

# **Multiple-Source Streaming over Remote Radio Light Head:** a pragmatic, efficient and reliable video streaming system for 5G intra-building use cases

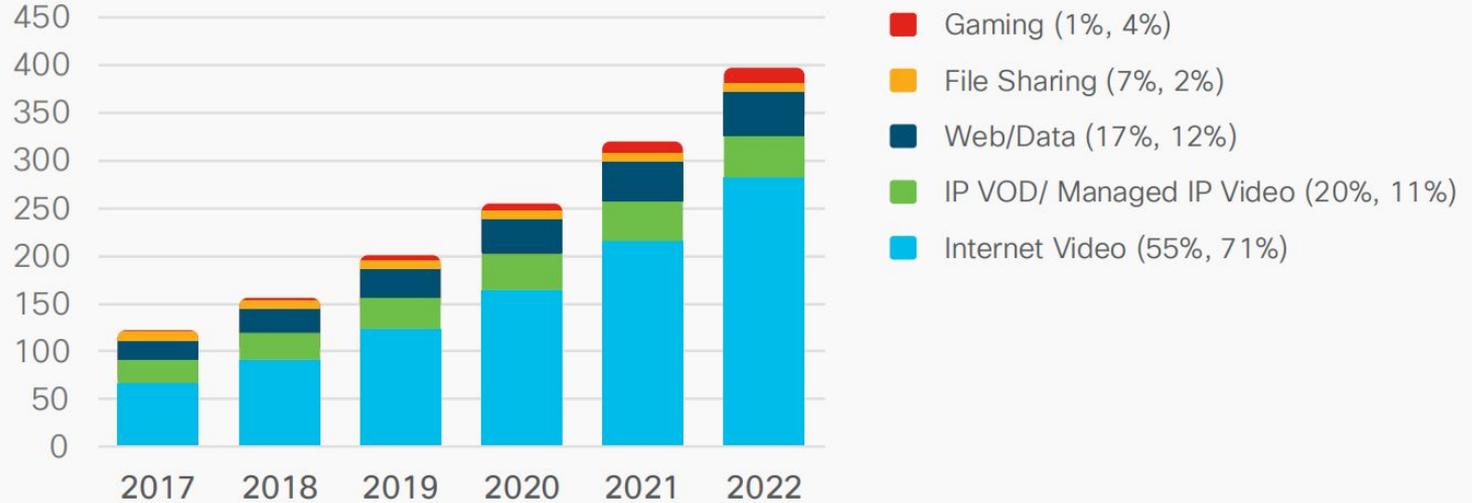
Mathias Lacaud  
mlacaud@joadada.net  
JOADA SAS

# Acknowledgement and disclaimer

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- ❑ This presentation reflects the author's view, only, and the Commission is not responsible for any use that may be made of the information provided.

