

On using QoE for in-network adaptation of SVC streams

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Workshop on Optimisation of Network Resources for
Content Access and Delivery
September the 6th

INSTITUT DE RECHERCHE EN INFORMATIQUE ET SYSTEMES ALÉATOIRES

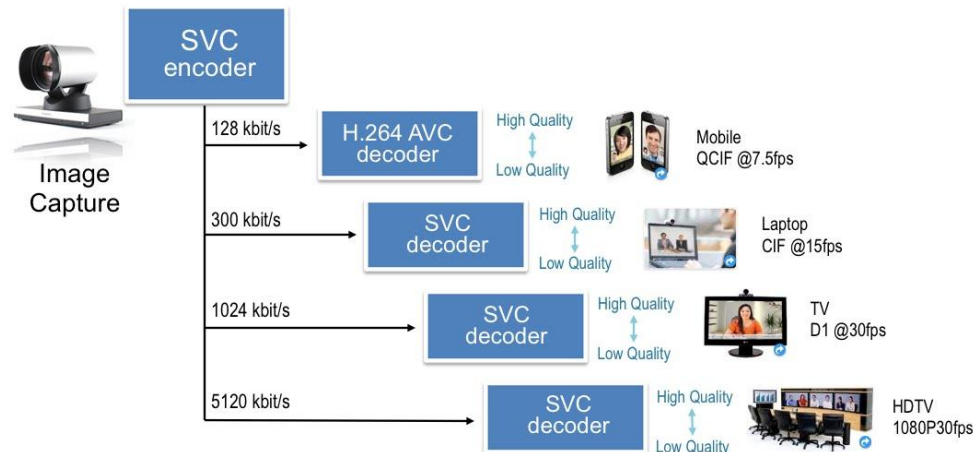


Overview

- Background on SVC and QoE
- QoE tool for evaluating SVC streams
- QoE-based in-network adaptation of SVC streams
 - DVB-T2
 - Multicast IP
- Conclusion

Scalable Video Coding

- It is the scalable extension of H.264/MPEG-4 AVC video compression.
- Devide the original flow onto different layers (1 Base layer and n enhanced layers).
 - Spatiale scalability (QCIF, CIF, SD, HD), Temporal scalability and SNR scalability (Quality scalability)
 - Adapt to user context (terminal capacities, user throughput).



Quality of Experience (QoE)

- What is QoE?
- The overall acceptability of an application or service, as perceived by the end user (ITU-T source).
 - QoE is different from Quality of Service (QoS).
 - QoE gives a Mean Opinion Score (MOS).
- **QoE vs QoS**
 - *QoS is used to get information on the network quality (bandwidth, loss rate, jitter).*
 - *QoE gives a precise idea about the visual quality of a perceived video sequence.*
 - *QoS indicators are not efficient to validate the Quality of a delivered service.*

QoE tools for SVC

- Subjective evaluation
 - Panel of users evaluates different video sequences
 - Output in mean of MOS as specified by the ITU-R



- Accurate but highly expensive in time and preparation

QoE tools for SVC (2)

