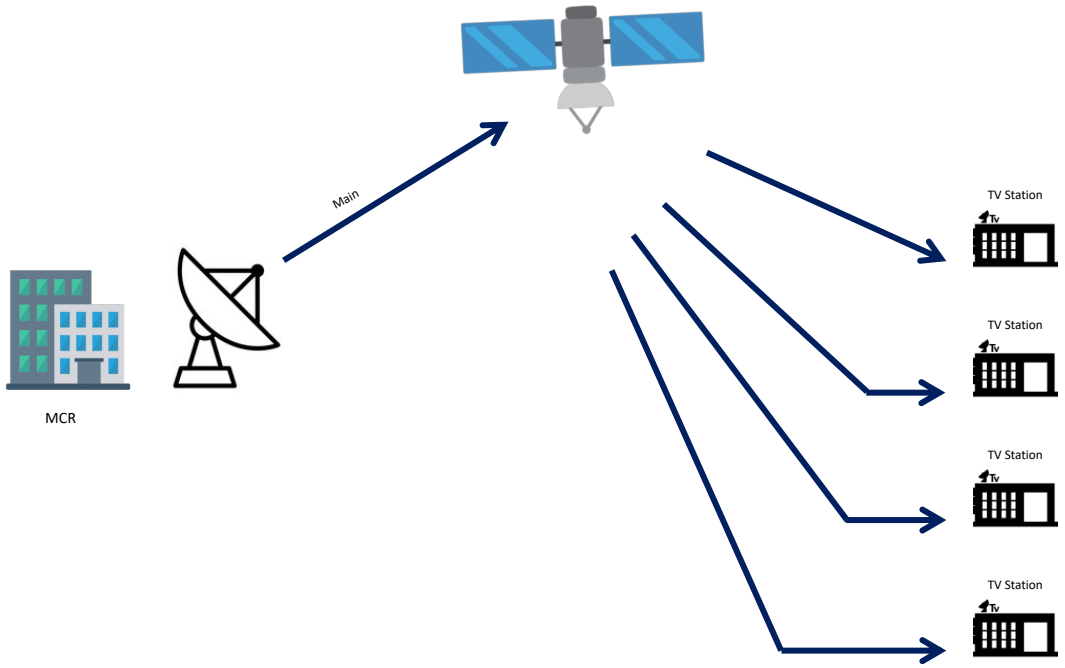
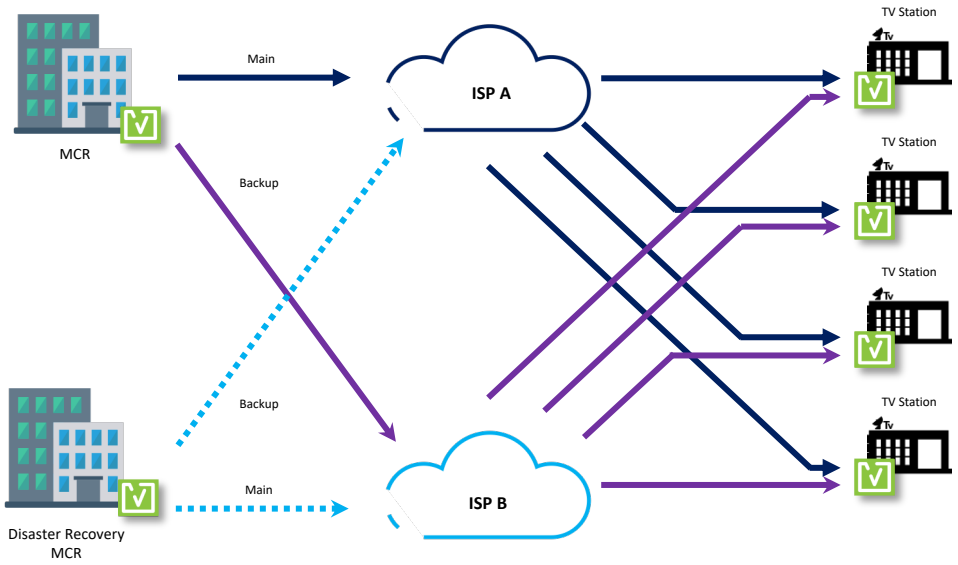
Replacing Satellite with IP streaming

