

Using SDN To Facilitate Precisely Timed Actions On Real-Time Data Streams



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Live Professional Video

- HD-SDI (HD Serial Digital Interface)
 - 1.5 Gbps Uncompressed HD digital video
 - On 75Ω coax (*best solution in 1996*)
 - 1 HD video signal per cable, unidirectional
- Could it be on Ethernet?
 - **SMPTE 2022-6** carries HD-SDI bit stream on multicast RTP
 - 6 HD signals on 10 GbE, 66 HD signals on 100 GbE
 - Multicast because we need point-to-multipoint





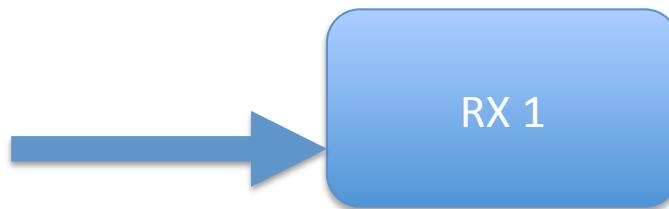
1 video signal per cable in one direction means lots of cables...

“Video Switching”: Best during the Vertical Interval...



Use IGMP for “Destination-Timed” Video Switching?

- Receiving existing video flow



- Receiving existing video flow
- **DOUBLE**
- Wait for Switch Point
- **BANDWIDTH!!!**
- IGMP Leave old video flow



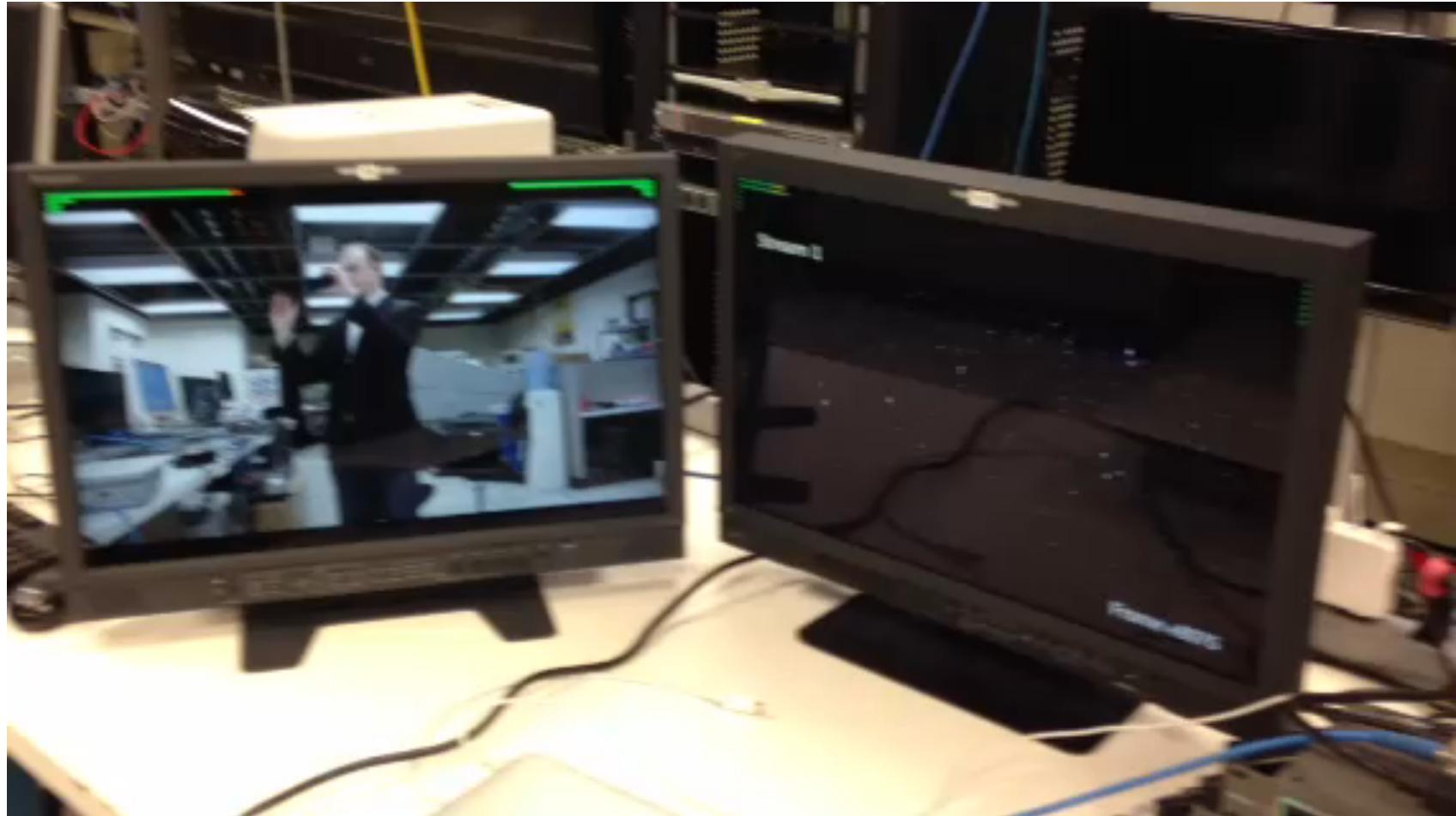
Use SDN for “Switch-Timed Video Switching”?

