Time window duration for bitrate measurement

Agreement on bitrate measurement between endpoints and network elements for advised bitrate conformance purpose

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tl;dr

- Video services are bursty. Bursty traffic profile is good for QoE and RAN scheduling efficiency.

- Key observation from the lab experiment;
  - Current time window value 20 sec is too low and restrictive for video services.
  - “Time window duration” that meets the advised bitrate is function of advised bitrate value.
  - **Based on the experiment results, 120 sec seems to be a reasonable value.**
    - Compatible with existing VOD applications when ~2 mbps is the advised bitrate.
    - Another reference point - https://datatracker.ietf.org/doc/html/rfc4787. “A NAT UDP mapping timer MUST NOT expire in less than two minutes”

Context & Problem Statement

- Application indicates support for SCONE
- Network element sends advised bitrate to application end point
- Application endpoint self adapts to advised bitrate and network element does not “rate limit”/throttle the flow
- Network element measures bitrate over a “fixed duration averaging time window” to verify the conformance
    - bitrate = bits_transferred_in_time_window / time_window
- ***What should be the duration of time_window which is acceptable to CAPs and CSPs.***

  https://github.com/ietf-wg-scone/scone/issues/20
- *Streaming applications are bursty with data burst followed by idle period*
    - Bursty traffic profile is good for QoE and RAN scheduling efficiency (PDCCH and PDSCH)
    - Different apps prefer different window length - Different burst profiles.
    - Current value of 20 second may be restrictive for video services.

- ***Specify a longer window to accommodate different applications, but not too long***

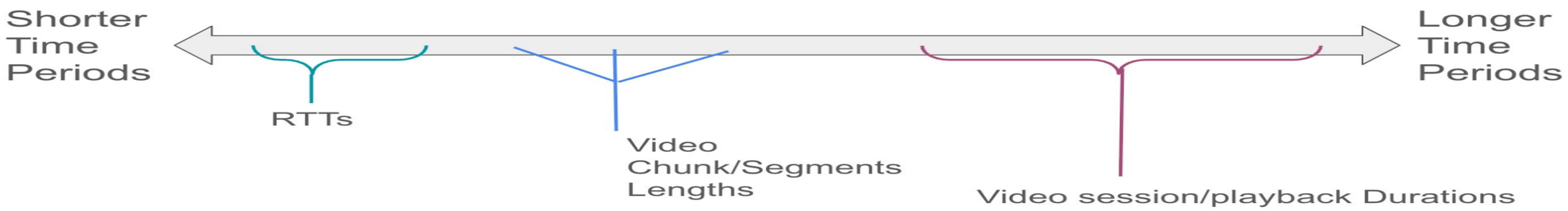
How to decide the time window duration - Possible options

1. Use RTT
   - Challenge - RTTs can have wide range. And can be very restrictive for video services.

2. Use video segment size
   - Challenge -
     - Different video services use different segment durations (e.g. 2s, 5s). Video traffic is bursty and consists of short “video segment transfer period” followed by long “idle period”. Can be very restrictive for video services.

3. Use Video Playback Duration
   - Challenge - Video Playback Duration can have wide range - 60 seconds to many minutes

4. Refer apps’ traffic profiles over the wire and use this as a basis for defining time window duration.



Lab experiments to observe apps' traffic profiles over the wire

Methodology

1. Capture the PCAPs on SGi/N6* interface for different apps.

2. Setup - LTE FDD - 5 & 10 MHz BW, 2*2 DL and single layer UL, Only one user active at a time. Watch different VOD apps (swipe random videos) in sequential manner. Good channel conditions.

3. Calculate the average bitrate for each app with different averaging window values.

**at 4G/5G packet core*

Observations

“Averaging time window duration” that meets the advised bitrate is function of

- Value of advised bitrate - lower is the advised bit-rate, longer is the required window size
- Application traffic profile (App specific)
- How the averaging is performed - Block window averaging and sliding window averaging

What is sliding window averaging -Calculate average bitrate over a window and then slide the window partially by 0.01 second (slide_sec=0.01) Partial overlap

What is block window averaging - Calculate average bitrate over a window and then slide the window completely by window second. No overlap

Block Window Averaging (Summary)

Advised bitrate	**APP 1 Result 1** Min Window Size (Seconds)	**APP 1 Result 2** Min Window Size (Seconds)	**APP 2 Result 1** Min Window Size (Seconds)	**APP 2 Result 2** Min Window Size (Seconds)	**APP 3 Result 1** Min Window Size (Seconds)	**APP 3 Result 2** Min Window Size (Seconds)	**APP 4 Result 1** Min Window Size (Seconds)	**APP 4 Result 2** Min Window Size (Seconds)
1 Mbps	120	>120	>120	>120	>120	>120	>120	>120
1.5 Mbps	60	60	120	120	>120	>120	>120	>120
2 Mbps	60	30	90	90	120	>120	90	120
2.5 Mbps	20	20	60	60	90	120	60	60
3 Mbps	20	20	60	60	90	90	30	60
4 Mbps	20	20	30	30	30	60	30	30
5 Mbps	20	20	30	20	30	60	30	20
6 Mbps	20	20	20	20	20	60	20	20
10 Mbps	20	20	20	20	20	20	20	20

- The lower the advised bit-rate, the longer the required window size
- If we consider 1 Mbps as baseline bit-rate window duration has to be > 120 second

Sliding Window Averaging (Summary)

Advised bitrate	**APP 1 Result 1** Min Window Size (Seconds)	**APP 1 Result 2** Min Window Size (Seconds)	**APP 2 Result 1** Min Window Size (Seconds)	**APP 2 Result 2** Min Window Size (Seconds)	**APP 3 Result 1** Min Window Size (Seconds)	**APP 3 Result 2** Min Window Size (Seconds)	**APP 4 Result 1** Min Window Size (Seconds)	**APP 4 Result 2** Min Window Size (Seconds)
1 Mbps	120	>120	>120	>120	>120	>120	>120	>120
1.5 Mbps	60	90	120	120	>120	>120	>120	>120
2 Mbps	60	60	90	90	120	>120	90	>120
2.5 Mbps	20	30	60	60	90	120	60	120
3 Mbps	20	30	60	60	90	90	60	90
4 Mbps	20	20	30	30	30	60	30	30
5 Mbps	20	20	30	20	30	60	30	30
6 Mbps	20	20	20	20	20	60	20	20
10 Mbps	20	20	20	20	20	20	20	20

- TLDR: Sliding and block windows perform similarly

Recommendation

- **Based on the experiment results, 120 sec seems to be a reasonable value**
  - Compatible with existing applications when ~2 mbps is the advised bitrate.
  - Another reference point - https://datatracker.ietf.org/doc/html/rfc4787. “A NAT UDP mapping timer MUST NOT expire in less than two minutes” This also implies that there can be a idle period of at least 2 minutes during the UDP data flow.

Open issue

- Need to specify overall mechanism to be used by CSPs to measure the bit rate on the n/w element. May be in applicability and manageability document !!