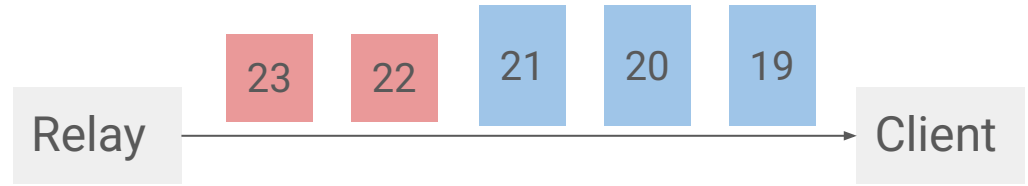


#1378 SWITCH

Gwendal Simon – Will Law – Ali C. Begen – Zafer Gurel
Feb. 2026

What is a Switch?



Definitions

- **Switch Group:** A set of tracks having some common group boundaries
- **Navigation:** define the possible switch *options* among tracks in an Switch Group
 - E.g., from Track 3, switch is possible to Track 2 (up), Track 4 (down), or Track 7 (disaster)
- **Trigger algorithm:** for each navigation *option*, define rules
 - E.g., Track 3 → Track 4, if (throughput < 3000 kbps for more than 2s) or (packet loss > 3% and lag > 1 group for more than 1s) or (overall Relay throughput > 9750 Mbps for more than 5s)
- **Switch Execution:** at a common group boundary, Relay starts sending Track B's objects instead of Track A's objects
 - No gap (from last Track A's group before transition → Track 'B group at transition)
 - No duplicate Objects
 - No concurrent subscriptions

#1378 SWITCH

A Subscriber-triggered Relay-executed Switch

- Subscriber knows **Switch Group** (via catalog or offline) – out of scope of #1378
- Subscriber knows **Switch Group Navigation** (via catalog or offline) – out of scope
- Subscriber implements a **trigger** algorithm, restricted to
 - Switch ASAP → at the next transition point from Relay's standpoint
 - Switch between two tracks from a valid navigation option
- Relay **executes** switch

Why **Subscriber-triggered** Switch Matters

- **Adaptive Bit-Rate (ABR)** when network connection is unstable
 - Essential feature of streaming industry
 - Vast literature on client-side trigger algorithms based on
 - Buffer threshold and/or evolution
 - Observed network metrics (throughput, losses, RTT changes)
 - Client settings (manual/auto, more or less aggressive, media-oriented)
 - Client-triggered ABR has proven great scalability (*serverless* deployment)
- **Application-specific client-driven usage**
 - Change camera in a multi-view event (e.g., F1 car, multi-player eSport)
 - Change audio/subtitles settings (e.g., from English to French)
 - Change settings (e.g., stereo to surround-stereo audio, 1:1 to 16:9 when mobile to TV)
 - Client-driven quality selection (e.g., to minimize data usage)
 - Client knows the playout buffer size and maybe it can survive transient bw drops easily
- **VR headset based on head movement**
- Plan old **TV channel zapping**

Why **Relay-Executed** Switch is Necessary

The Subscriber does **not** know

- The latest Group of Track A at Relay
 - Under congestion, the Subscriber is unaware of accumulated lag behind live
- Whether the Relay has any upstream established connection for Track B
 - If so
 - What is the latest Group of Track B at Relay
 - Whether Relay has track B's objects in cache (or can fetch past objects)
 - What is the next common boundary group
 - If not, how long it will take to establish connection to Publisher + All of the above

Current Subscriber-side APIs to execute switch have **key weaknesses**

- Cannot prevent multiple concurrent subscriptions (priority cannot help #1101)
- Require at least three messages (in a precise order) for a frequent atomic action
- Rely on guessing a future common boundary → risk of gaps or late switch

SWITCH API Proposal

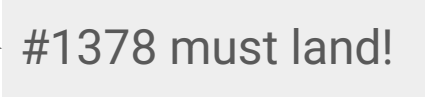
<pre>SWITCH Message { Type (i) = 0x12, Length (16), Old Request ID (i), New Request ID (i), Track Namespace (...), Track Name Length (i), Track Name (...), Auth Info Length (i), Auth Info (...), Close-After-Switch (i), Number of Parameters (i), Parameters (...) ..., }</pre>	<p>Should be related to an existing Subscription</p> <p>The new Subscription ID</p> <p>The new Track</p> <p>Optional authorization info. If <code>length=0</code>, the receiver uses the same auth info as Old Request ID</p> <p>Flag: if 0, terminate the old Subscription, else keep it open with <code>Forward=0</code></p> <p>New parameters. Relay does union of old and new Parameters. If in conflict, new params apply</p>
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Relay Behavior