- Need timing accuracy $\sim 10 \mu\text{s}$ to synchronously switch video in vertical interval (SMPTE RP 168)
- **1-10 ms** to update flow rules on switches
- **No guarantees** on flow rule update latency
- Other solutions?

“Source-Timed SDN Flow Switching”

- Before video switch (~100 ms), add new flow rule that matches packet header value **not being sent yet**
- At **precise time** of video switch, all video sources update packet header value to **match new rule** [sources are “video aware”]
- Video flows over new flow rules
- Old rules can idle_timeout, etc.
- Live PoC used UDP SRC port (header field) & DirectFlow (SDN API) on Arista switch

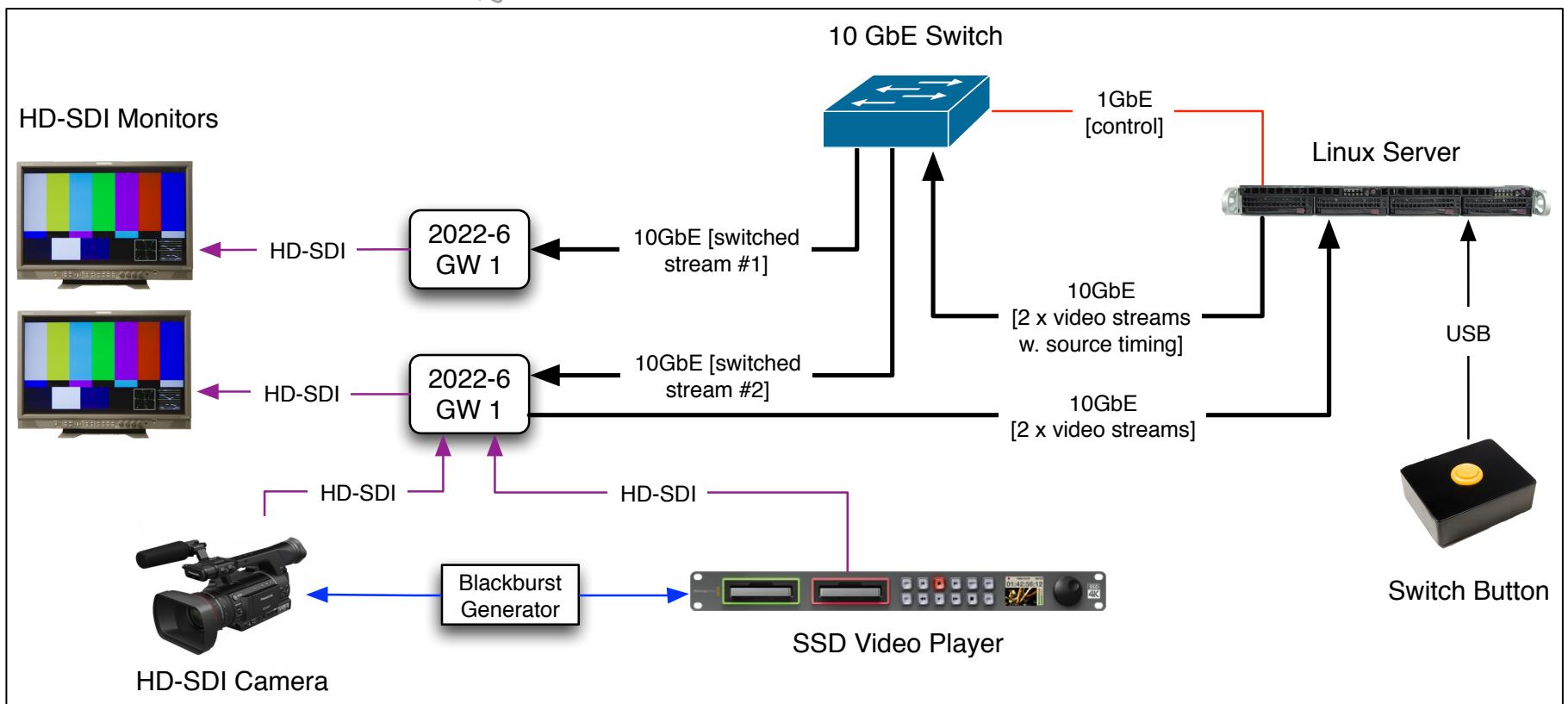
It worked...