**26% CAGR**  
2017-2022

Exabytes  
per Month



\* Figures (n) refer to 2017, 2022 traffic share

Source: Cisco VNI Global IP Traffic Forecast, 2017-2022

More  
Internet  
Users



More  
Devices &  
Connections



Faster  
Broadband  
Speeds



More  
Video  
Viewing

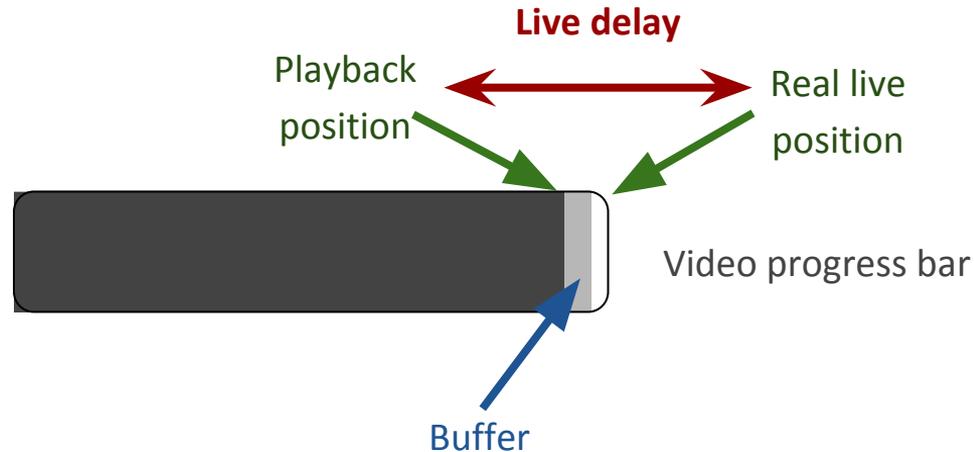


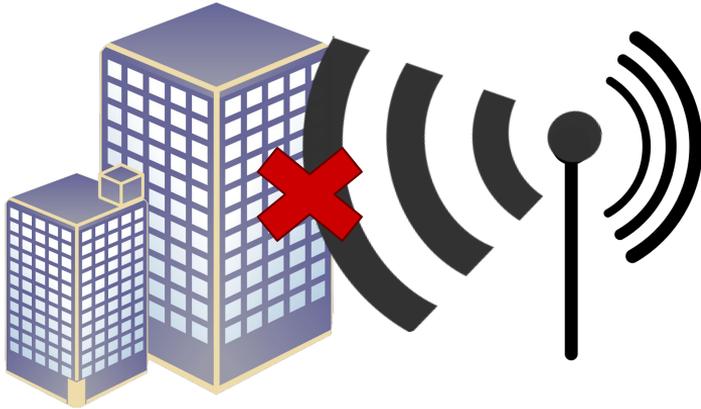
More users

Faster networks

UHD content and immersive videos

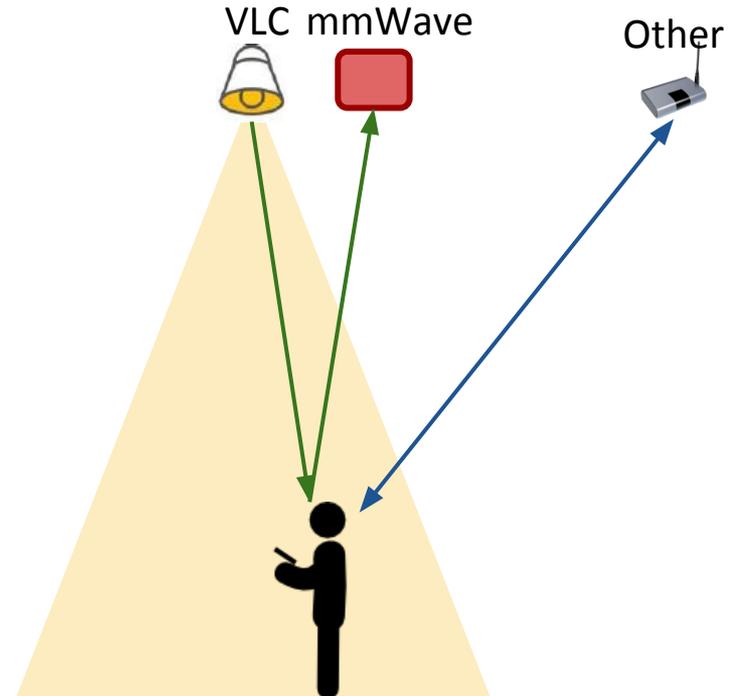
- More than 17% of video streams will be **live** streams
- **Live**: Segments are created at the same time the user is watching.



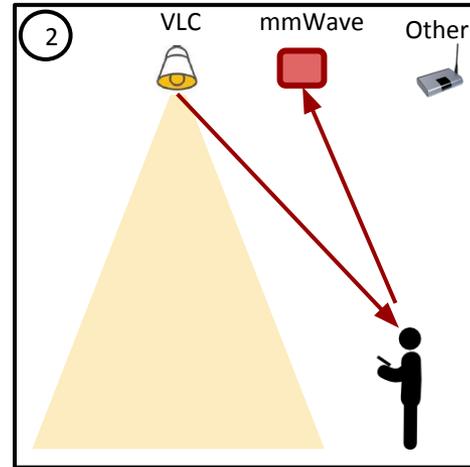
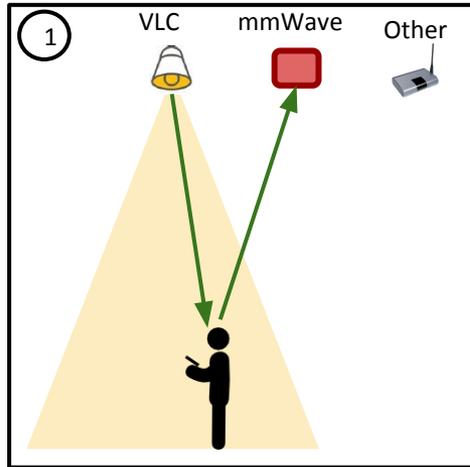


- Materials may block wireless signals
- Indoor congestion because of the high density of devices

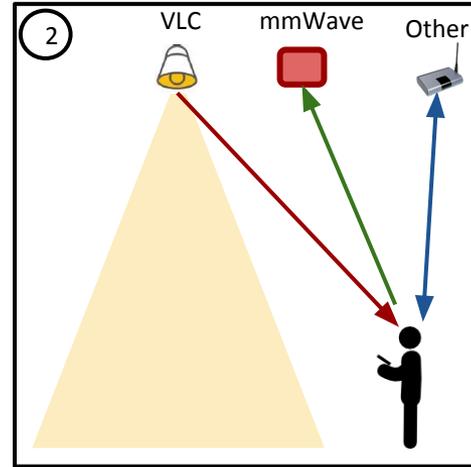
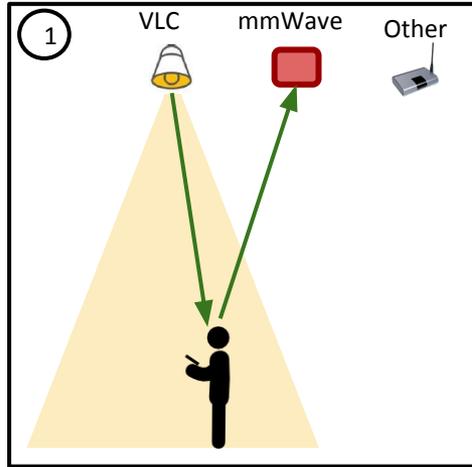
- ❑ Indoor connection through:
  - ❑ Visible light (**DL**)
  - ❑ mmWave (**UL**)
  - ❑ Existing wireless networks (4G, Wi-Fi)