- Do not forward – process locally
- Check whether `old Request ID` (i.e., Track A) exists ⇒ if not, `REQUEST_ERROR`
- Is there any existing upstream Subscription for Track B
 - If so, same behavior as usual (if parameter set matches, then reuse)
 - If not, create a new upstream Subscription
- Determine transition point (**G_switch**), the next available common Group boundary, wrt
 - The current group in the ongoing Track A subscription **and** the availability of groups from Track B
 - If fail in determining `G_switch` ⇒ `REQUEST_ERROR`
- Sends `SUBSCRIBE_OK` for `new Request ID`
 - Initially `Forward=0`
- At `G_switch`, execute clean switch
 - `Forward=1` for `new Request ID`
 - If `close-after-switch`, `PUBLISH_DONE` for `old Request ID`
 - Else `Forward=0` for `old Request ID`

To sum up #1378

- The whole streaming industry is waiting for **Subscriber-Triggered SWITCH**
- **Relay-executed SWITCH** is necessary
- SWITCH message carries the information needed by Relay to execute it
- Existing SWITCH implementation experience (MOQtail demo)



#1378 must land!

Appendix

Possible add-on (not in PR #1378)

- **Delay the switch upon conditions** (a.k.a. basic server-side switch)

```
SWITCH Message {  
  <same format>  
  cond (i)  
  rule = {  
    metrics  
    oper  
    value  
  }  
}
```

Flag: if 0, then immediately; if 1, then later based on the rule

Only if `cond = 1`. **Define the trigger.** Example

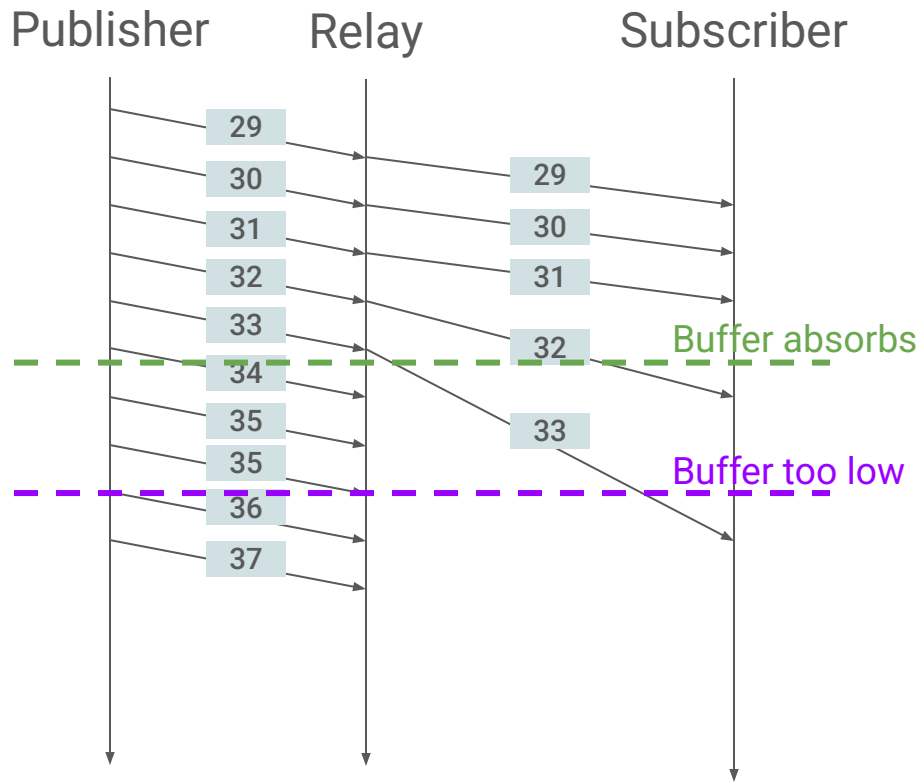
- Throughput ; "<" ; 5000 kbps
- Packet loss ; ">" ; 5%
- Lag-to-live : ">" ; 2 groups

- Let a **3rd-party entity** impose SWITCH downstream (Publisher, CDN manager)

```
SWITCH Message {  
  <same format>  
  downstream (i)
```

Optional: if present, the switch from `old Request ID` to a `new Request ID` is initiated by an external entity. At Relay, same behavior as if initiated by Subscriber

Limitations of existing APIs: Example ABR under congestion



Implementation with current API

SUBSCRIBE B Latest → 37
ABSOLUTE JOINING FETCH B 34
UNSUBSCRIBE A 33

Problems

- Circumvoluted set of messages 🤯
- 3 concurrent subscriptions on wire 🤯
 - Priorities cannot help #1101
- Risk gap before B-34 arrives
 - Whether B-34 is in the Relay cache
 - How much of A-33 is still on the wire
 - How much of A-34 is queued