On Demand Bandwidth Boost: Improving video streaming over cellular networks with Network APIs

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broadpeak
This is streaming at its peak

FRANCE 2030

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01. Motivation

Mobile phones are subject to varying network conditions

- Mobility
- Coverage issues
- Interferences
- Loaded network at busy hours
- …

ABR adaptation might compensate some of these issues, but often it is not enough…

➔ Poor quality of experience

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01. Network APIs

Mobile industry is working on “network APIs” for application developers

- network operators can expose network capabilities

Set of low-level RAN-specific APIs

- configure and program RAN behavior

Set of high-level APIs

- edge cloud, device location, device status…

Quality on Demand API

- to request for additional network resources
- commercially available at some major operators

[1] https://opengateway.telefonica.com/en/apis/qod-mobile
[2] https://www.telekom.com/en/media/media-information/archive/new-network-apis-1027626
[3] https://developer.orange.com/apis/camara-quality-on-demand

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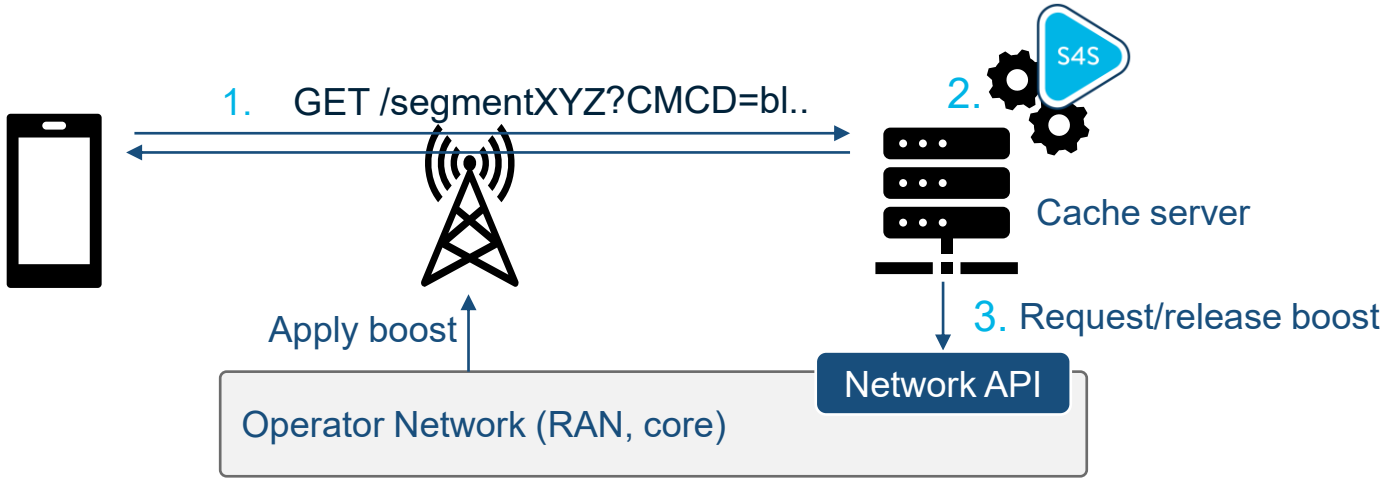
01. General idea of this talk: bandwidth boost



1. Player fetches video over cellular network
2. Cache server observes video player conditions
   - Either CMCD: buffer length, encoded bitrate, buffer starvation …
   - Or server side: S4S bandwidth estimation, …
3. Exploit network APIs in difficult conditions ➔ ***Bandwidth boost***
   - Ask for additional network resources
4. Release network resource as soon as not needed anymore

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02. Network APIs

03. Boosting strategies

04. First results

05. Conclusion

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02. LF Camara – QoD API

CAMARA
THE TELCO GLOBAL API ALLIANCE

QoS Sessions Manage QoS sessions

POST	/sessions	Creates a new session
GET	/sessions/{sessionId}	Get QoS session information
DELETE	/sessions/{sessionId}	Delete a QoS session
POST	/sessions/{sessionId}/extend	Extend the duration of an active session