Perhaps there are other flows that need precisely-timed changes besides video?



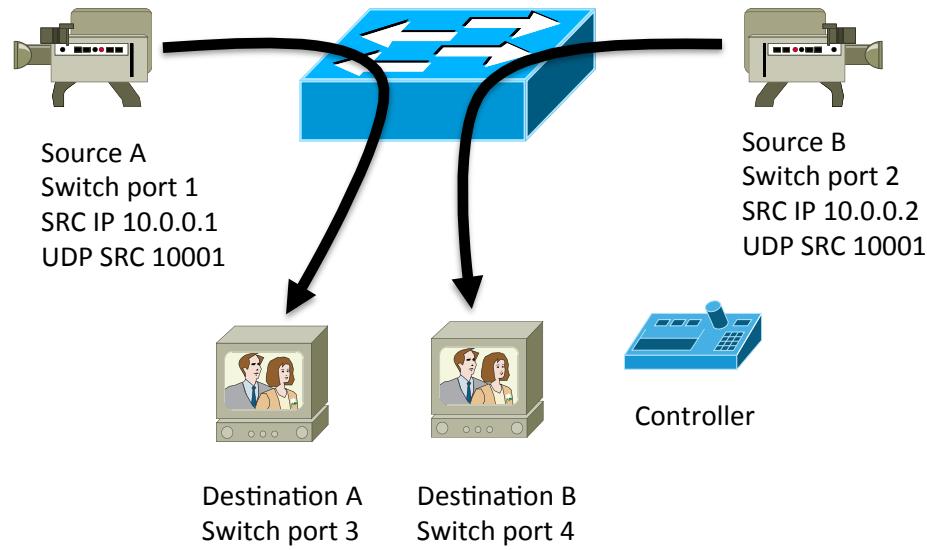
Questions?