# Architecture issue



# Architecture issue



## First solution:

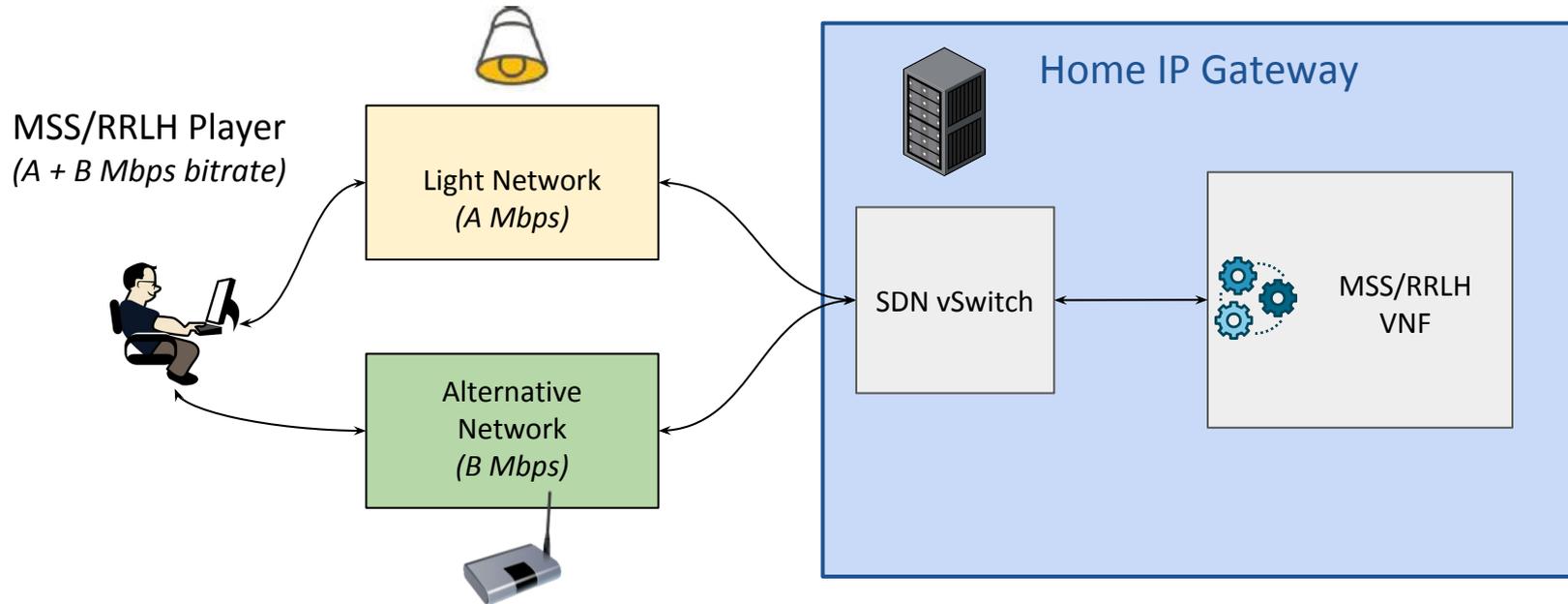
Monitor packet loss to detect when a user is out of range and switch

## Problems for live streams:

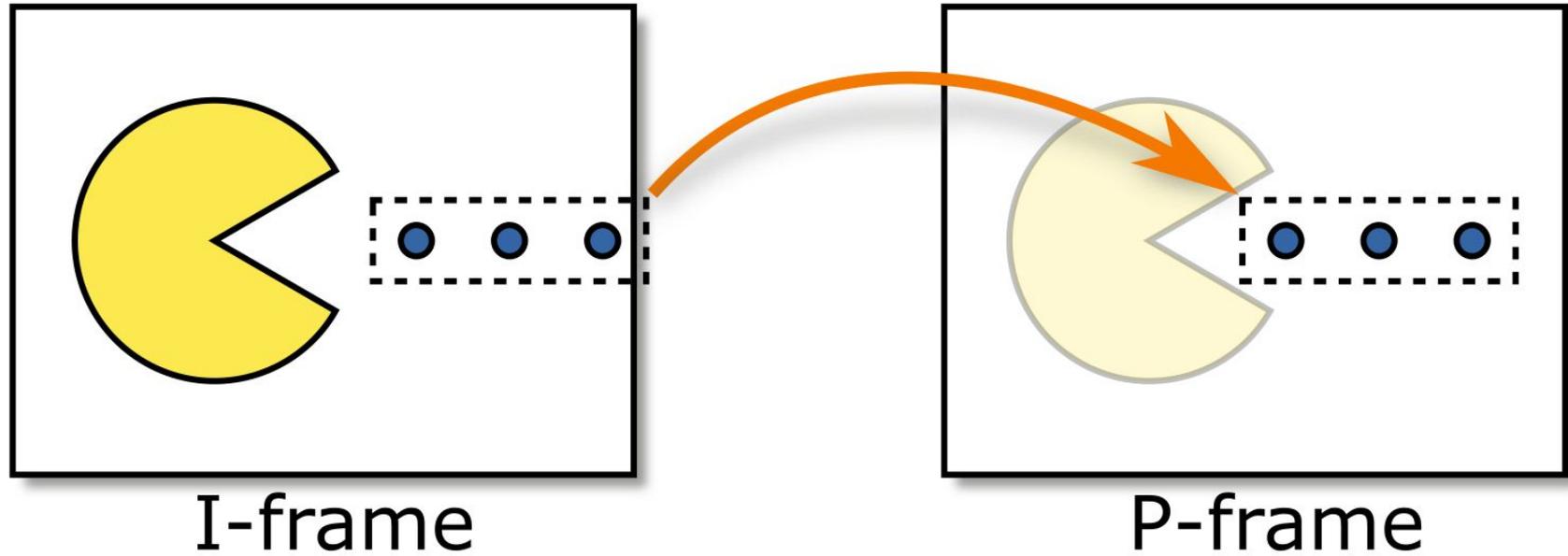
- (1) detection latency
- (2) No bandwidth aggregation

