Publisher and player channel quality control

When a WebRTC stream is publishing, picture quality depends on media data transfer channel between client and server, especillay for high definition streams (HD, FullHD, 4K). The ability to control channel quality and notify publisher about bandwidth decrease in time usingWebSDK was added since build5.2.398.Subscriber, in its turn, can be notified about bandwidth decrease since build5.2.409.

The publishing and playback bitrate values on client side are periodically comparing with server side one. The steady divergence of those values means channel bandwidth decrease. The peaks and sudden changes are smoothed byKalman filter.

Server configuration

Current server side publishing bitrate values sending to client for later comparison is enabled with the following parameter inflashphoner.propertiesfile

```
inbound_video_rate_stat_send_interval=1
```

Current server side playback bitrate values sending is enabled with the following parameter

```
outbound_video_rate_stat_send_interval=1
```

The settings above define bitrate values sending interval in seconds. It is recommended to send bitrate to client every second.

Channel quality displaying on client side

Let's look at channel quality and bitrate changing graphs displaying using Media Devicesexample.

1. A function to prepare to display graphscode

```
function createOrClearChart(chartId, bitrateComparisonChart) {
    if (!bitrateComparisonChart) {
        var canvas = document.getElementById(chartId);
        var ctx = canvas.getContext('2d');
        bitrateComparisonChart = new ComparisonChart(ctx);
    } else {
        bitrateComparisonChart.clearBitrateChart();
    }
    return bitrateComparisonChart;
}
```

function usage while publishingcode

```
function publish() {
    ...
    publishConnectionQualityStat.chart = createOrClearChart('publishBitrateChart', publishConnectionQualityStat.
chart);

    publishStream = session.createStream({
    ...
    });
    publishStream.publish();
}
```

function usage while playingcode

```
function play() {
    ...
    playConnectionQualityStat.chart = createOrClearChart('playBitrateChart', playConnectionQualityStat.chart);

    previewStream = session.createStream({
    ...
    });
    previewStream.play();
}
```

2. Channel quality and bitrate values receiving, bitrate graphs displaying

CONNECTION_QUALITY.UPDATE

event handling while publishingcode

```
    publishStream = session.createStream({
        ...
    }).on(CONNECTION_QUALITY.UPDATE, function (quality, clientFiltered, serverFiltered) {
        updateChart(quality, clientFiltered, serverFiltered, publishConnectionQualityStat);
    });
    publishStream.publish();
```

while playingcode

```
    previewStream = session.createStream({
        ...
    }).on(CONNECTION_QUALITY.UPDATE, function (quality, clientFiltered, serverFiltered) {
        updateChart(quality, clientFiltered, serverFiltered, playConnectionQualityStat);
    });
    previewStream.play();
```

a function to update graphs and qualitycode

```
function updateChart(calculatedQuality, clientFiltered, serverFiltered, connectionQualityStat) {
    var timestamp = new Date().valueOf();
    connectionQualityStat.connectionQualityUpdateTimestamp = timestamp;
    connectionQualityStat.chart.updateChart(clientFiltered, serverFiltered);
    connectionQualityStat.quality = calculatedQuality;
}
```

4. Set channel quality to UNKNOWN, if CONNECTION_QUALITY.UPDATE event is not received

while publishingcode

```
function loadStats() {
    if (publishStream) {
                    ...
                    if(new Date().valueOf() - CONNECTION_QUALITY_UPDATE_TIMEOUT_MS >
publishConnectionQualityStat.connectionQualityUpdateTimestamp) {
                        publishConnectionQualityStat.quality = CONNECTION_QUALITY.UNKNOWN;
                    }
                    ...
```

while playingcode

```
function loadStats() {
    ...
    if (previewStream) {
                    ...
                    if(new Date().valueOf() - CONNECTION_QUALITY_UPDATE_TIMEOUT_MS >
publishConnectionQualityStat.connectionQualityUpdateTimestamp) {
                        publishConnectionQualityStat.quality = CONNECTION_QUALITY.UNKNOWN;
                    }
                    ...
```

