Alternative architectures for Broadcast TV/Video Distribution in Metro Ethernet Networks

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Agenda

- **L2 vs L3 for the aggregation**
- **Video Service and QOS Requirements**
- **Dual Stream Video Architecture**
- **Conclusion**

L2 vs L3 for the aggregation

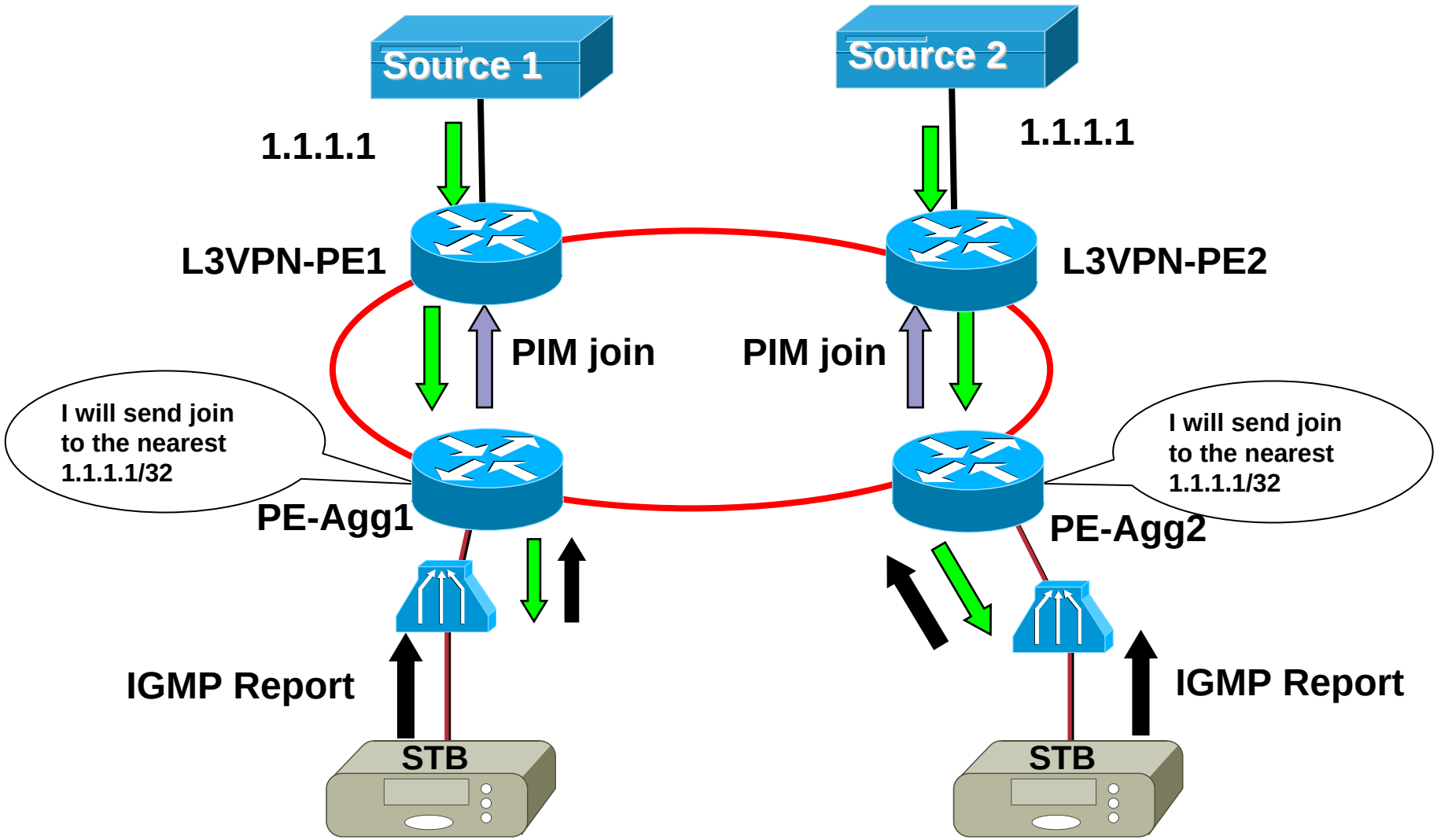
Why Layer 3 for Video in Distribution Network?