Traditional SAT





Simple DR, higher resilience

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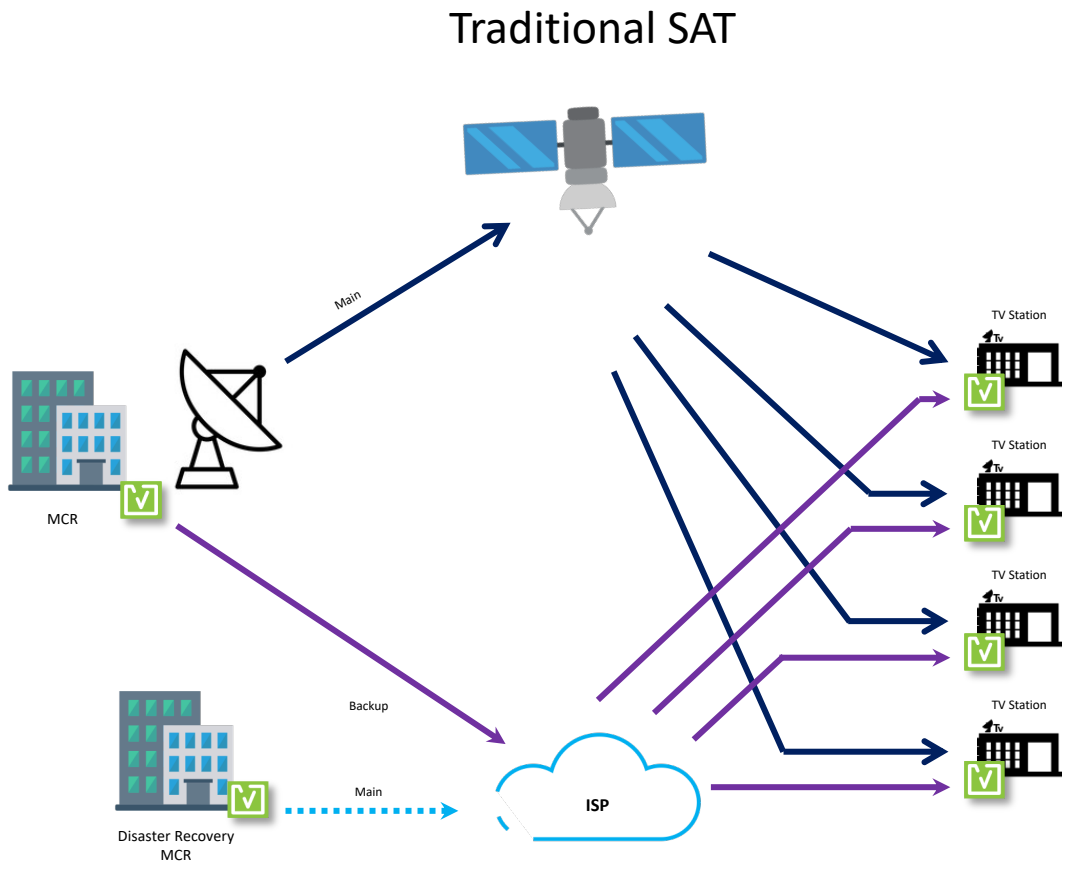
Complementing Satellite with IP streaming

- Traditional Satellite distribution has a perfect friend: IP
- Create a backup delivery when conditions are bad
- Monitor the reception (Alarms, ETR290, confidence return)
- Add disaster recovery