5. Channel quality displaying

while publishingcode

```
function loadStats() {
    if (publishStream) {
            ...
            if (publishConnectionQualityStat.quality !== undefined) {
                showStat({"quality": publishConnectionQualityStat.quality}, "outConnectionStat");
            ...
```

while playingcode

```
function loadStats() {
    if (publishStream) {
                ...
                if (playConnectionQualityStat.quality !== undefined) {
                    showStat({"quality": playConnectionQualityStat.quality}, "inConnectionStat");
                }
                ...
```

a function to display qualitycode

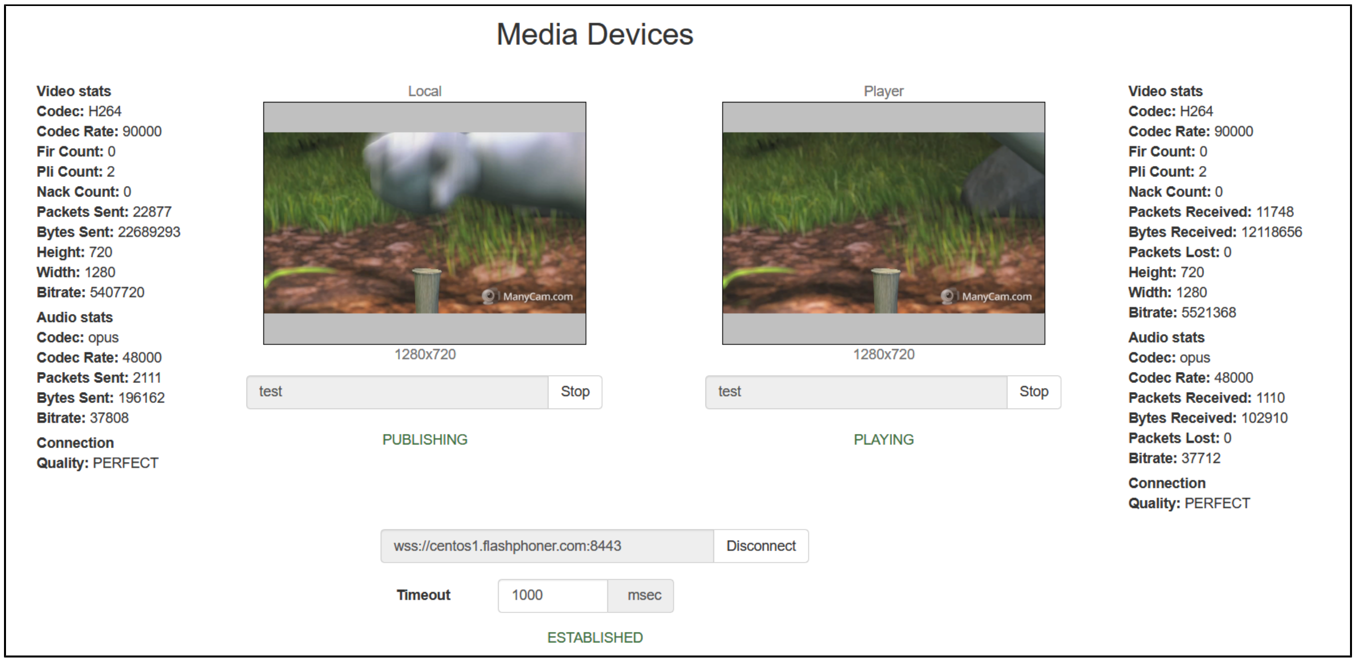
```
    function showStat(stat, type) {
        Object.keys(stat).forEach(function(key) {
            if (typeof stat[key] !== 'object') {
                let k = key.split(/(?=[A-Z])/);
                let metric = "";
                for (let i = 0; i < k.length; i++) {
                    metric += k[i][0].toUpperCase() + k[i].substring(1) + " ";
                }
                if ($("#" + key + "-" + type).length == 0) {
                    let html = "<div style='font-weight: bold'>" + metric.trim() + ": <span id='" + key  + "-"
+ type + "' style='font-weight: normal'></span>" + "</div>";
                    // $(html).insertAfter("#" + type);
                    $("#" + type).append(html);
                } else {
                    $("#" + key + "-" + type).text(stat[key]);
                }
            }
        });
    }
```

Testing

1. For the test we use:

- WCS5.2.409or newer
- Media Devices example in Chrome browser
- publishing channel with 100 Mbps upload and download bandwidth
- bandwidth shaping tool, winShaperon Windows orNetwork Link Conditioneron MacOS for example