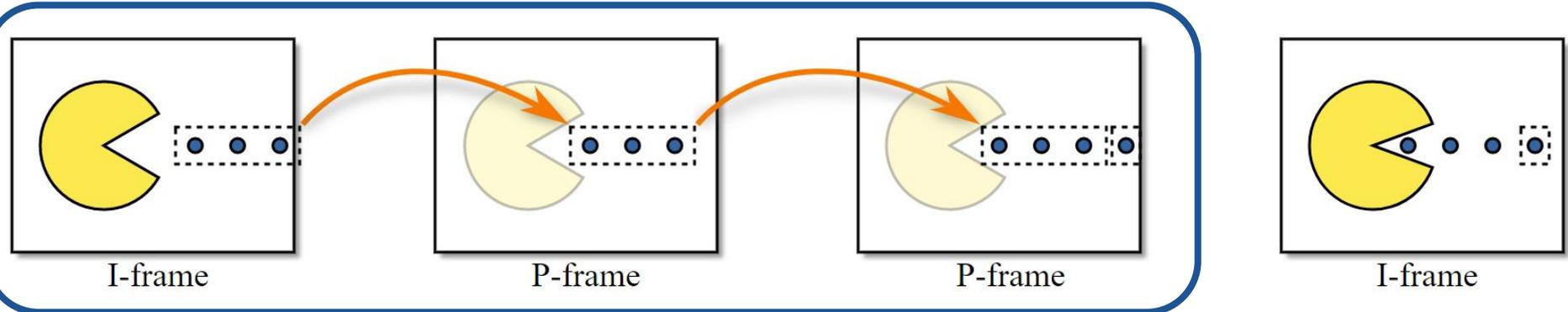
## Multiple-Source Streaming over Remote Radio Light Head

(MSS/RRLH or MSS)