QoS Profiles Manage QoS Profiles

GET	/qos-profiles	Get All QoS Profiles
GET	/qos-profiles/{name}	Get QoS Profile for a given name

The application can request

- a QoS profile
  - Upstream and downstream rate
  - Latency/jitter, error loss rate
  - Set of available profiles often predefined by network operator
- for a device or traffic flow

```
{
  "duration": 400,
  "device": {
    "ipv4Address": {
      "publicAddress": "84.125.93.10",
      "publicPort": 59765
    }
  },
  "qosProfile": "BITRATE_HIGH"
}
```

QoS profiles are mapped to network configurations of the underlying network

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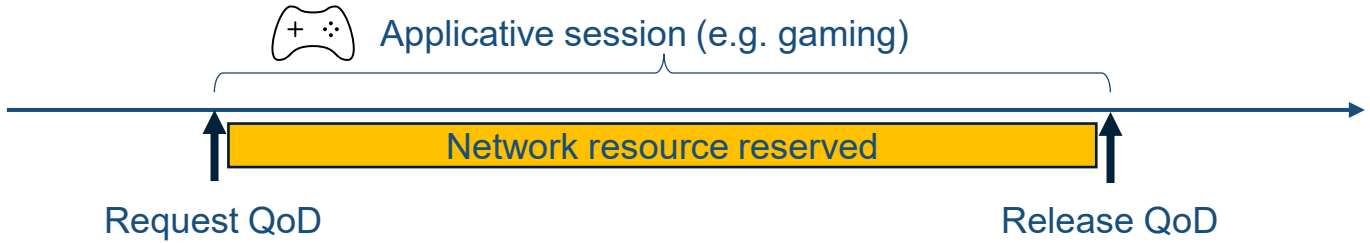
02. LF Camara – QoD API

Demonstrated use-cases

- gaming, event broadcasting, remote surgery, online training…[1]

QoD is requested for the whole duration of the applicative session

- equivalent to assigning a slice to the application
- waste of resource



[1]https://opengateway.telefonica.com/en/apis/qod-mobile

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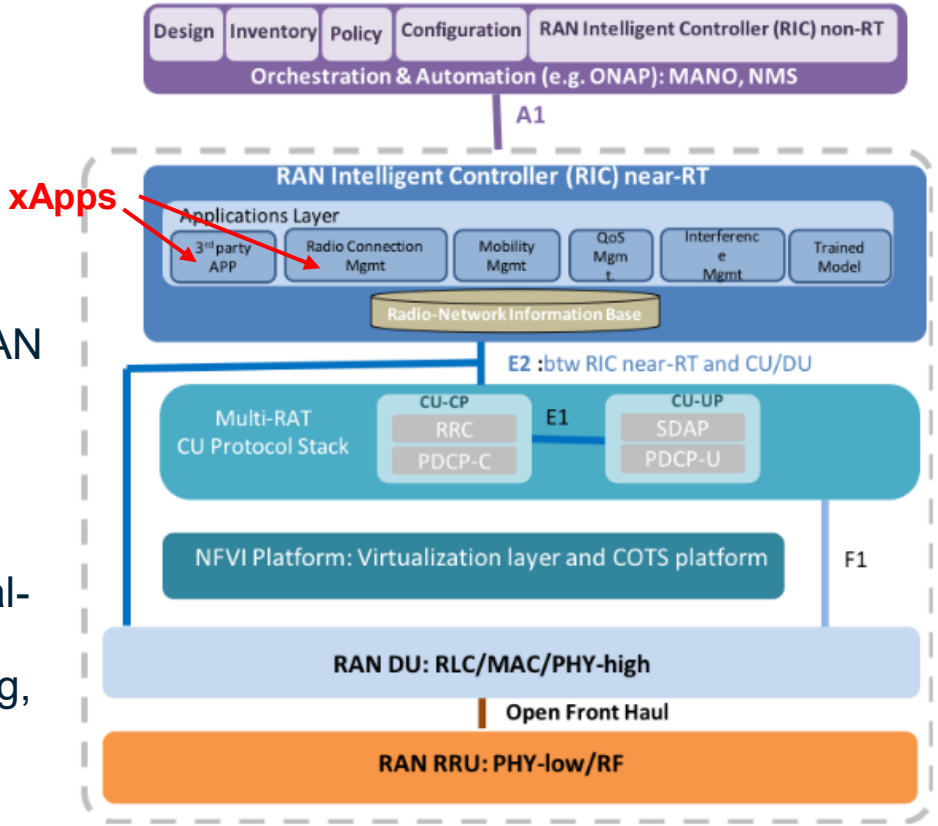
02. Network APIs