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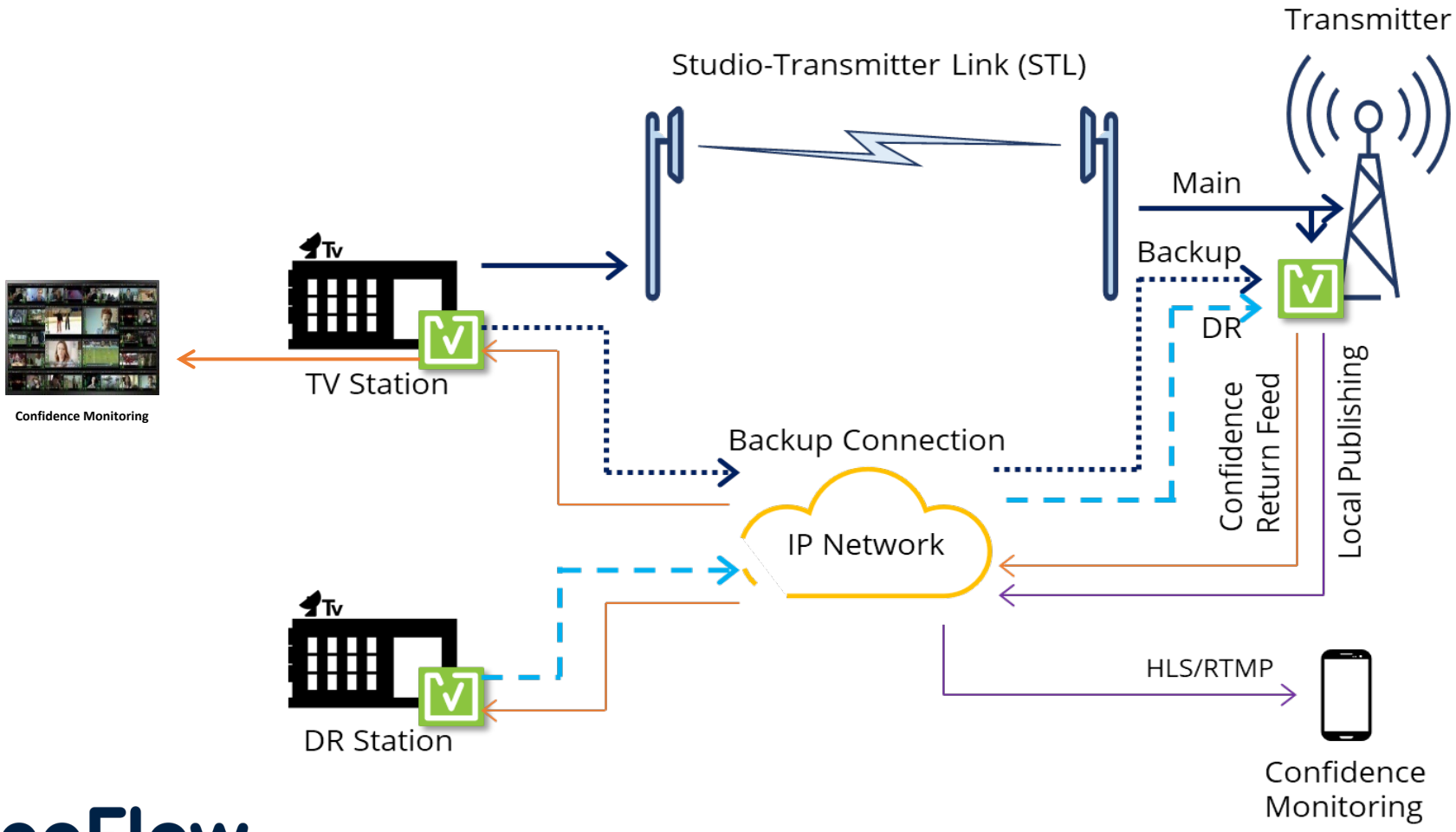
Operational efficiency : ATSC1.0 STL