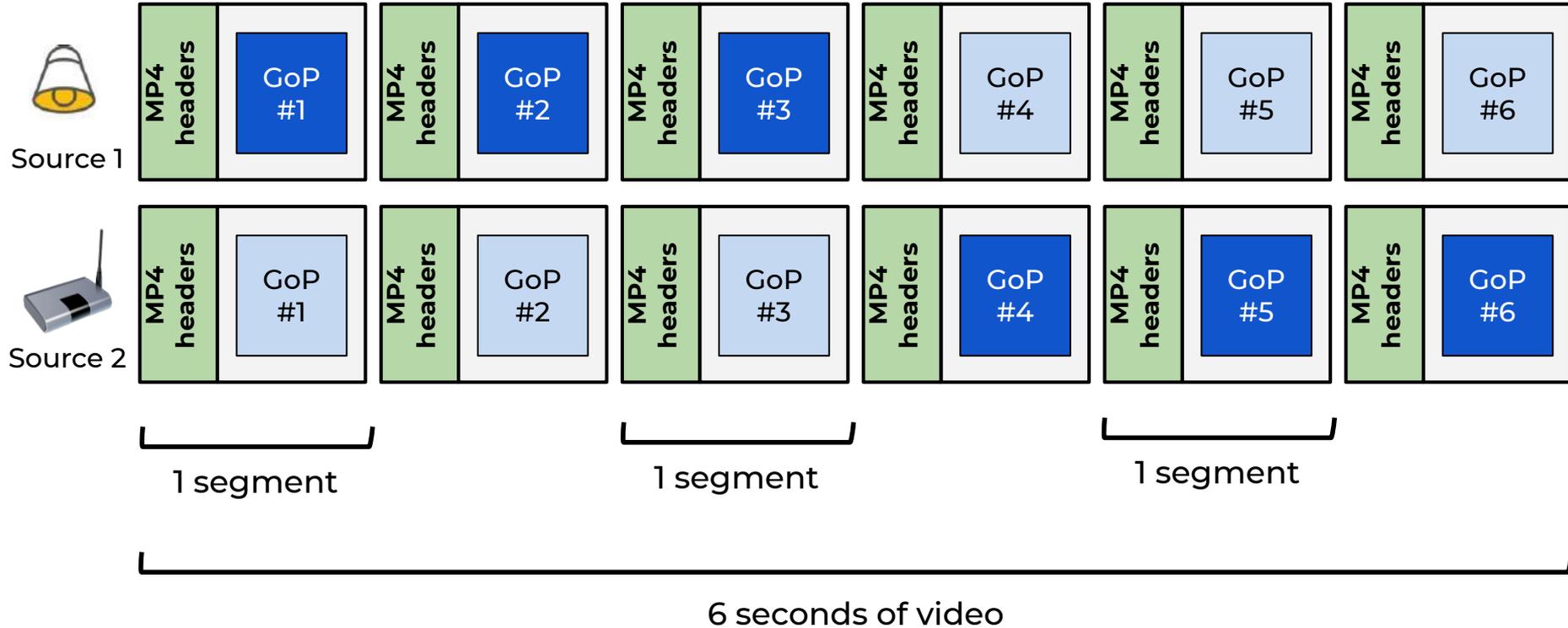
# MSS concept



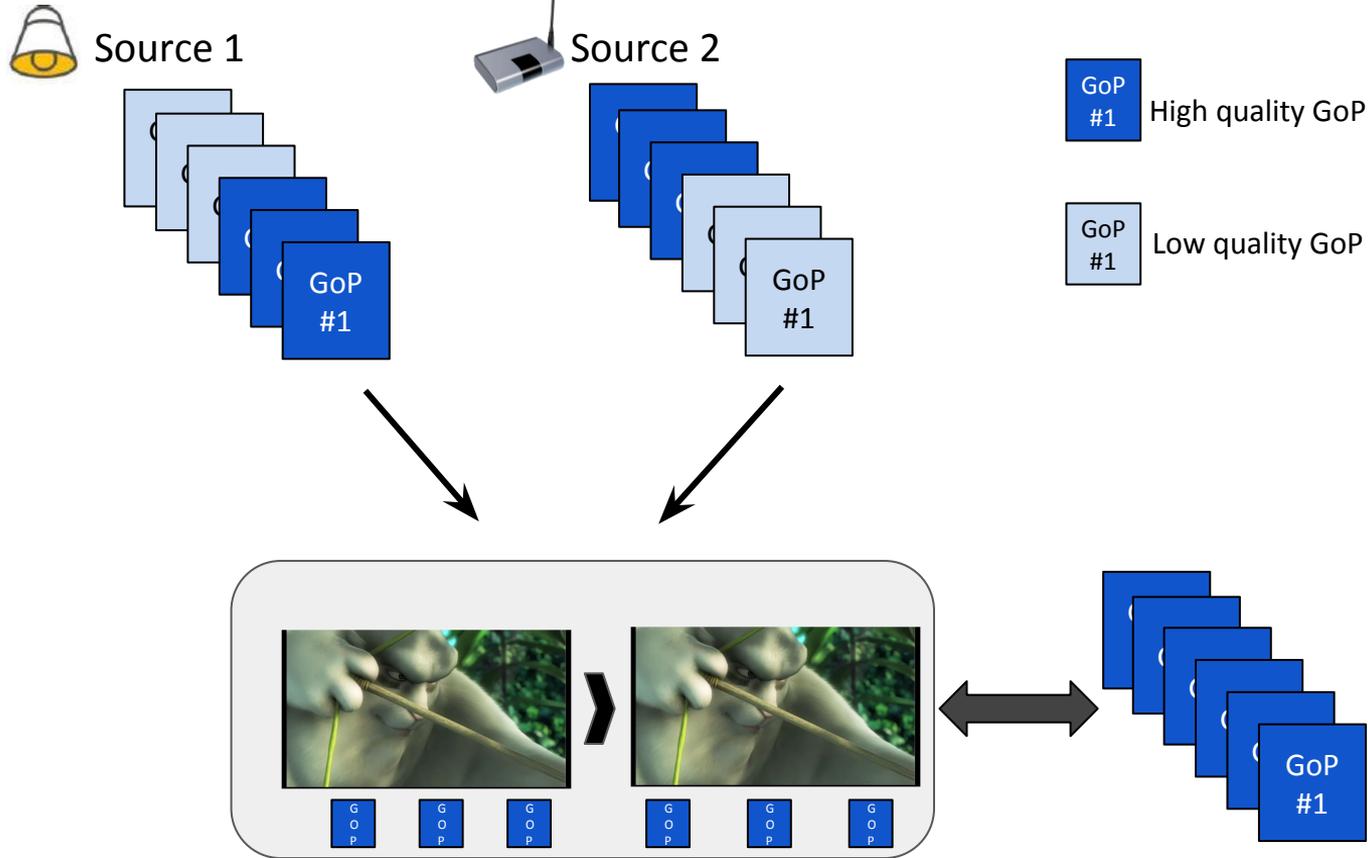


## Group of Pictures (GoP)

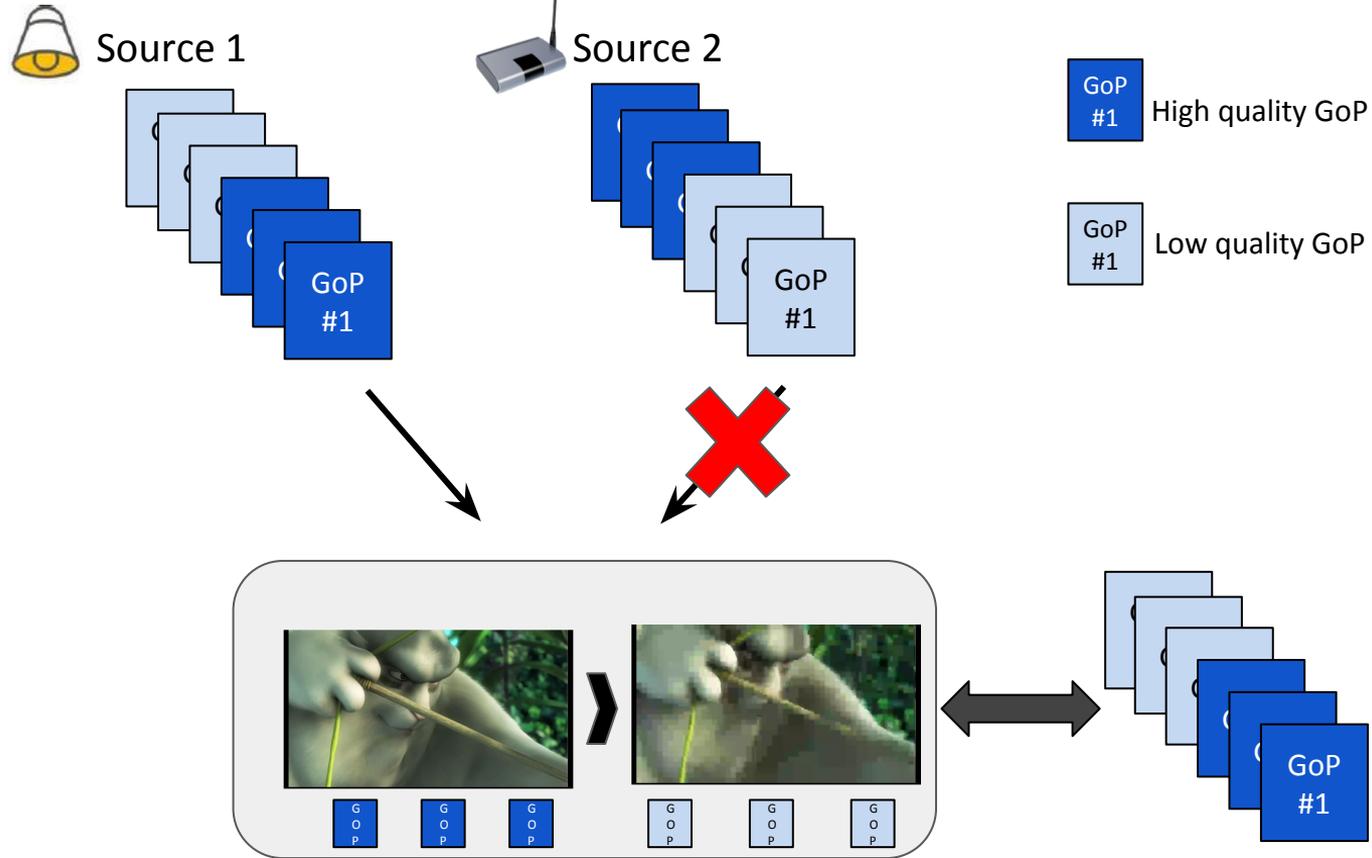
# MSS concept



# MSS concept



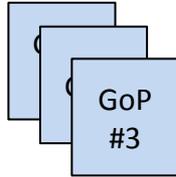
# MSS concept



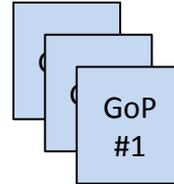
# MSS concept



Source 1



Source 2