- **Better ARP / Forwarding Adjacency Scaling**
  - IP Aggregation Interface Requires 1 ARP + 1 Forwarding Entry / STB
  - Example Worst Case Numbers:
    - 400 Video Subscribers / DSLAM, 40 DSLAMs / PE-Agg
    - 10 PE-Agg / L3VPN-PE
  - L2 Aggregation Scaling == 160000 ARP + Forwarding Entries in N-PE
  - L3 Aggregation Scaling == 16000 ARP + Forwarding Entries in PE-Agg
- **Simpler VLAN Topology**
  - L2 Architecture Uses Separate Video VLAN per PE-Agg in Distribution
    - Needed Due to Bridge Table Scaling Issues in Distribution Network
    - Multicast VLAN Routing Needed to Reduce Multicast B/W in Distribution
  - L3 Architecture Uses Single Video VLAN in Distribution
    - No Bridge Tables in Distribution Network; No Scaling Issues
    - Unicast and Multicast Video Carried in same VLAN

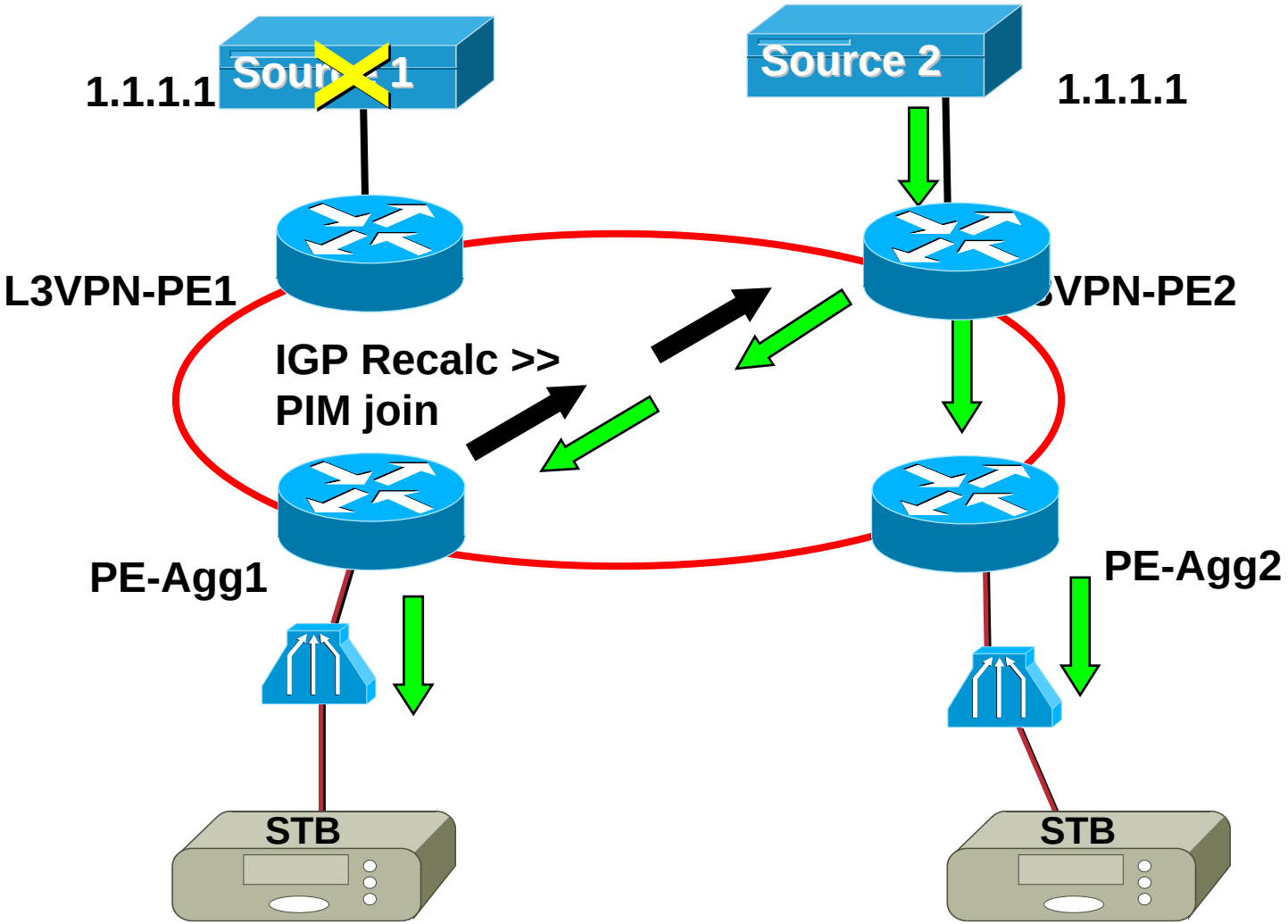
Why Layer 3 for Video in Distribution Network?