O-RAN alliance

- Defines open interfaces and specifications to build interoperable RAN components

RAN intelligent controller (RIC)

- Allows application developer to deploy *xApps* that control the RAN in near real-time
- Controls RAN configuration, scheduling, …



O-Ran alliance, O-RAN: Towards an Open and Smart RAN, White paper, October 2018

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03. Boosting strategies

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03. Boosting strategies

Buffer-based strategy

- Objective: Avoid buffer underruns
- Simplified idea
  - If buffer length < min. threshold ➔ boost
  - If buffer length > max. threshold ➔ remove boost
- Targets mobile phones

Quality-based strategy

- Objective: Ensure video quality
- Simplified idea
  - If quality < min. threshold ➔ boost
  - If quality > max.threshold ➔ remove boost
- Targets TVs, STBs using Fixed-Wireless Access

A cache might implement only one or both strategies

- type of end-device, location of cache, type of subscriptions offered by network operator…

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03. First results

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04. First results - Emulated

Emulated network

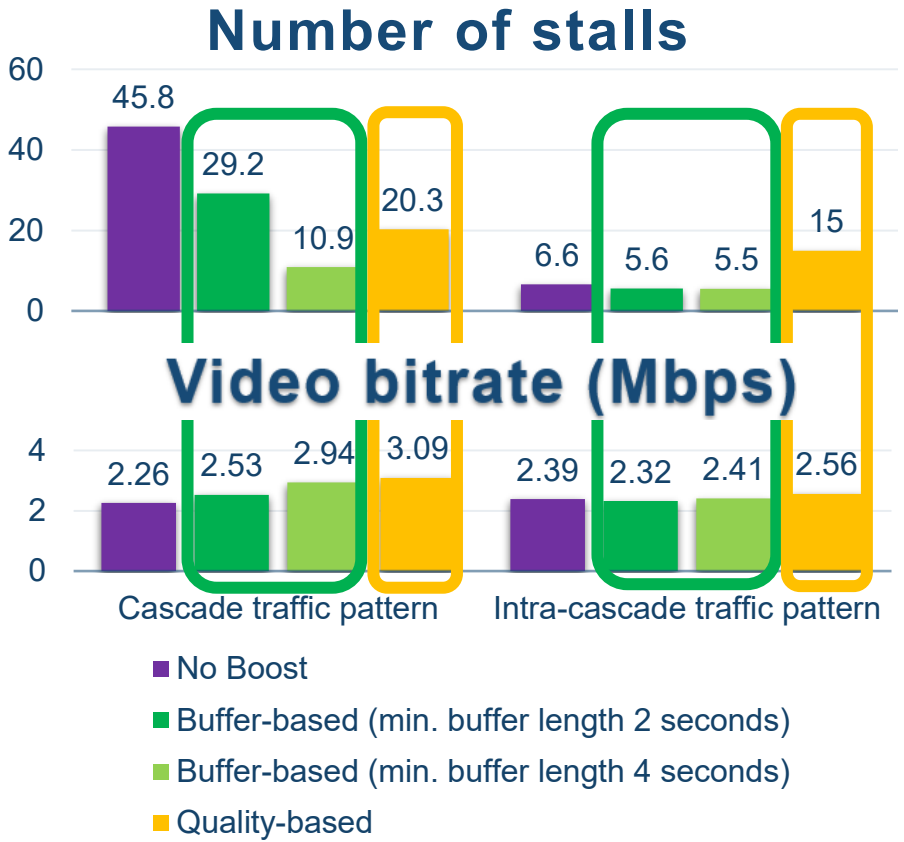
- tc applies a twitch challenge traffic patterns
- if QoD is requested, the pattern is overwritten by requested QoS profile
- 30 minutes video (no low-latency); avg. results 10 runs