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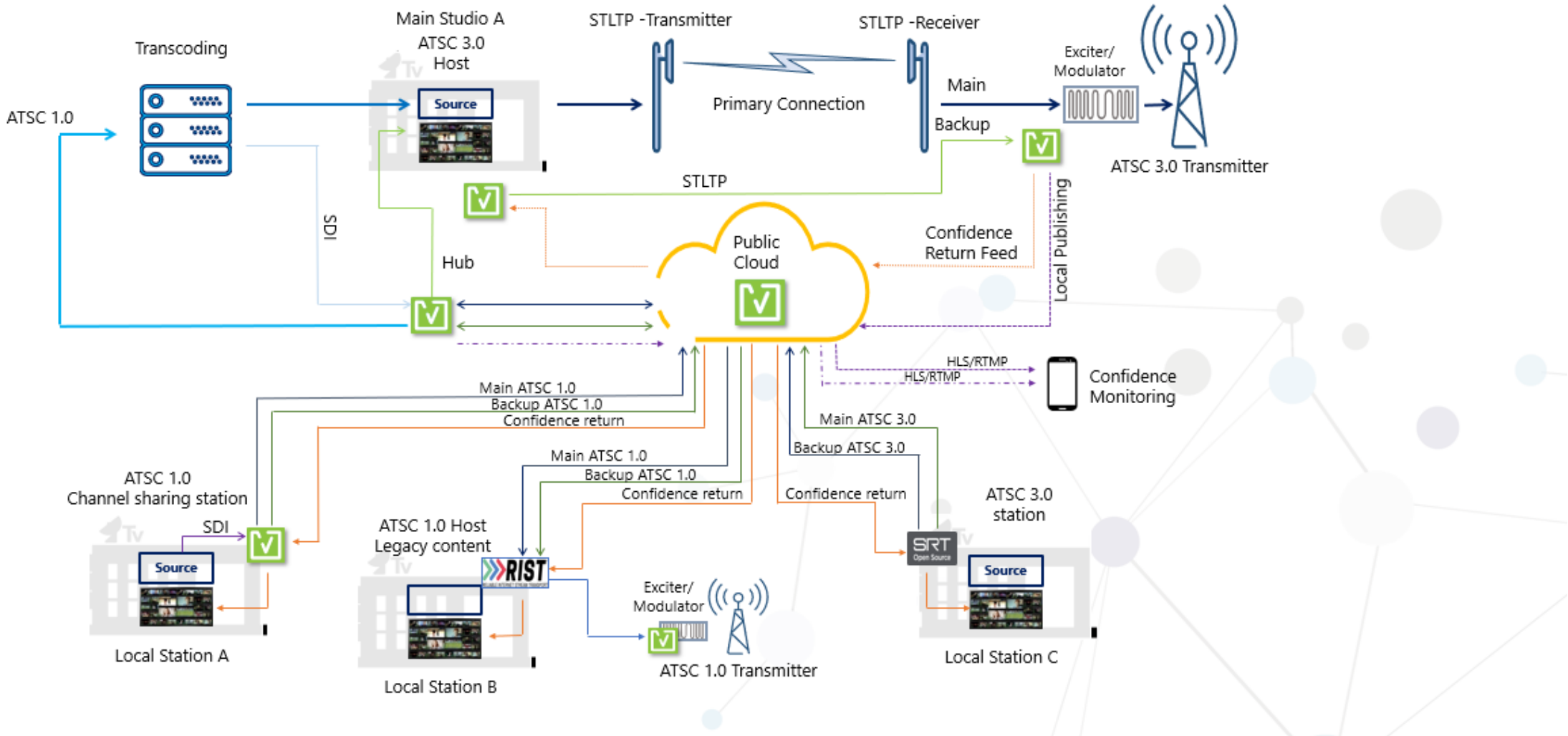
Hosted ATSC 3.0 system



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Q&A

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