- **Enables IP Multicast Replication in Distribution Network**
  - **IGMPv2 >> SSM Mapping in PE-Agg**
  - **Source Based Replication (SSM) More Secure**
- **Enables Anycast for Multicast**
  - **Supports Separate multicast trees for Redundant Encoders**
  - **Allows Fast Fail Over of Redundant Encoders**
    - **Fail Over Occurs within IP reconvergence time**
- **Enables Multicast Load Balancing**
  - **No Multicast Load Balancing with Dual N-PE Routers with L2 Distribution**
  - **Potential Fail Over Issue as Well**
  - **No Issue If PIM Runs to PE-Agg Router**
- **PE-Agg Supports Simultaneous L2 and L3 Forwarding**
  - **Some Services Require Layer 2 Distribution Network**
  - **Catalyst Switches Support Different Switching Models on Per VLAN Basis**
    - **Layer 2, Layer 3, Layer 2 + Layer 3 (Switched Virtual Interface)**

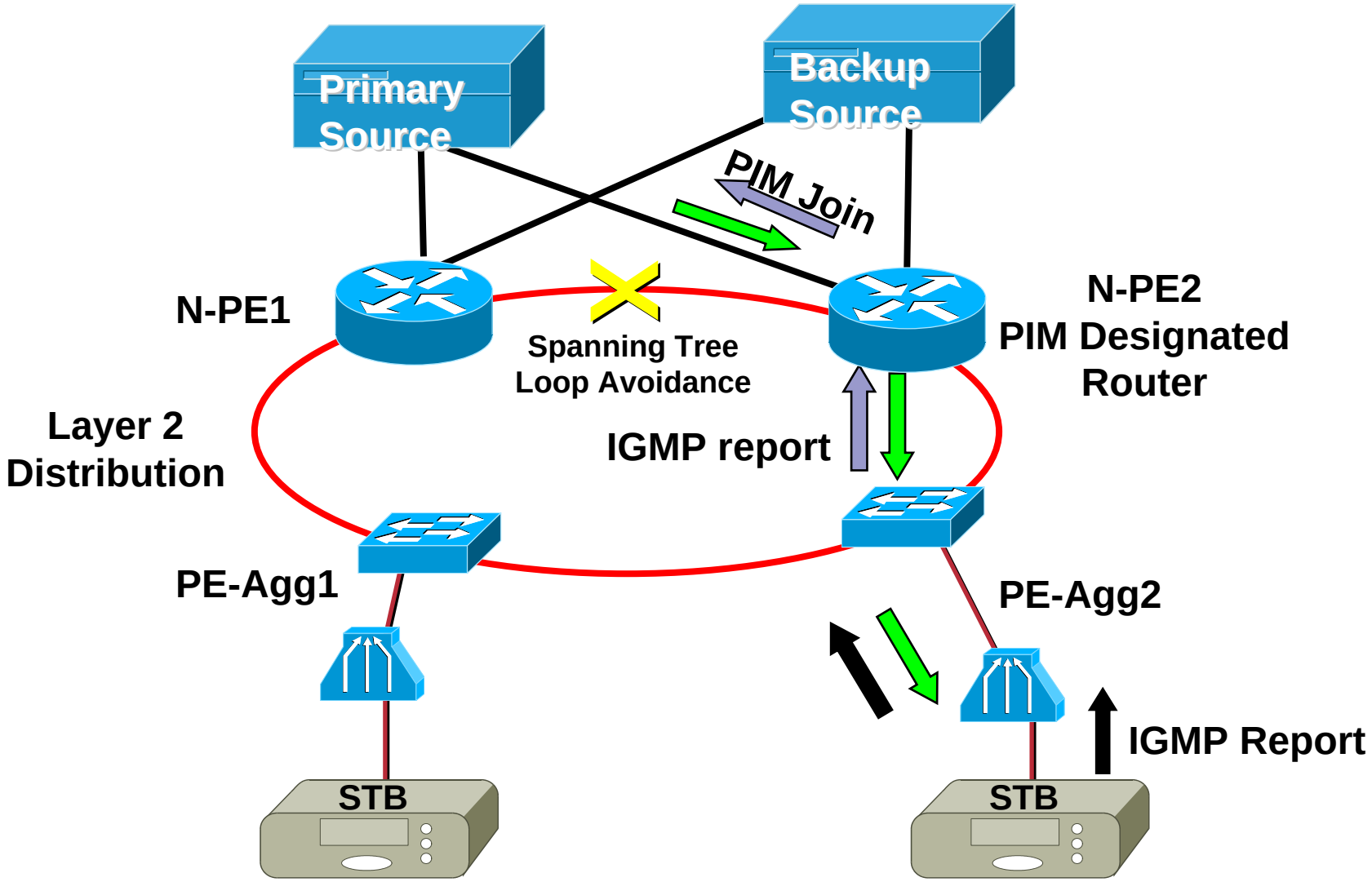
L3 allows Anycast Based Load Sharing



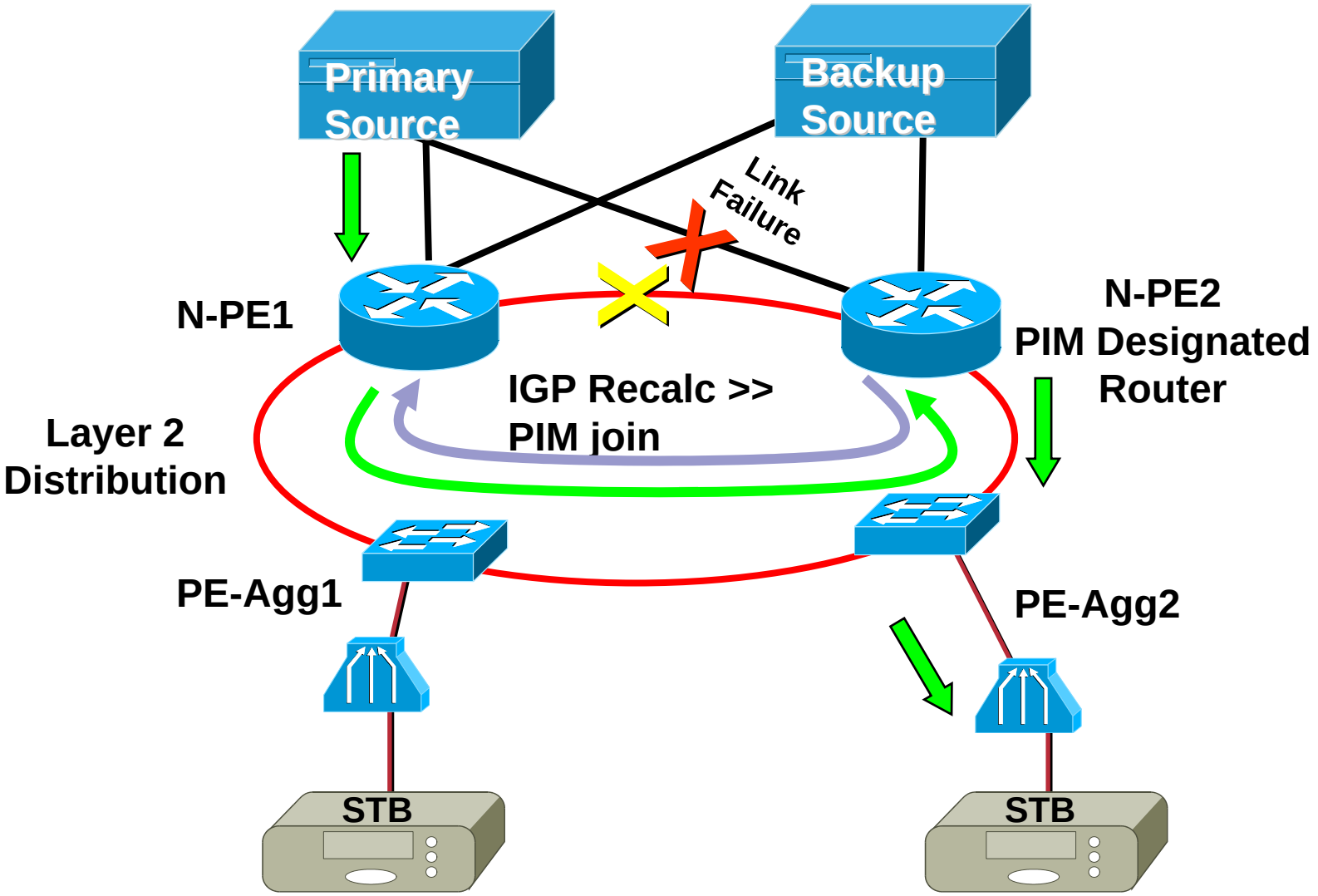
L3 and Encoder Fail Over Using Anycast



Multicast Convergence with Layer 2 Distribution



Potential Multicast Convergence Issues with Layer 2 Distribution



- Video Service
- and
- QOS Requirements

Broadcast Video Service Challenges

Contributors to Channel Change Delay @STB

1. Multicast Leave for old Channel (50 msec)
2. Delay for Multicast Stream to Stop (150 msec w/ Fast Leave)
   Delays Due to IGMP Queries / Timeouts on Access Link
   Fast Leave Processing on DSLAM Removes This Delay
3. Multicast Join for New Channel (50 msec – 200 msec)
4. Jitter Buffer Fill (200 msec)
5. I-Frame Delay (500 msec – 1 sec)