2. Publish and play 720p stream on Media Devices page



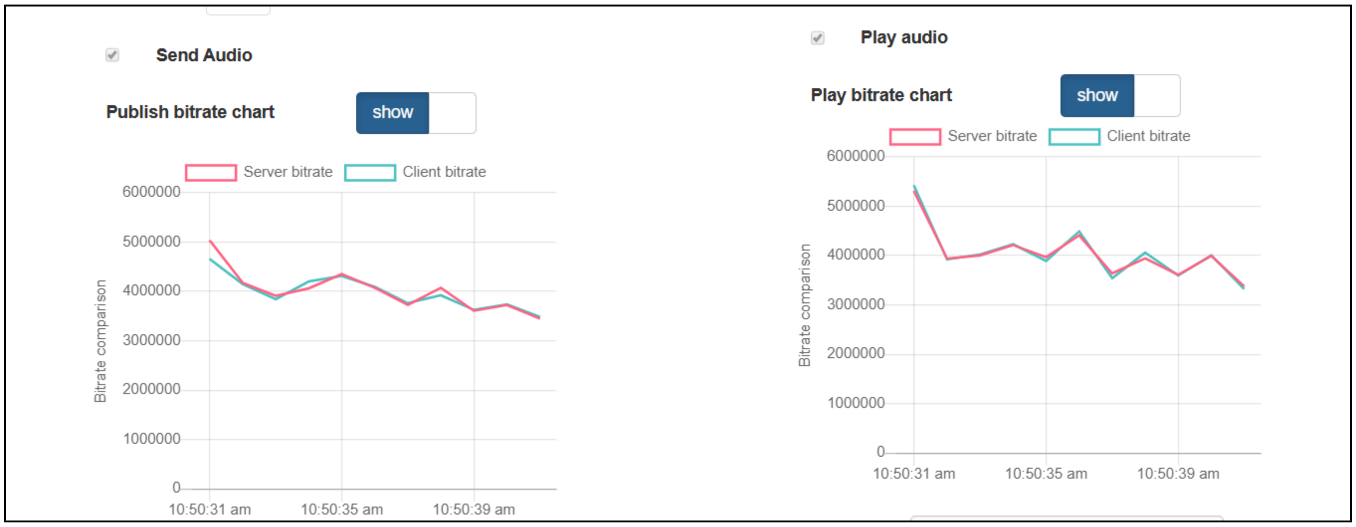
Media Devices

Video stats
Codec: H264
Codec Rate: 90000
Fir Count: 0
Pli Count: 2
Nack Count: 0
Packets Sent: 22877
Bytes Sent: 22689293
Height: 720
Width: 1280
Bitrate: 5407720
Audio stats
Codec: opus
Codec Rate: 48000
Packets Sent: 2111
Bytes Sent: 196162
Bitrate: 37808
Connection
Quality: PERFECT

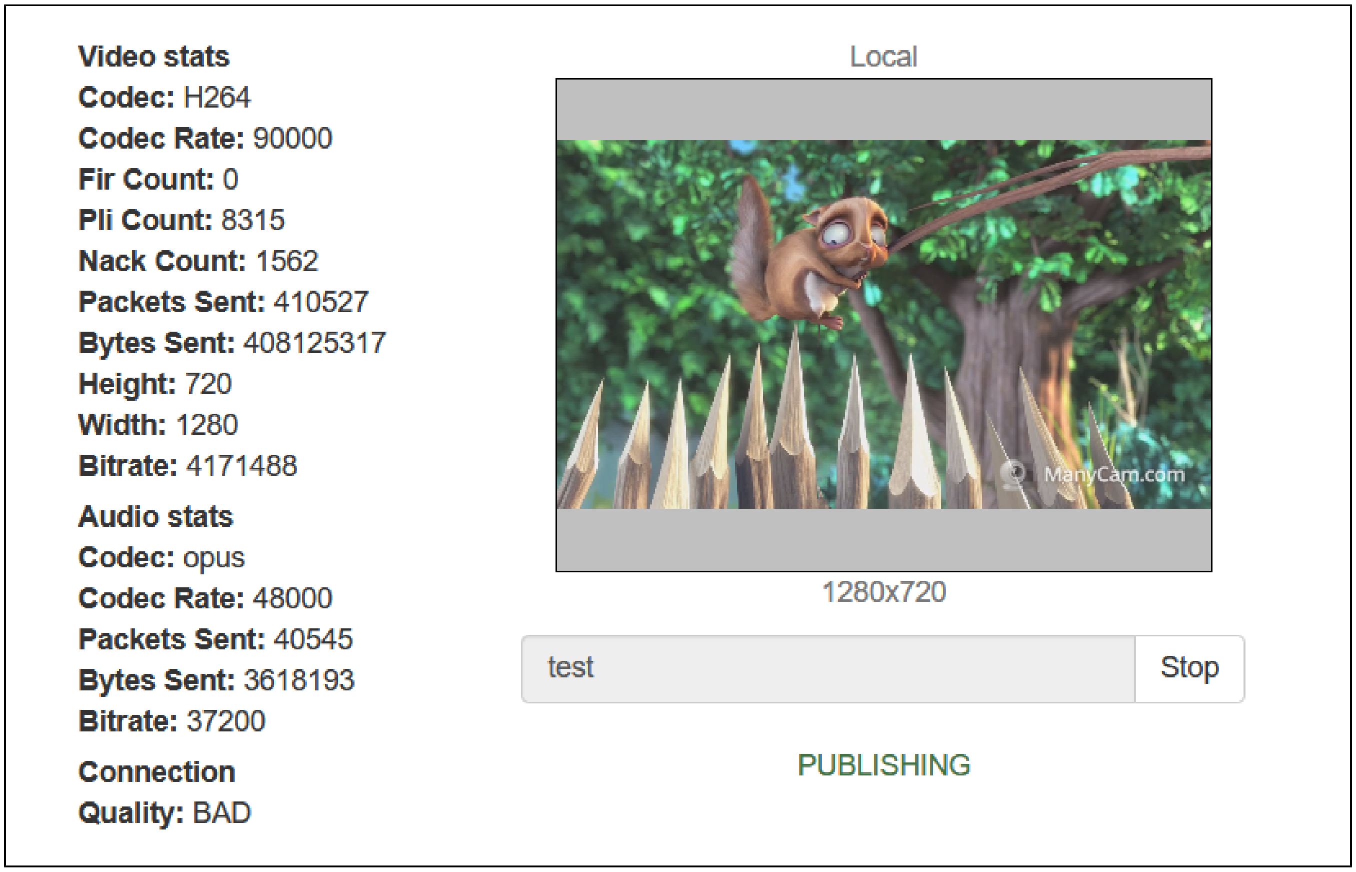
Video stats
Codec: H264
Codec Rate: 90000
Fir Count: 0
Pli Count: 2
Nack Count: 0
Packets Received: 11748
Bytes Received: 12118656
Packets Lost: 0
Height: 720
Width: 1280
Bitrate: 5521368
Audio stats
Codec: opus
Codec Rate: 48000
Packets Received: 1110
Bytes Received: 102910
Packets Lost: 0
Bitrate: 37712
Connection
Quality: PERFECT