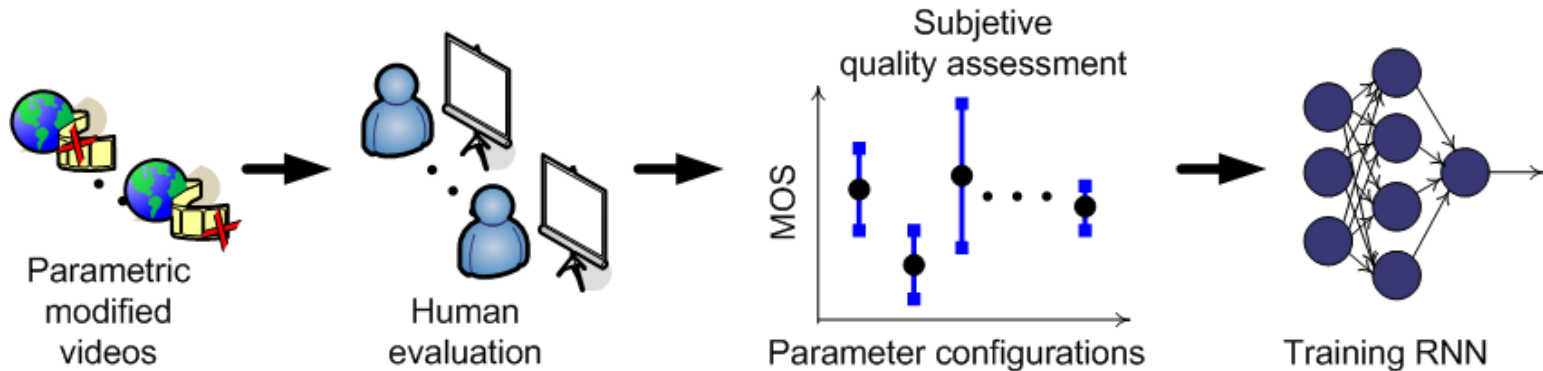
- Objective tools : algorithms and formulas
 - PNSR, SSIM, VQM,...
 - Compare the original sequence with distorted sequence
 - Cannot be used in real-time.

QoE tool for SVC (3)

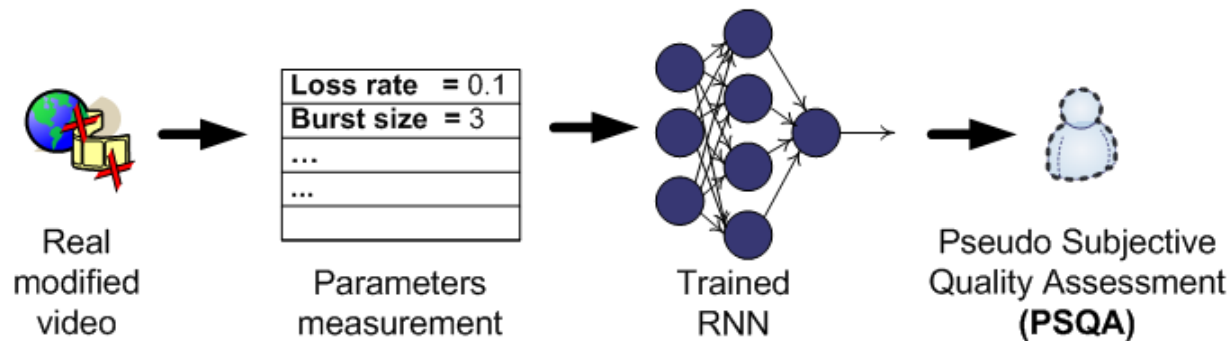
- Pseudo-Subjective Quality Assessment (**PSQA**)
 - No-reference/parametric tool, no need for the original video sequence
 - Hybrid between subjective and objective QoE assessment tool
 - Identify the parameters that have most impact on the service quality (network parameters of encoding parameters)
 - Evaluate the MOS by means of subjective test
 - Approximate the empirical test values obtained in the subjective test by means of a trained Random Neural Network