Video QoS Requirements

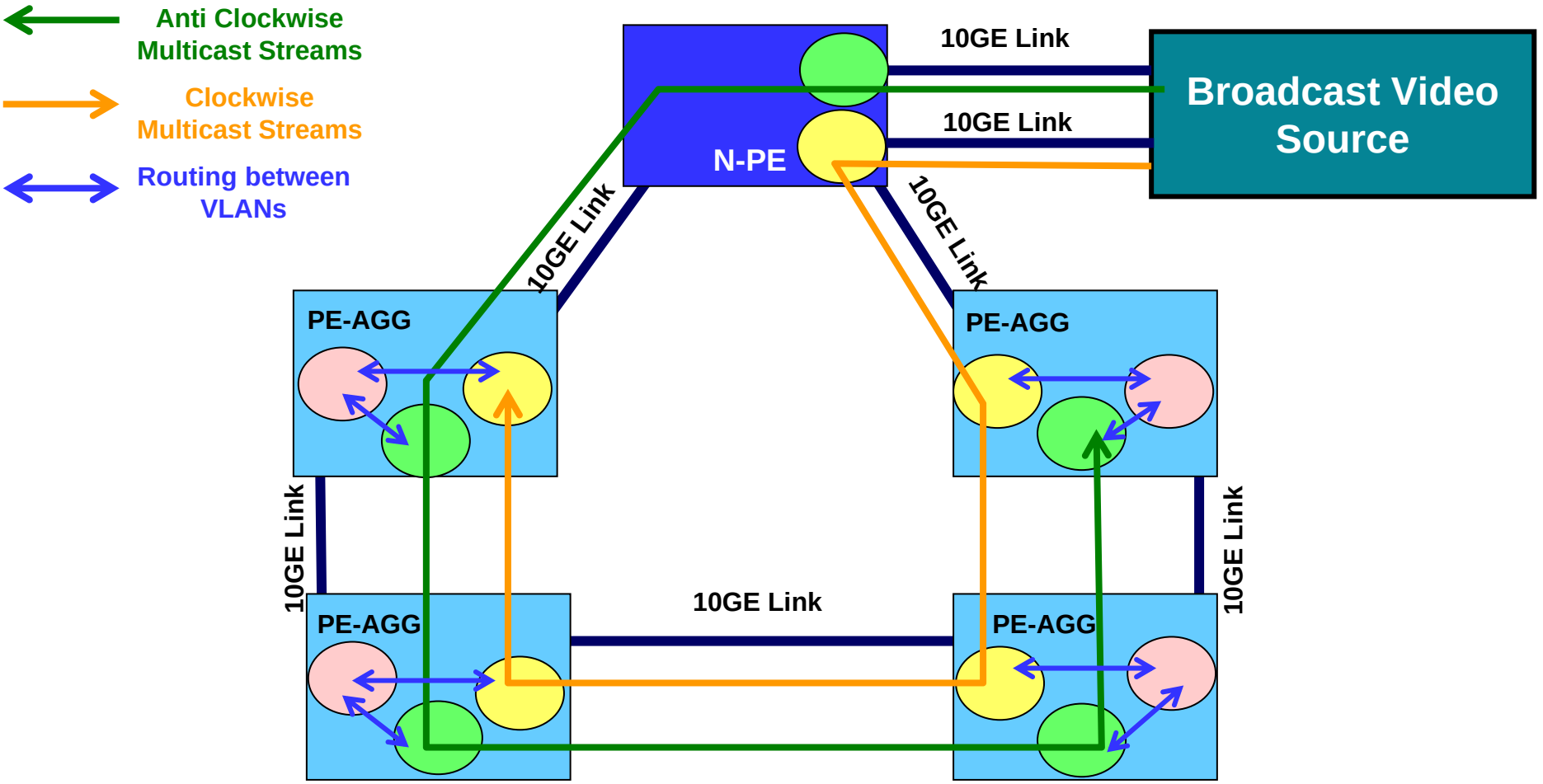
- Video and Voice Have Competing QoS Requirements
  - Video QoS Requirements
    - Allowed Drop Rate ~= 10**-6
    - Allowed Jitter ~= 200 Msec
  - Voice QoS Requirements
    - Allowed Drop Rate ~= 10**-2
    - Allowed Jitter ~= 60 Msec
- Voice Requires Minimal Jitter; Use Priority Queue
- Video Requires Extremely Low Drop Rate
  - Low Drop Rate == Large Buffering
  - Requirement Due to Burst Accumulation
  - Queue Length Must be > Max Expected Jitter to 10**-6 Probability
- Platform Buffering Capacity will be Important for Video in the Future