The PERFECT channel quality is displayed for publisher and player

3. Check publishing and playing bitrate graphs on perfect channel



4. Shape outgoing traffic to 768 kbps,simulating a typical 3G connection



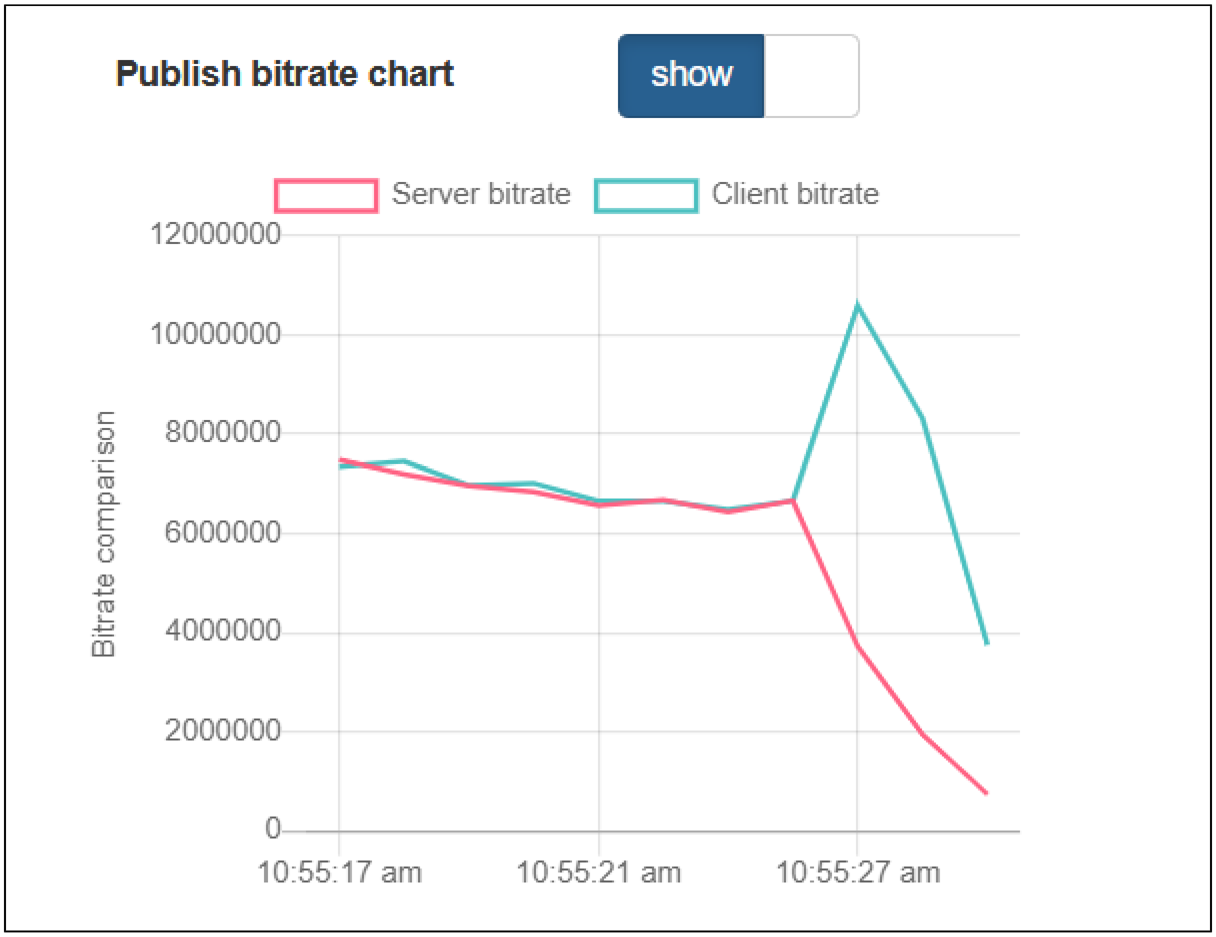
Video stats
Codec: H264
Codec Rate: 90000
Fir Count: 0
Pli Count: 8315
Nack Count: 1562
Packets Sent: 410527
Bytes Sent: 408125317
Height: 720
Width: 1280
Bitrate: 4171488