PSQA for SVC

Training PSQA



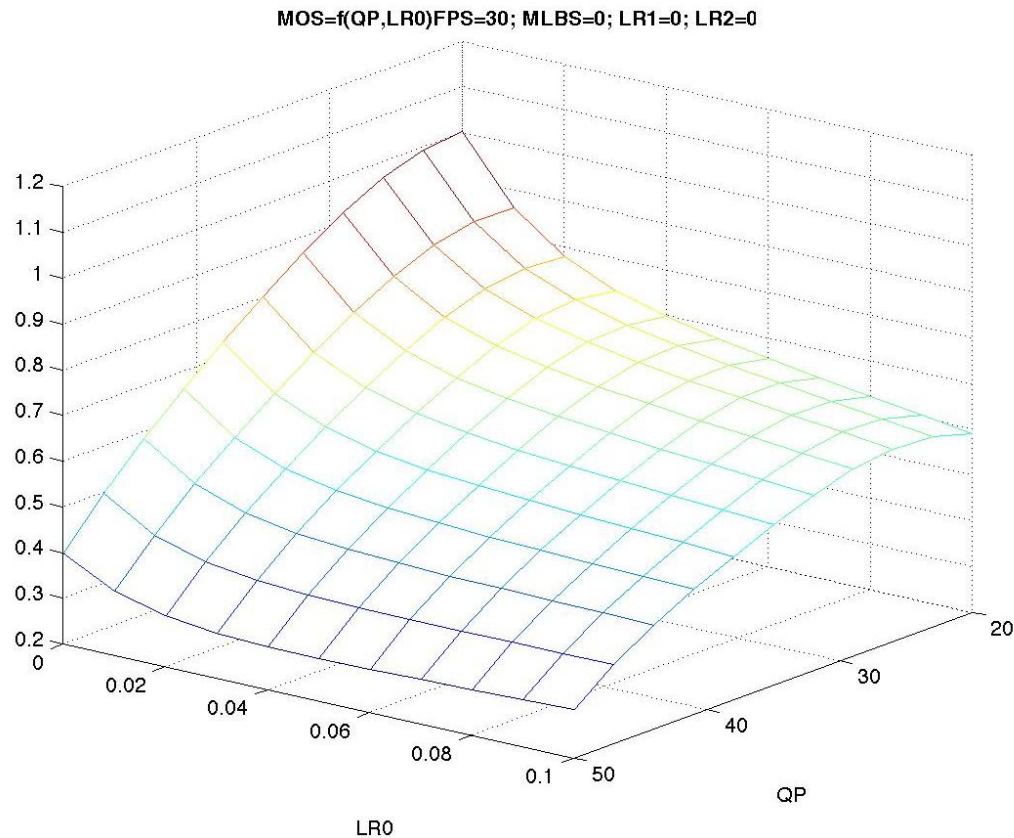
Using PSQA



PSQA for SVC (2)

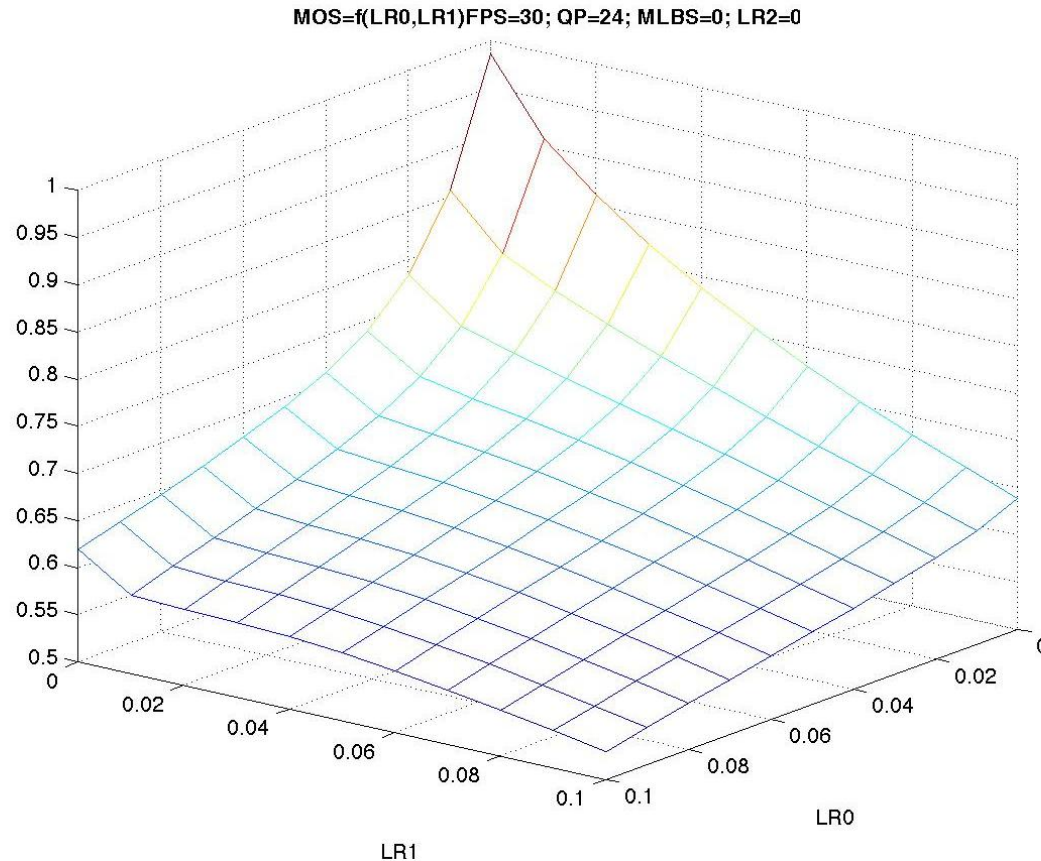
- PSQA for SVC
 - SVC with SNR scalability (each layer decreases the QP value, i.e increases the quality)
 - 1 Base layer and 2 enhanced layers
 - Parameters having an impact on the SVC stream quality
 - NALU Loss Rate (LR) for each layer composing the stream
 - Mean Loss Burst Size (MLBS) of the Base layer
 - QP value