High quality GoP



Low quality GoP

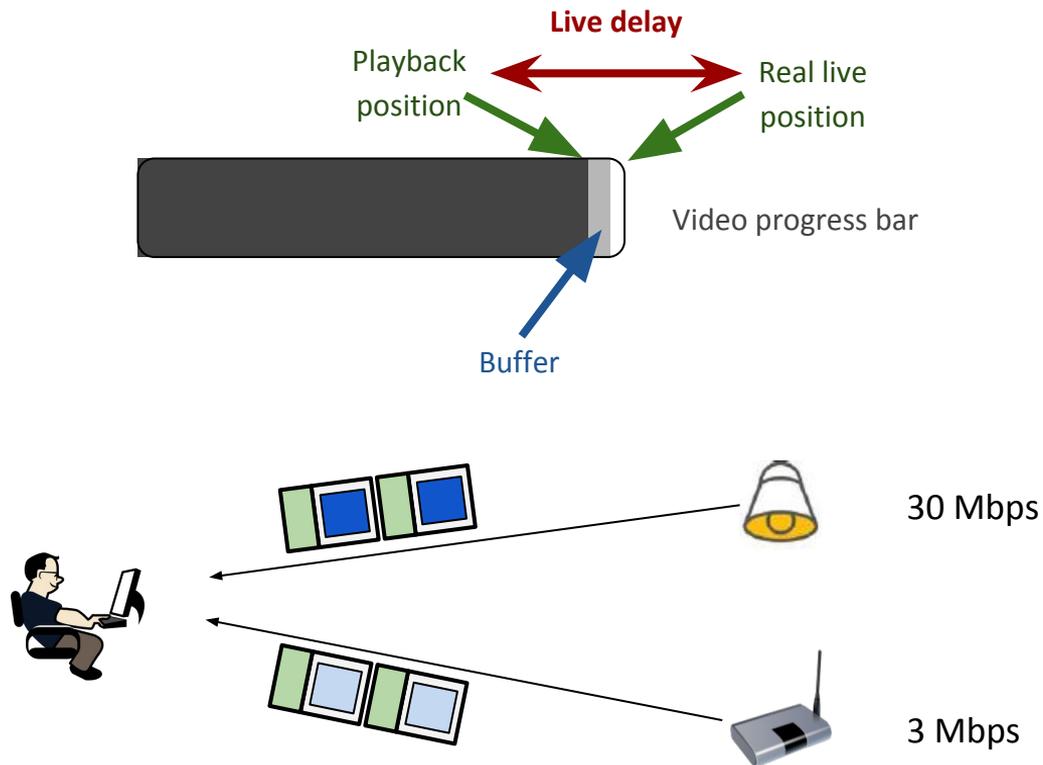


**Overhead**

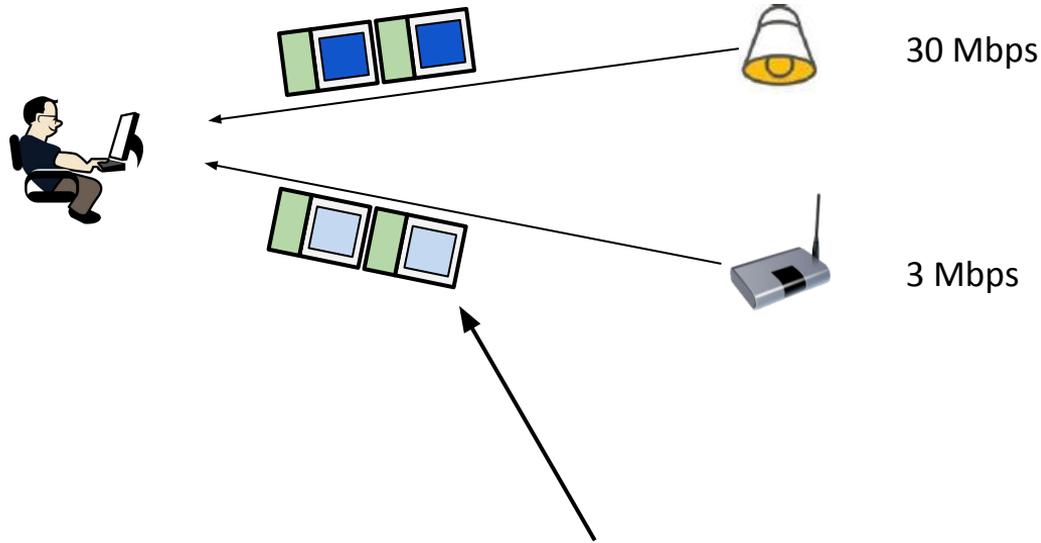
**Drawback**

**Can create network congestion**

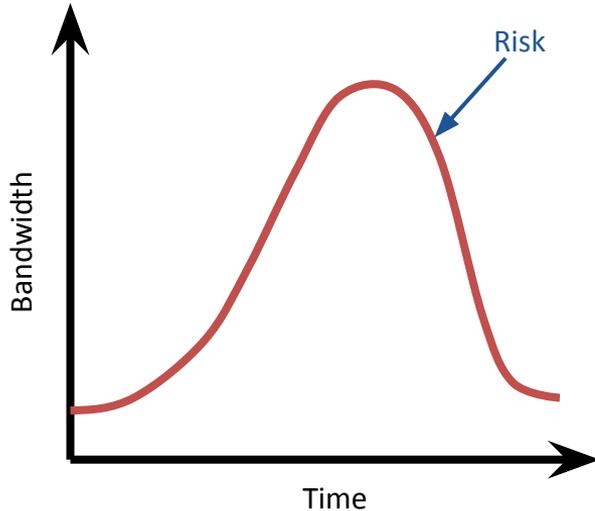
# MSS for Live



# MSS for Live



**Is it necessary to download the redundant GoPs ?**



Risk evaluation according to previous  
bandwidth estimations

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**Algorithm** Overhead Reduction (OR) for live streaming: is a low-quality request necessary to guarantee the reliability?

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**Input:**  $B_{Qi}$  the bitrate of quality  $i$ , with  $i=0$  the lowest quality.

