A Use Case of Packets' Significance Difference with Media Scalability

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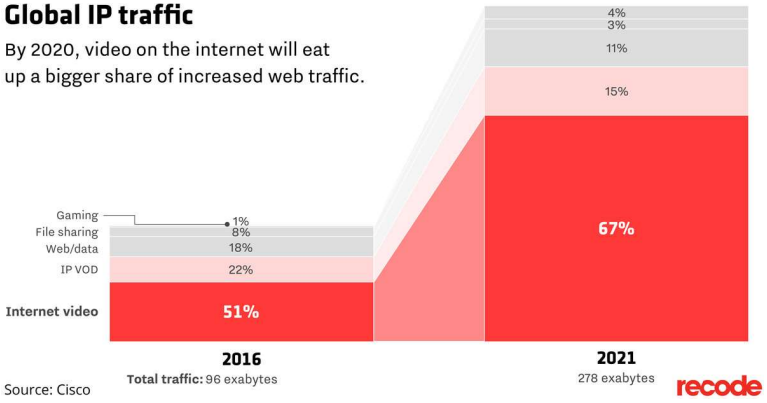
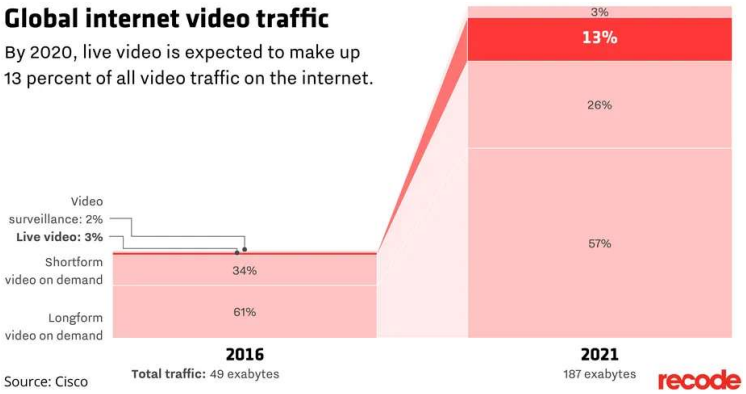
Video Traffic Dominates Internet Usage





- The Internet is dominant by video traffic
  - IP video traffic will be 67 percent of all consumer Internet traffic by 2021 in a global scale, up from 51 percent in 2016.
  - Live video has grown 15-fold from 2016 to 2021, accounts for 13 percent of Internet video traffic by 2021.

Multiple streaming flows may share a bottleneck link, which would inevitably cause network congestion.

Ref: https://www.vox.com/2017/6/8/15757594/future-internet-traffic-watch-live-video-facebook-google-netflix

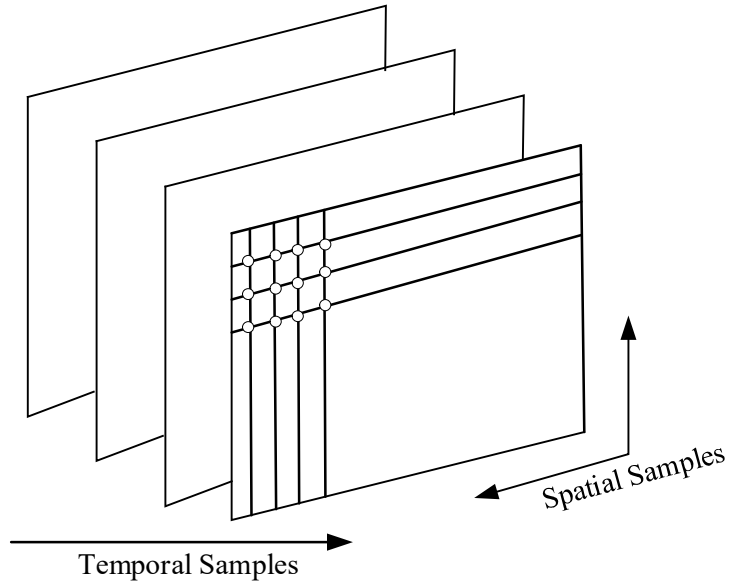
Scalability in Modern Video Codecs

- A visual scene is represented in digital form by sampling the real scene spatially and temporally as a sequence of still frames.