Buffer-based boost increases QoE

- less stalls
- slightly higher bitrate

Quality-based boost increases quality BUT

- can have adversarial effects on stalls
- we suspect a bad interaction with ABR algorithm



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04. First results – xApp enabled 5G RAN

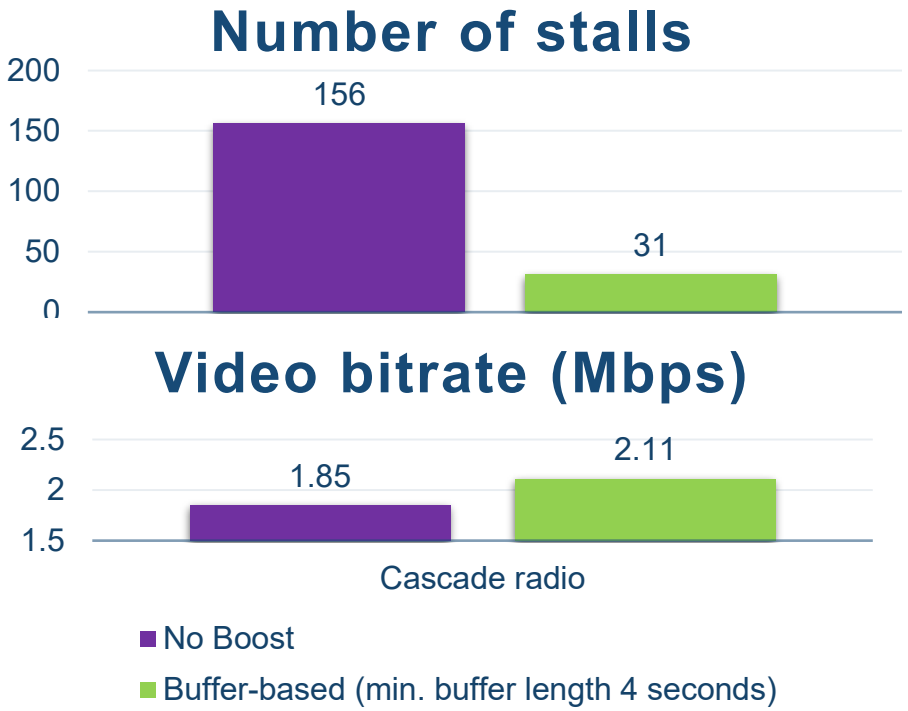
Implemented xApp

- No boost
  - fixed number of radio resource blocks
  - bandwidth changes according to radio conditions
- Boost
  - adapt number of radio resource blocks dynamically to reach request QoS profile

Radio patterns

- Change coding rate (MCS) according to twitch traffic pattern

30 minutes video; avg. results 10 runs



Significant gains with bandwidth boost !

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04. Conclusion

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04. Conclusion

Cellular networks might create adverse conditions for video streaming

Proposed “on-demand bandwidth boost“

- exploit Network APIs to ask for additional bandwidth if needed

Proposed different boosting strategies

- buffer-based, quality-based

Showed potential benefit

- but careful design of boosting algorithm needed due to ABR algorithm interaction

➔ Avenue for future research

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Thank you!

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