Audio stats
Codec: opus
Codec Rate: 48000
Packets Sent: 40545
Bytes Sent: 3618193
Bitrate: 37200

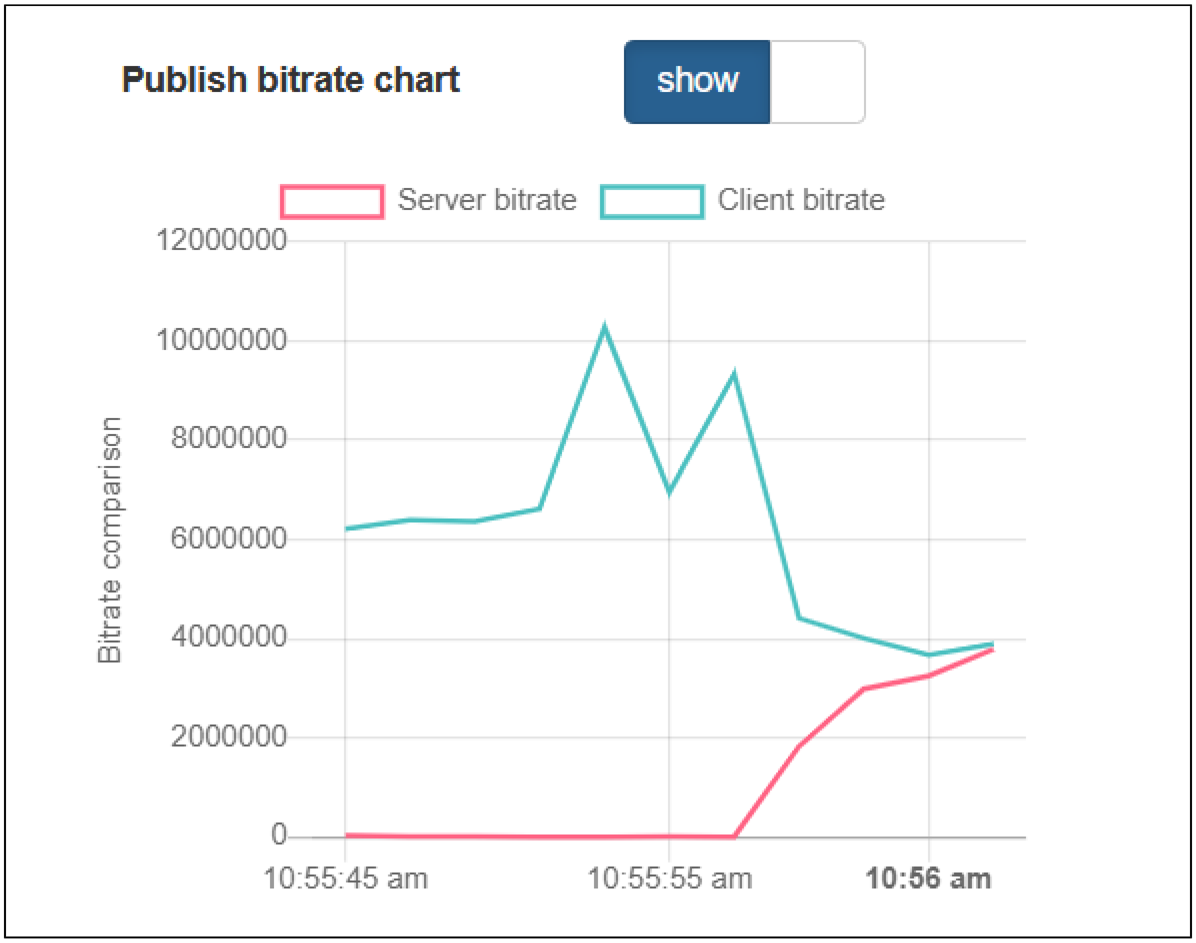
Connection
Quality: BAD

The PERFECT value changes to BAD for publisher

