Demo: Edge Transcoding with Name-based Routing

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ABSTRACT

This demonstration shows the use of ICN for tile-based panoramic video streaming. To reduce the bandwidth usage, tiles are encoded with different qualities. Tiles having a valuable impact on user QoE are fetched by the client at high quality, the others at low quality. A well-known drawback of having a video with multiple qualities is the reduction of the cache hit probability, since clients can single out different quality for a same tile. To cope this problem, we introduce transcoding functionality on edge nodes, which exploits ICN routing by name for edge processing implementation.

CCS CONCEPTS

• **Networks** → *Network experimentation*; • **Information systems** → Multimedia streaming;

KEYWORDS

Information Centric Networking, Panoramic Video

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1 INTRODUCTION

Edge computing, including fog and mobile edge computing, is becoming an important network component due to its outstanding performance for low-latency, reliability, efficiency and so on. It introduces on the network path an intermediary component with processing and storage resources. By utilizing in-network advanced components, an edge computing node has a high affinity with ICN node, hence can be exploited to implement ICN functionality on the network edge, i.e., where they have a high impact [1].

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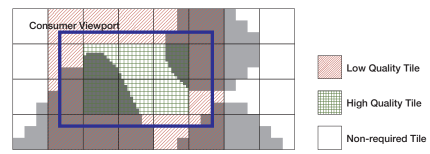


Figure 1: Mixed quality tile-based streaming.

In this paper, we show the benefit and the effect of the panoramic video transcoding on edge components with ICN functionality. We achieve both a reduction of traffic and an improvement of cache hit ratio on the network edge. Additionally, by the name-based routing on ICN, a consumer is able to request contents without awareness of its processing and storage locations.

2 EDGE TRANSCODING FOR TILES

In panoramic video, users see only a part of the whole captured frame. The tile-based streaming technique is a well known [3] technique to archive viewport streaming without per-user or per-orientation encoding. Each captured video frame is divided into non-overlapping tiles and clients request only a subset of tiles according to their viewport. We developed an ICN-based panoramic video streaming by assigning a unique name to each tile [5]. The system is called *named tile-based panoramic streaming*. A consumer requests only necessary tiles, depending on its own viewport, and ICN caching is exploited to reduce network traffic and producer's load.

The mixing of tiles with different quality to build a viewport frame is proposed in [4] to reduce the bandwidth usage without degrading QoE. Figure 1 shows an example of mixed quality tiles. User does not care about the quality of tiles where he does not pay attention, e.g., out or at edge of sight. Thus, the producer provides many quality levels (e.g., high and low), and sends tiles of appropriate quality according to the user's focus. This technique can be applied to our *named tile-based panoramic streaming*. However, the multi-level quality increases the number of available ICN content objects for the same tile, since a content object is generated for each tile quality levels. Therefore different users can request the same tile but with a different quality. These occurrences cause a reduction in cache hit ratio, and as a consequence the traffic might increase. To cope this problem, we leverage edge transcoding.

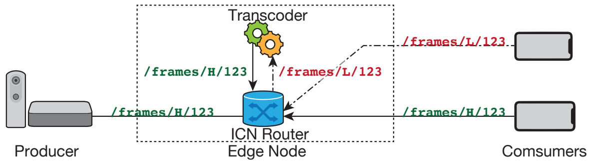


Figure 2: Edge transcoding with name-based routing

Figure 2 shows an example of edge transcoding with name-based routing. The producer provides multi-level quality tiles identified by the name prefixes, e.g., high- and low-qualities are identified by prefixes /frames/H/ and /frame/L/, respectively. When a client requests a low-quality tile, ICN router on the edge node forwards-by-name the request to the transcoder application, which in turn requests the high-quality tile and converts it to low-quality. If the other client requests the high-quality tile, these requests are aggregated. The benefits of this system are the follows:

Improving cache hit ratio: Since only high-quality tiles are forwarded between the producer and the edge node, the cache hit ratio is not affected by the increase in the quality levels.

Request classification: Comparing with proxy-based approaches on the current IP network, ICN-based approaches can retrieve necessary requests for transcoding without the application-level packet inspection.

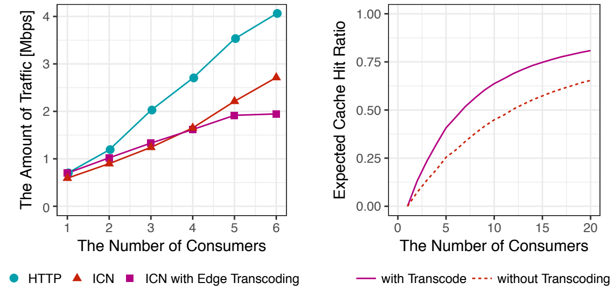
Fault tolerance: Even if the transcoding application fails, requests are forwarded to the producer and the service is continued.

3 IMPLEMENTATION

We implemented the edge transcoding system on NDN [2]. As for our past implementation [5], the producer uses Motion JPEG as the encoding format. It provides two-level quality ties, and the high-quality tiles have twice the resolution compared to low-quality tiles. The consumer is implemented by JavaScript with some useful libraries, i.e., ndn-js and THREE.js. When two or more corners of a tile are out of view, consumers request the low-quality tile. The edge transcoder is deployed on a Raspberry Pi 3, and advertises only a prefix of low-quality tiles. When the transcoder receives an Interest packet, it requests the corresponding high-quality tile. After it receives the requested high-quality tile, it transcodes it to the corresponding low-quality tile and sends it. It is important to note that if the processing is completed within the PIT lifetime, the transcoder does not need to be aware of the transaction, i.e., the relationship between the request and response: the ICN router covers the complex transaction processing, e.g., the duplicate requests.

4 EVALUATION

To show the effect of the edge transcoding on ICN, we evaluated the implemented system. Figure 3a shows the relationship with the traffic usage and the number of consumers. The traffic usage was measured by *nettop* command on the producer and represents the total amount of traffic between the server and the edge node. The resolution of the omnidirectional camera was 1920×960 pixels and the video was subdivided into 10×10 tiles. The frame ratio was set as 2 fps to avoid the effect of congestion.



(a) Traffic Usage **(b) Cache Hit Ratio**

Figure 3: Relationship with the number of consumers

In HTTP, the traffic usage increased in proportion to the number of consumers, since the producer needs to send tiles separately for each consumer. On the other hand, the traffic usage in ICN grows slowly with increasing the number of consumers due to the request aggregation and the caching on the edge node. In the presence of the edge transcoding, with a small number of consumers, the usage was slightly large because only high-quality tiles were transferred. However the increase in the usage with increasing the number of consumers was suppressed. This reason was the improvement of cache hit ratio by the edge transcoder. Figure 3b shows the expected cache hit ratio which is calculated from viewports measured on the implemented consumers. From these results, the transcoding on edge node improves the cache hit ratio and reduces the bandwidth usage at the both of the core network, i.e., between the producer and the edge node, and the access network, i.e., between the edge node and consumers.

5 CONCLUSION

This paper describes the benefits of edge transcoding for the panoramic streaming and of ICN functionalities for the development of the edge function. Our demonstration shows the behavior of our streaming system and the traffic usage reduction effect on the local network environment.

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