PSQA for SVC: Results



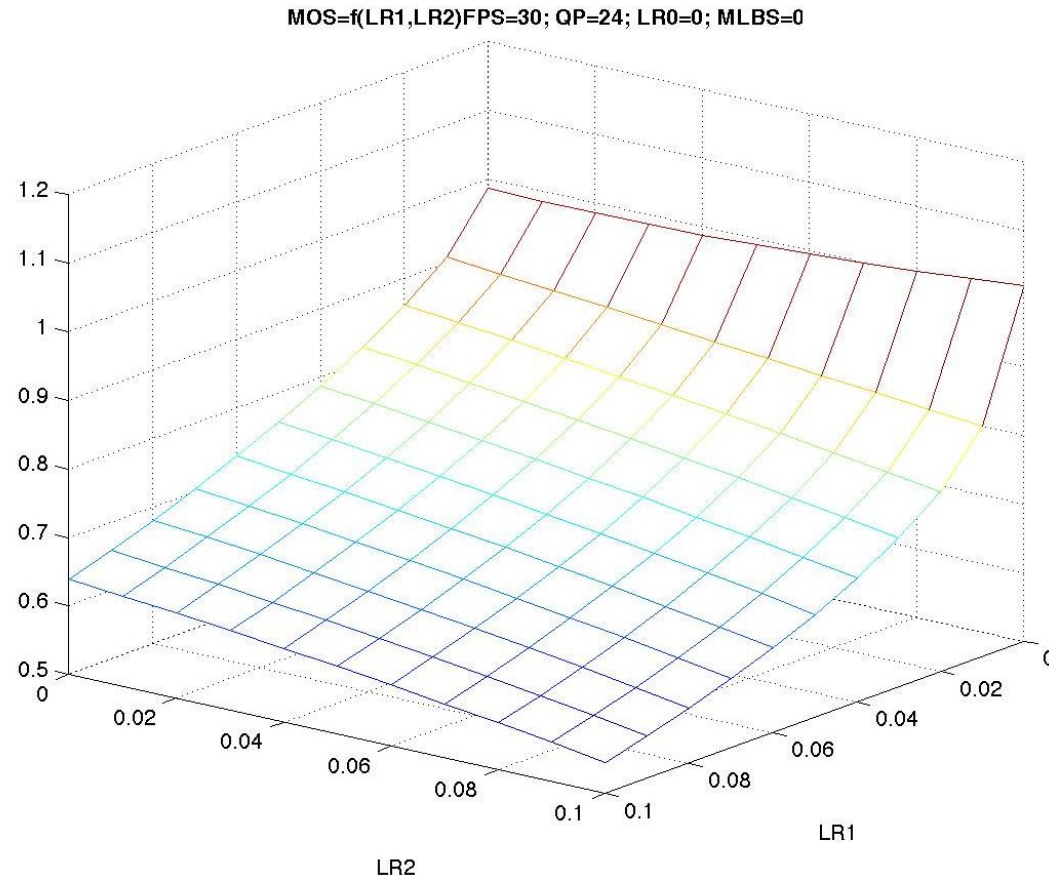
MOS versus NALU Loss Rate (Base layer) and QP