Source-Timed Switching PoC Schematic



Source-Timed Video Switching: Initial Conditions



UDP SRC port used as “timing header” to signal VRT Version

→ Video flows

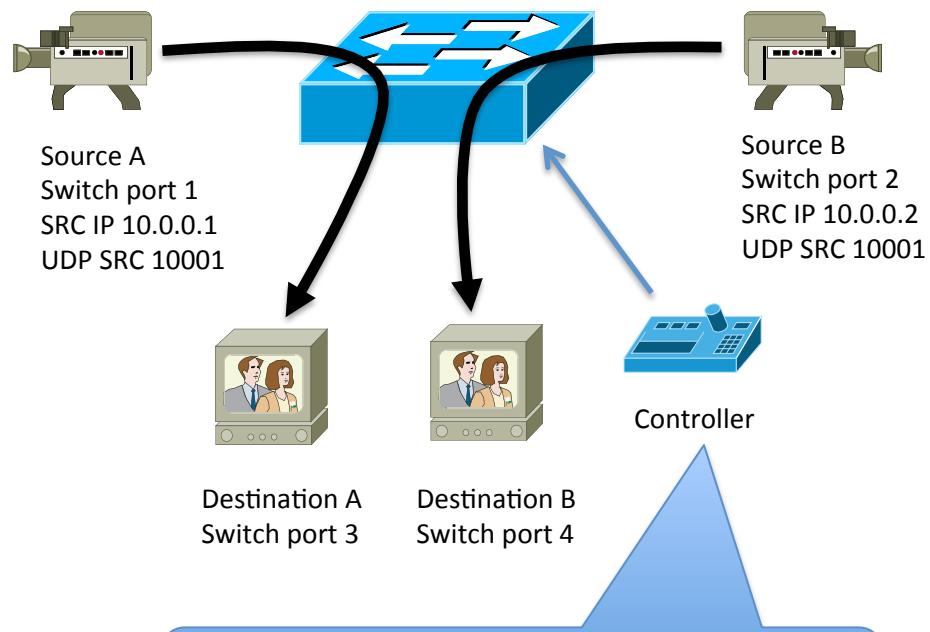
Initial Video Routing Table (VRT):

| VRT #10001 | Source A | Source B |
|---------------|----------|----------|
| Destination A | X | |
| Destination B | | X |

Initial SDN switch flow table:

| IP SRC | UDP SRC port | Action |
|----------|--------------|----------------|
| 10.0.0.1 | 10001 | Forward Port 3 |
| 10.0.0.2 | 10001 | Forward Port 4 |

Switching Request



→ Video flows

→ SDN Flow table update

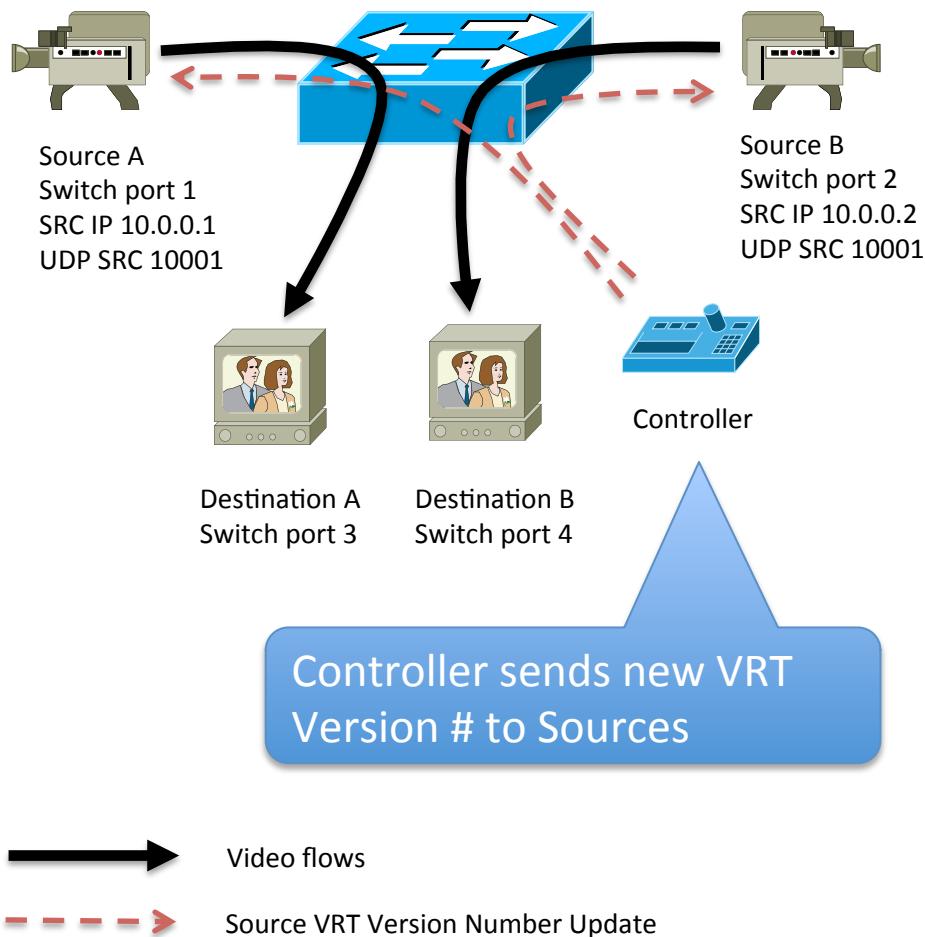
1) VRT Updated & VRT Version # incremented:

| VRT #10002 | Source A | Source B |
|---------------|----------|----------|
| Destination A | | X |
| Destination B | X | |

3) New entries added to SDN switch flow table:

| IP SRC | UDP SRC port | Action |
|----------|--------------|----------------|
| 10.0.0.1 | 10001 | Forward Port 3 |
| 10.0.0.2 | 10001 | Forward Port 4 |
| 10.0.0.1 | 10002 | Forward Port 4 |
| 10.0.0.2 | 10002 | Forward Port 3 |

Updating Source VRT Version



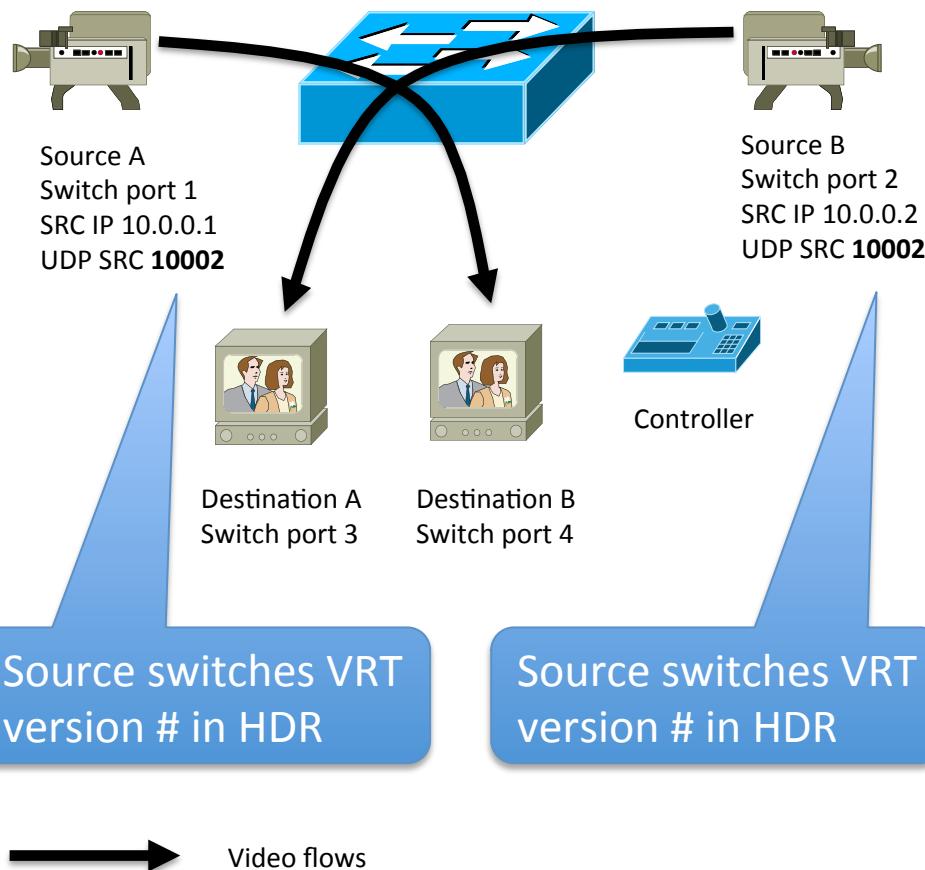
Video Routing Table:

| VRT #10002 | Source A | Source B |
|---------------|----------|----------|
| Destination A | | X |
| Destination B | X | |