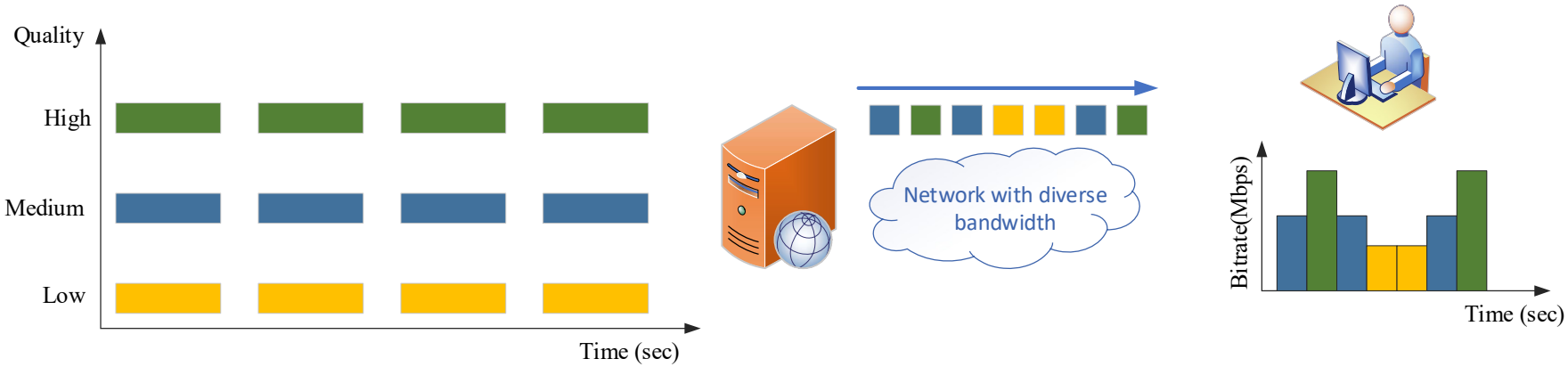
- Correspondingly, modern media codec incorporates three types of "Scalability":
  - Temporal scalability
  - Spatial scalability
  - Quality (SNR) scalability

- For example: SVC (Scalable Video Coding) divides a single video bitstream into multiple representations or layers (base layer and enhancement layers)

- The video may be scaled up by adding the enhancement layer(s) or scaled down by dropping the enhancement layer(s).



Rate Control and Video Adaptation



- Degraded QoE in media streaming is usually caused by network congestion.
- Despite all kinds of congestion control mechanisms developed in the community over the decades, they often target different goals, e.g., link utilization improvement, loss reduction, fairness enhancement.
- Variable types of scalability in modern video codecs have enabled rate control and video adaptation methods to minimize the possibility of network congestion.

Packet Dropping During Network Congestion

- The existing congestion control and congestion avoidance mechanisms do reduce the possibility of network congestion, however they might not be prompt enough to cope with the dropping of packets on the wire.

The minimal, independent,
and self-sufficient unit

Gets classified, forwarded,
or dropped completely

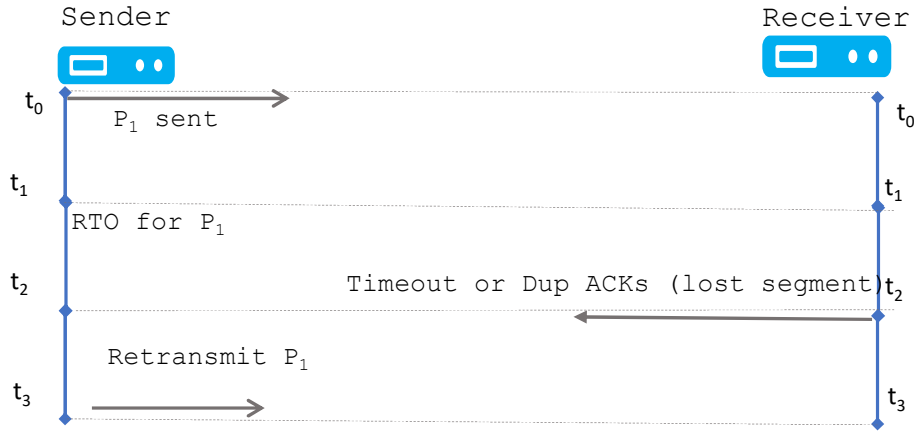
Every bit/byte has the same
significance to the routers

Cost of Packet Dropping

- Packet dropping results in losing the pictures in transit (annoying quality to end users).

- When reliable transport layer protocol is used, packet drops result in the retransmission of the packet.

- Cost of re-transmissions
  - Wastes network resources
  - Reduces the overall throughput,
  - Unpredictable longer delays.



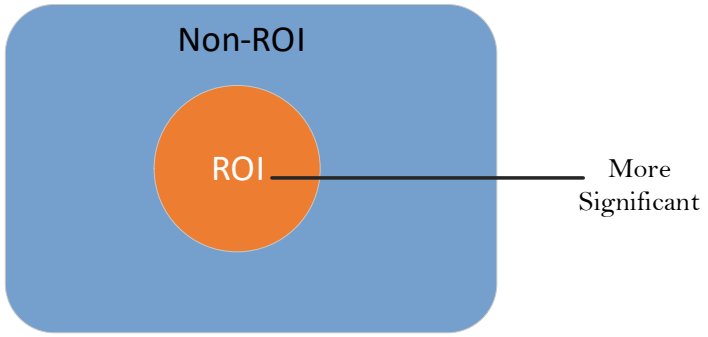
Significance Difference Among Packets

- With the various scalability implemented in the media codec, some bits of an encoded media stream are more important than others.
  - Bits belonging to base layer usually are more significant to the decoder than bits belonging to enhancement layers.
  - Macroblocks that are identified to represent the objects in RoI are likely more important than other macroblocks of non-RoI regions.