**Input:**  $RBW_{T-n}$  the bandwidth of the RRLH path measured  $n$  segments before.

$addLowQuality = false$

**if**  $RBW_{T-1} \leq B_{Q1}$  **then**

$addLowQuality = true$

**else**

$\Delta RBW = RBW_{T-1} - RBW_{T-2}$

$nextRBW = RBW_{T-1} + \Delta RBW$

**if**  $nextRBW \leq B_{Q1}$  **or**  $nextRBW < \frac{2}{3}RBW_{T-1}$  **then**

$addLowQuality = true$

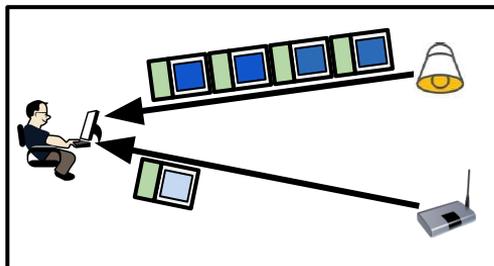
**end if**

**end if**

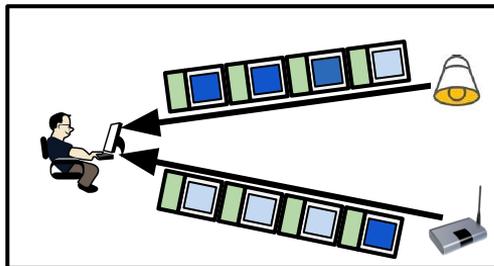
**return**  $addLowQuality$

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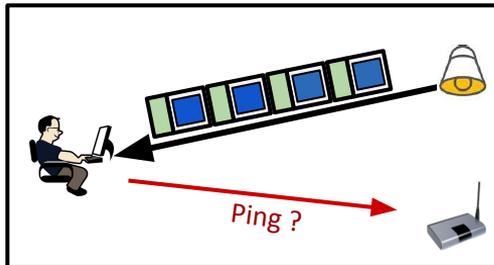
# MSS evaluation



MSS/RRLH

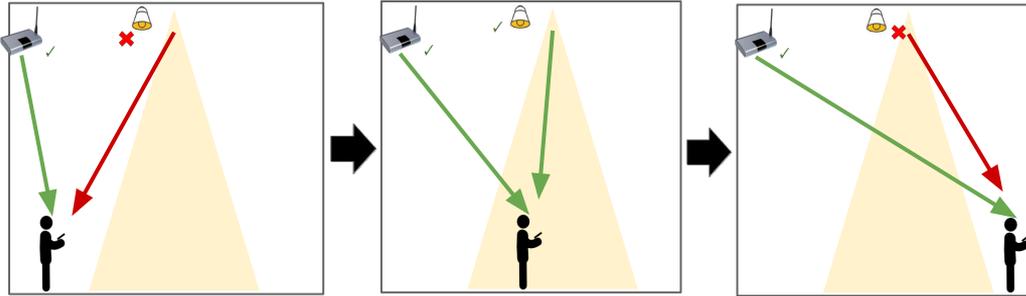


MSS/RRLH with every  
redundant segment



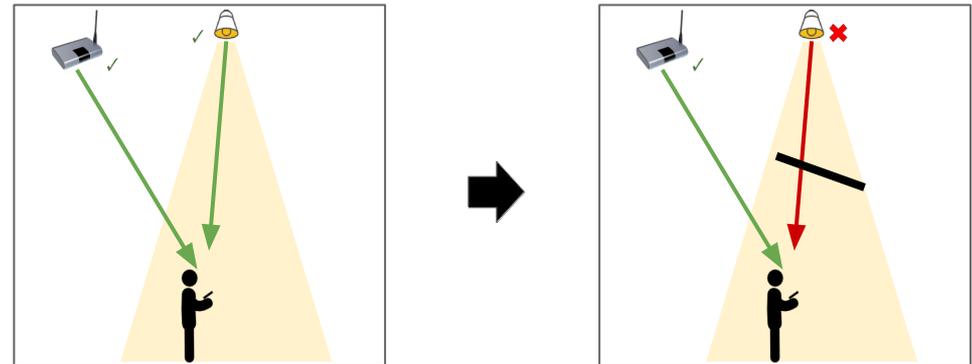
Improved DASH

# MSS evaluation



**Scenario 1:** A user is slowly moving under the lights

**Scenario 2:** An obstacle suddenly blocks the light



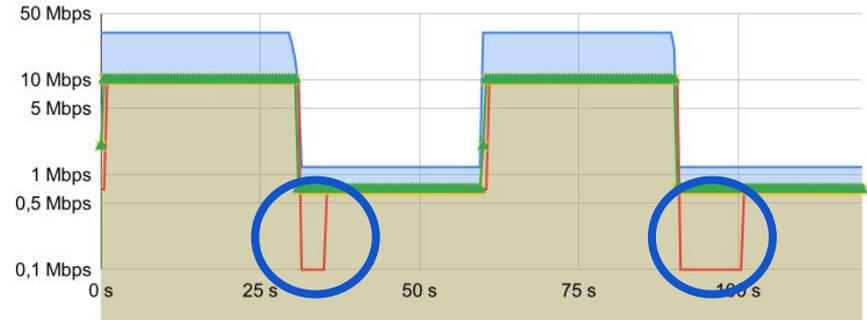
■ Cumulative RRLH/WLAN bandwidth ■ Dash ★ MSS/RRLH without OR  
▲ MSS/RRLH



**Scenario 1:** A user is slowly moving under the lights

**Scenario 2:** An obstacle suddenly blocks the light

■ Cumulative RRLH/WLAN bandwidth ■ Dash ★ MSS/RRLH without OR  
▲ MSS/RRLH



# MSS evaluation

	Improved DASH	MSS/RRLH with overhead	MSS/RRLH
Rebufferings (s)	3	<1	<1
Live latency (s)	6	3	3
Overhead (%)	<1	8.1	2

MSS improves:

- ❑ **The quality:** aggregation of network resources
- ❑ **The reliability:** simultaneous download of low quality redundant GoPs

At the cost of an overhead  $\Rightarrow$  reduced to a minimum by specific algorithms.

**N.B.:** Another version has been developed for VoD streaming

# Thank you for your attention

[mlacaud@joadanet.net](mailto:mlacaud@joadanet.net) and [IoRL-contact@5g-ppp.eu](mailto:IoRL-contact@5g-ppp.eu)  
<https://iorl.5g-ppp.eu/>