SDN switch flow table:

| IP SRC | UDP SRC port | Action |
|----------|--------------|----------------|
| 10.0.0.1 | 10001 | Forward Port 3 |
| 10.0.0.2 | 10001 | Forward Port 4 |
| 10.0.0.1 | 10002 | Forward Port 4 |
| 10.0.0.2 | 10002 | Forward Port 3 |

Sources Switch VRT Version at appropriate time (e.g. SMPTE RP 168)



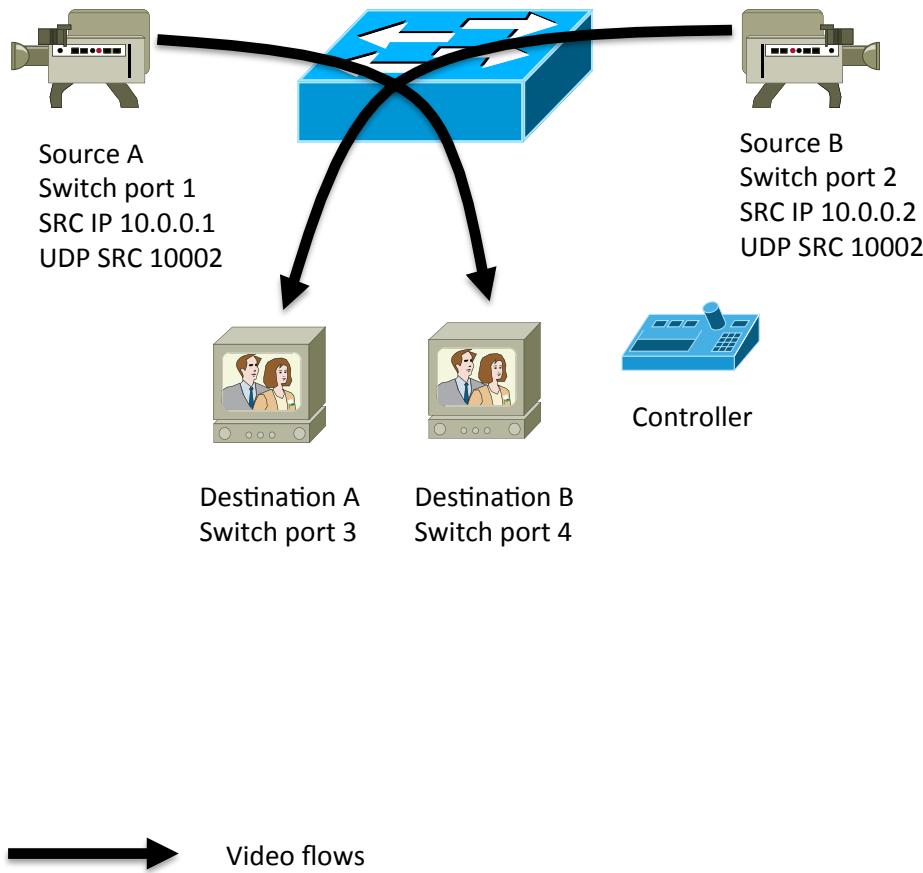
Video Routing Table:

| VRT #10002 | Source A | Source B |
|---------------|----------|----------|
| Destination A | | X |
| Destination B | X | |

SDN switch flow table:

| IP SRC | UDP SRC port | Action |
|----------|--------------|----------------|
| 10.0.0.1 | 10001 | Forward Port 3 |
| 10.0.0.2 | 10001 | Forward Port 4 |
| 10.0.0.1 | 10002 | Forward Port 4 |
| 10.0.0.2 | 10002 | Forward Port 3 |

Old Flow Rules Removed



Video Routing Table:

| VRT #10002 | Source A | Source B |
|---------------|----------|----------|
| Destination A | | X |
| Destination B | X | |

Old rules are specifically removed or
idle_timeout:

| IP SRC | UDP SRC port | Action |
|----------|--------------|----------------|
| 10.0.0.1 | 10002 | Forward Port 4 |
| 10.0.0.2 | 10002 | Forward Port 3 |