PSQA for SVC: Results (2)



MOS versus NALU Loss Rate (EL1) and NALU Loss Rate (Base layer)

PSQA for SVC: Results (3)



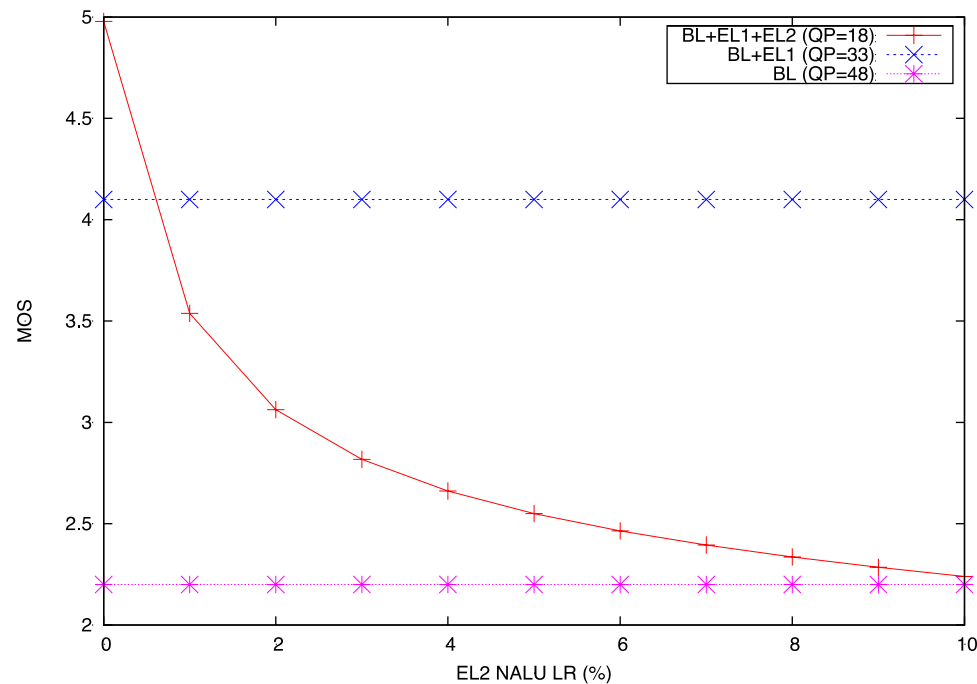
MOS versus NALU Loss Rate (EL2) and NALU Loss Rate (EL1)

QoE-based in-network adaptation of SVC streams

- SVC introduces the possibility to adapt to network fluctuation and user context.
- The IETF introduced the notion of *Media Aware Network Element (MANE)*
 - Adapts the number of SVC layers to send to client
 - What is the criteria to take such decision?

It could be QoE

QoE-based in-network adaptation of SVC streams (2)



- Decoding all SVC layers is not always efficient to achieve high user QoE
- Sometime, it is better to withdraw enhanced layers experiencing packet losses.

The adaptation algorithm at the MANE

Algorithm 1 Adaptive SVC Decoder

```
1: loop
2:   for  $i = 0$  to  $2$  do
3:      $QoE[i] \leftarrow \text{Compute\_QoE}(\text{NLR}(\text{for each involved}$ 
      layer), QP, MLBS),
4:   end for
5:   if  $QoE[2] \geq QoE[1]$  then
6:     Decode all layers
7:   end if
8:   if  $QoE[1] > QoE[2]$  and  $QoE[1] \geq QoE[0]$  then
9:     Decode EL1 and BL
10:  end if
11:  if  $QoE[0] > QoE[2]$  and  $QoE[0] > QoE[1]$  then
12:    Decode only BL
13:  end if
14: end loop
```