Publishing bitrate graph looks as follows

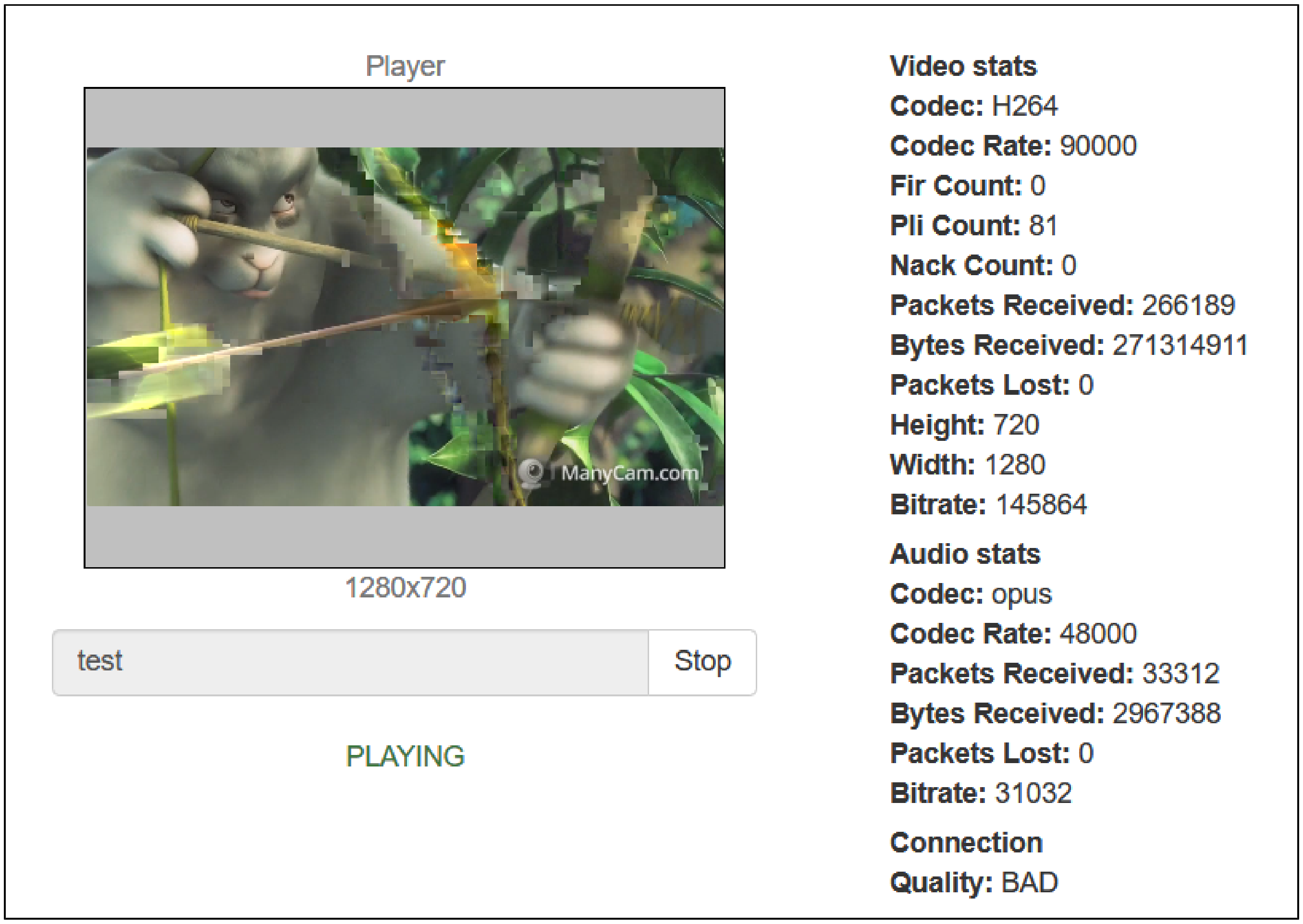


5. Stop bandwidth shaping, check publishing bitrate graphs



After the graphs converge again, the PERFECT publisher channel quality value is displayed.