I-frame — Have the most effect on perceived video quality

P-frame — A lost P-frame can impact the remaining part of the GOP.

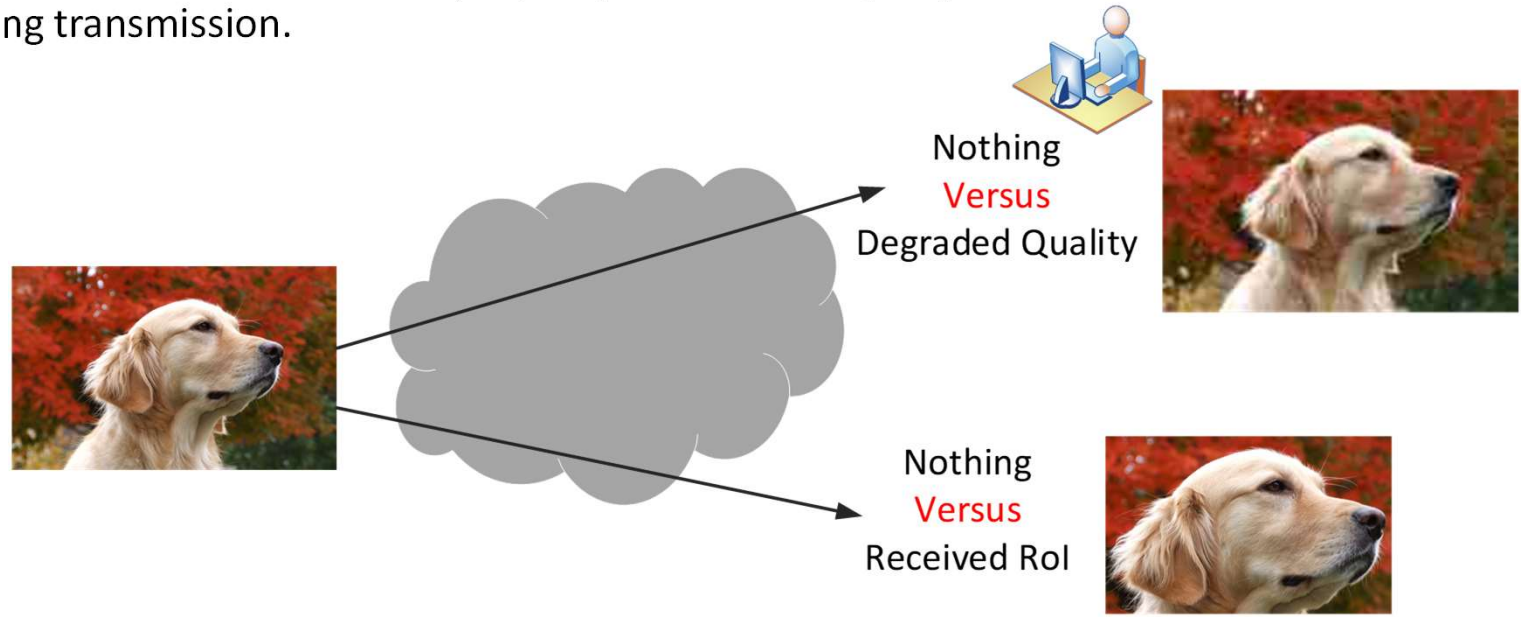
B-frame — A lost B-frame has only local effects in a slowly moving content or with large static background.



End User Preference

- It is very likely that a user may prefer to acquire the media content in a somewhat degraded quality that is above the tolerance threshold rather than getting nothing at all for a few seconds.

- A user may be particularly interested in certain group of blocks belonging to the interested objects in the media content (i.e., RoI). It is necessary to prevent the RoI blocks from being lost during transmission.



Some Preliminary Requirements for Network and Applications

- Although DiffServ enables packet dropping priority at class level, packet dropping does not differ within the same class.

- What if the network is able to treat the packets of media streams in a differentiated manner and at finer granularity than DiffServ.
  - The retransmission could be maximumly eliminated.
  - The receiving end user can consume the delivered packets as many as possible in-time with acceptable quality.

- The application shall reveal some information to the network to enable selective packet dropping. Some examples are listed below:
  - Receiving end user's preference on media quality, e.g., tolerable quality degradation regarding for example resolution.
  - Labeling of the packets or some parts of the packets that correspond to receiver's interested objects as RoI. o Characteristics of media content contained in the packets, e.g., frame type, movement level.

Thank You!

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