Compute QoE for each SVC stream
BL, BL+EL1, BL+EL2+EL3

Decode the
combinaison
that maximizes
QoE

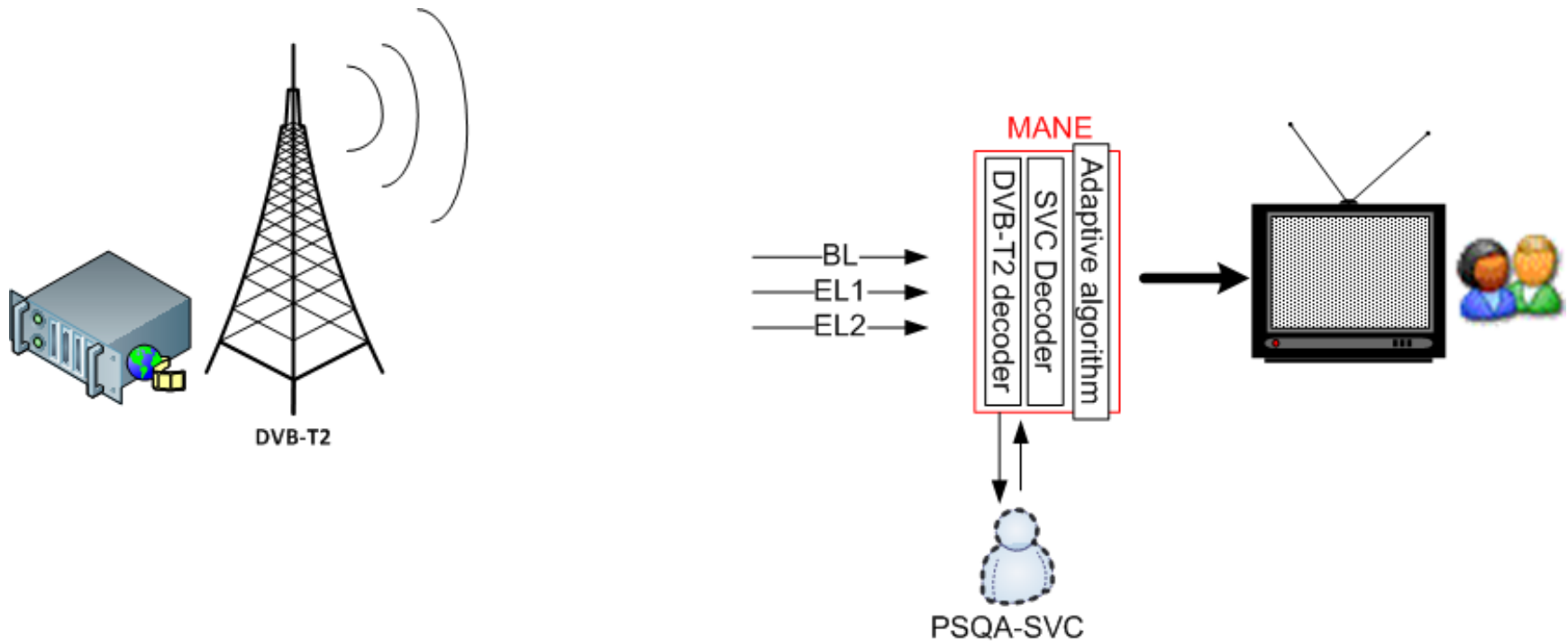
□ In-network adaption of SVC stream: DVB-T2 case

- DVB-T2 is the new standard for digital video broadcast (replace the DVB-T).
- DVB-T2 physical layer channel is divided into logical entities called PLP (Physical Layer Pipes).
 - Each PLP can carry one logical data stream.
 - PLP0 is the most robust, but it achieves less data rate.
 - PLP n is the less robust, but it ensures high data rate.