6. Shape incoming traffic to 768 кbps



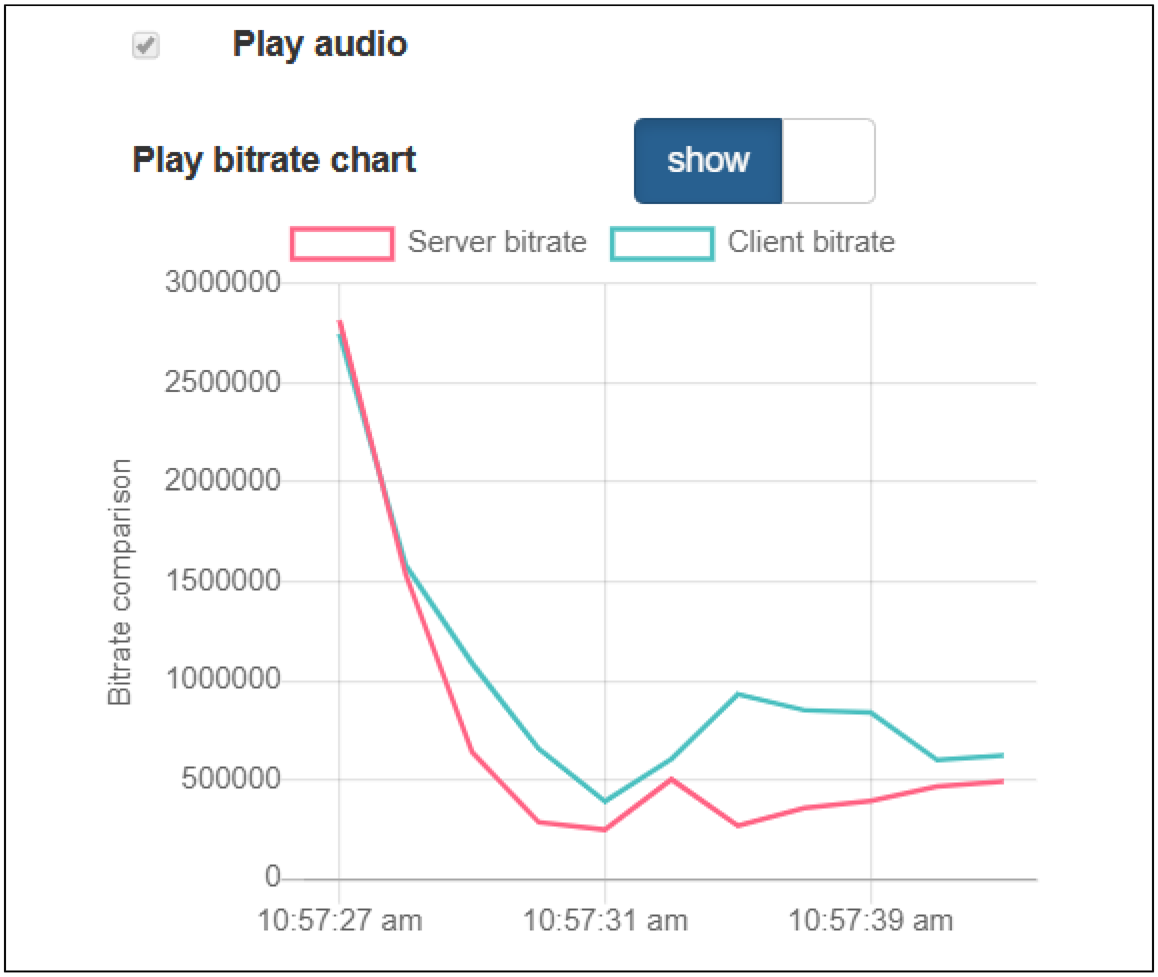
Video stats
Codec: H264
Codec Rate: 90000
Fir Count: 0
Pli Count: 81
Nack Count: 0
Packets Received: 266189
Bytes Received: 271314911
Packets Lost: 0
Height: 720
Width: 1280
Bitrate: 145864

Audio stats
Codec: opus
Codec Rate: 48000
Packets Received: 33312
Bytes Received: 2967388
Packets Lost: 0
Bitrate: 31032