Dual Stream Video Solution

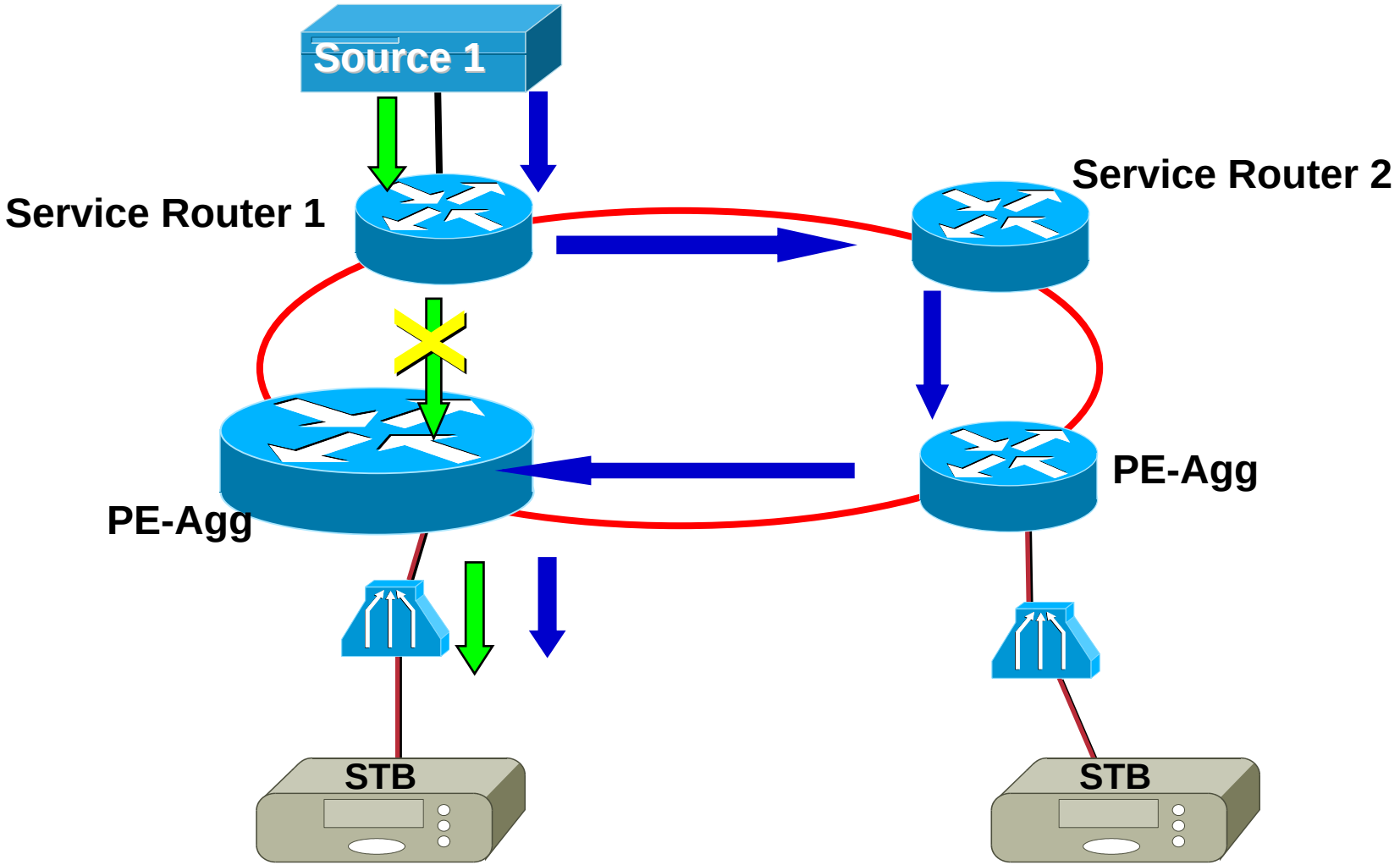
Video Challenge – Reliability

- **Broadcast Source Represents Single Point of Failure for Video**
  - **Failure of Real Time Encoder**
  - **Failure of Link(s) from Real Time Encoder**
- **Multicast Reroute Can Cause Broadcast Interruption**
  - **Network Must Re-converge in < STB Jitter Buffer Time (200 msec)**
  - **Network Must Buffer All Packets During Reconvergence**
- **Intelligent Video Processing Enables Hitless Fail Over**
  - **Send Redundant Multicast Streams to Intelligent Video Node**
  - **Intelligent Video Node Builds Single Output from Redundant Inputs**
  - **Instant Fail Over for Broadcast Video**
  - **No Service Disruption in the Event of Failures**

Layer 3 based Dual Stream Broadcast TV Solution



L3 based Dual Stream Video Redundancy



Dual Stream Redundancy
How it Works ?

- **Broadcast Stream from Encoder Sent to Two Multicast Groups**
- **IP Network Configured to Route Streams Separately**
  - **Constrained Reverse Path Look Up**
- **Multicast streams routed in opposite directions on the ring**
- **Failure of a link requires PIM Join to adjacent Link receiving the same stream**
- **Source Specific Multicast Routing to ensure security**
- **This architecture is fully upgradeable to future solutions**