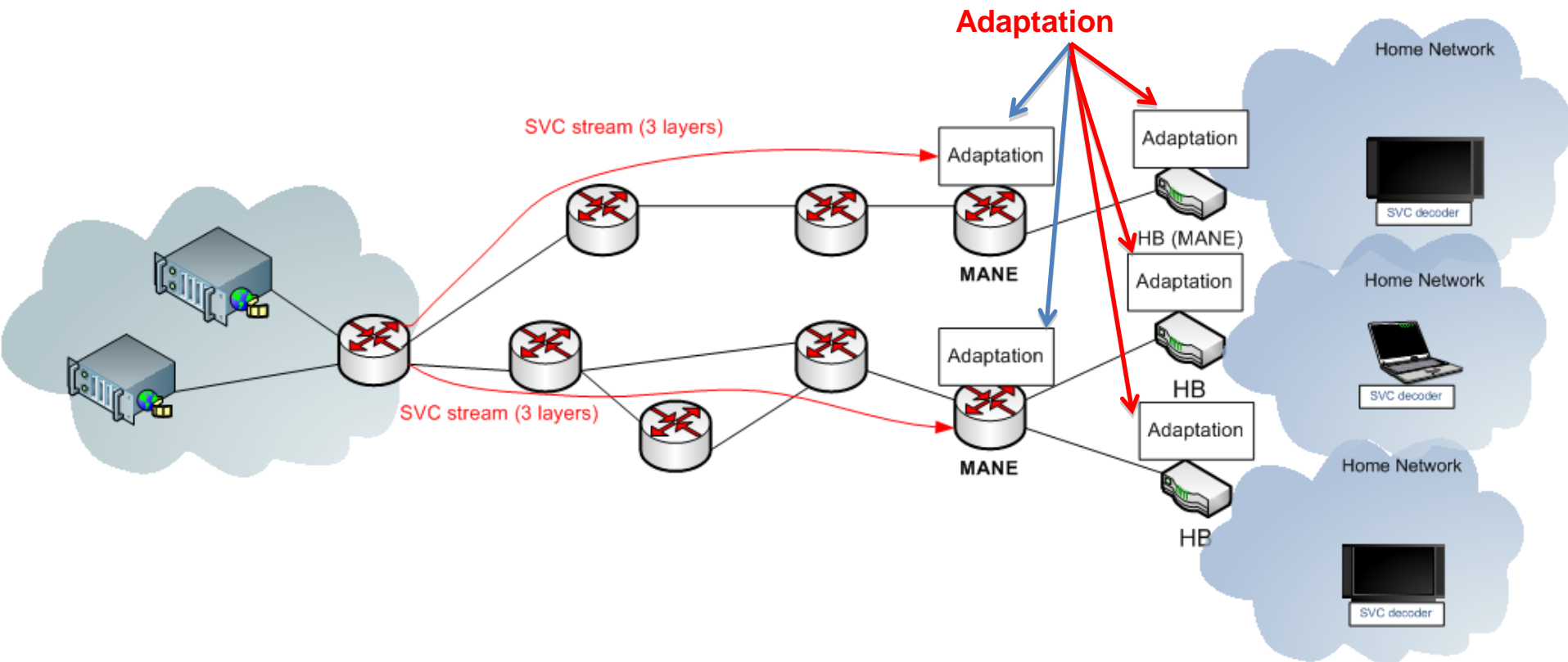
SVC over DVB-T2

- Base layer is sent through the PLP0.
 - Users with bad channel quality can at least decode the base layer.
- Enhanced layers are sent through the other PLPs.
 - Users with good channel quality can decode all the SVC layers and benefit from high video quality.
- However, the channel signal in DVB-T2 is rapidly changing.
 - Issue: which SVC layer the user terminal has to decode in order to maximise the perceived Quality of Experience (QoE)
- **MANE at the decoder side**

SVC over DVB-T2



In-network adaption of SVC stream: Multicast IP



Conclusion

- QoE is an interesting criteria for in-network adaptation of SVC streams.
- Efficient when no clients' feedbacks are available
 - Unidirectionnal communication (Broadcast)
 - Clients' feedbacks can overload the system as in multicast communication.

Acknowledgement

- This work was partially supported by:
 - FP7 Alicante (www.ict-alicante.eu)
 - French SVC4QoE project (www.svc4qoe.com).