FlexStream: Towards Flexible Adaptive Video Streaming on End Devices using Extreme SDN

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Motivation
- When HTTP Adaptive Streaming (HAS) players compete over the bottleneck:
  - Instability in the quality
  - Playback Stalls
  - Unfairness
  - Long startup delay
- Root cause: ON/OFF traffic pattern

Issues with Existing Solutions
- **Not effective**: they cannot address the main performance issues, and cannot comply with network policies.
- **Invasive**: Players have to follow specific adaptation logic.
- **Not generic**: Specific for HAS.
- **Costly**: Require large and special-purpose network infrastructure.
- **Infeasible (in practice)**: they require CDN edge server changes, or require player feedback and interactions.

Existing Solutions
- **Client-based solutions** (improving players' adaptation algorithm)
- **Edge-based solutions** (traffic management and control)

FlexStream Overview
1. **Data Collection**
   - Flow statistics (OVS), device context, user context
2. **Control & Management**
   - Resource allocation, admin policies
3. **Video Player**
   - Device-Agent
   - Video traffic
   - Control channel
   - Data channel

FlexStream Architecture
- **End Device**: Context data and policies
- **FlexStream Controller**: Network Monitor, Optimization Module, Policy Manager
- **Media Server**: HTTP Server

Implementation Challenges
- **Rate control on an end device**: extending SDN planes and open flow control to enable controlling the data rate on the end device through TCP flow control mechanism (modifying TCP receiving window).
- **Binding OVS to the cellular interface**: Installing a number of rules to the OVS flow table to rewrite the source/destination IP and MAC addresses with OVS addresses to force all traffic to pass through OVS.

Network Topology
- **Nexus 7 (7")**, **Nexus 4 (4.8")**, **WiFi AP (Ubuntu 14.04)**
- **Bitsavers**: 449,843,1416, 2556 kbps
- **9.00 mm**: Big Buck Bunny
- **Public HTTP server**
- **Proxy server (Squid v3.1)** TC Linux to limit data rate

Sample Results
- **Stability**
  - Phone1, Phone2, Tablet
- **Stall Duration**
  - AP capacity (Mbps)
- **Startup Delay**
  - AP capacity (Mbps)

(*) Big Buck Bunny: [https://peach.blender.org](https://peach.blender.org)

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