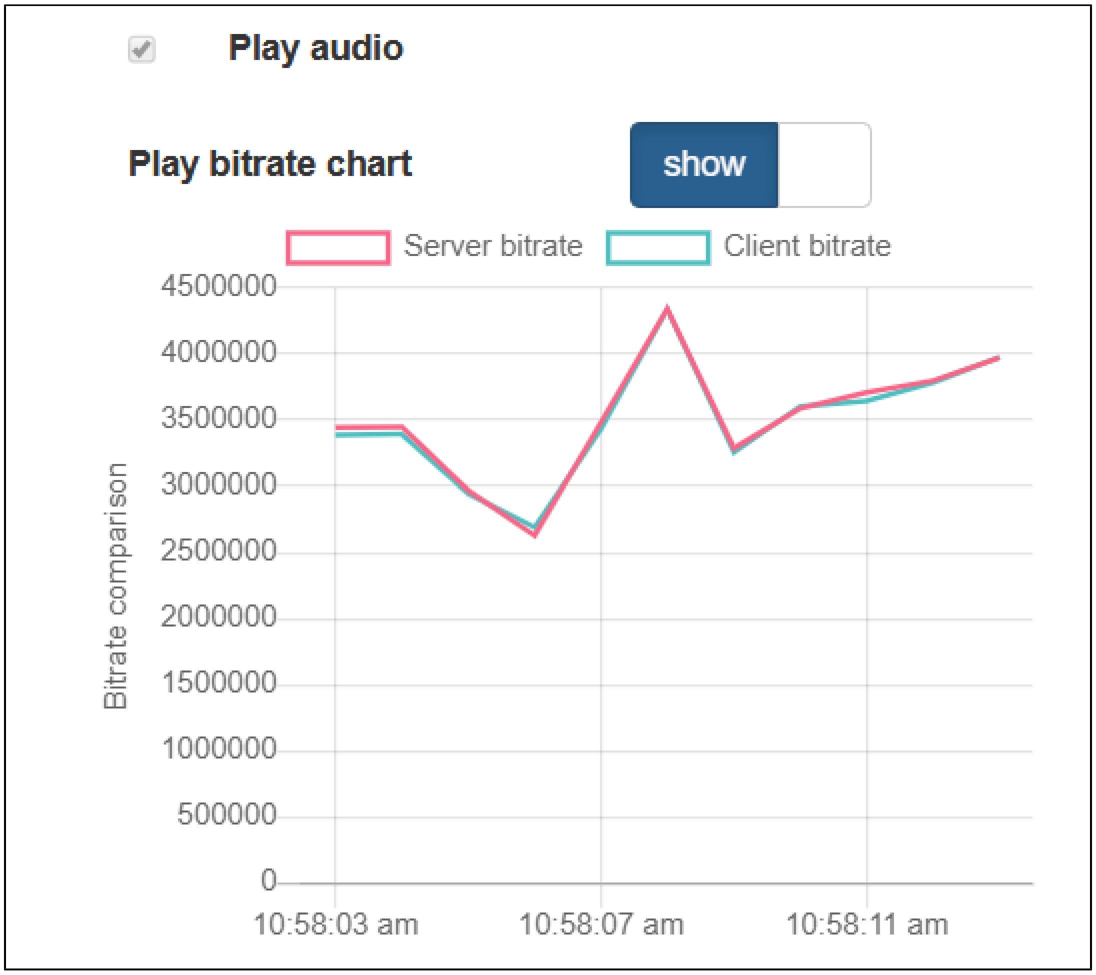
Connection
Quality: BAD

The PERFECT value changes to BAD for subscriber, picture freeze and artefacts are observed

Playing bitrate graph looks as follows



7.Stop bandwidth shaping, check playing bitrate graphs



After the graphs converge again, the PERFECT subscriber channel quality value is displayed, picture is restored

Recommendations to publishers

If channel quality is displayed as PERFECT or GOOD, it means channel bandwidth is enough to publish a stream with a currrent bitrate

If channel quality is changed steadily to BAD, it means channel bandwidth is not enough, and subscribers are viewing a problems. It is recommended to lower publishing bitrate and/or resolution if possible.

If channel quality is changed steadily to UNKNOWN, video frames can not reach the server. It is recommended to republish stream.

Recommendations to subscribers

If channel quality is displayed as PERFECT or GOOD, it means channel bandwidth is enough to play a stream with a currrent bitrate. If the problems occur while playing stream in this case, the source of the problems is probably on publisher side.

If channel quality is changed steadily to BAD, it means channel bandwidth is not enough, picture freeze and artefacts are observed. It is recommended to request the stream with lower bitrate and/or resolution if possible.

If channel quality is changed steadily to UNKNOWN, video frames can not be received from the server. It is recommended to reconnect and restart the stream playback.