



Cloudscape

OPTIONS FOR INTEGRATING VIDEO SURVEILLANCE TO THE
CLOUD

VEGA SYSTEMS INC.

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Introduction

In this document, we first look at surveillance needs that should be satisfied by a cloud solution. Then, for each cloud vendor considered, we chart a way towards satisfying these needs. Finally, we compare cloud costs to meet surveillance needs across cloud service providers. Four service providers are considered – Azure, AWS, Google Cloud and IBM.

We draw attention to the fact that uplink quality adaptation, which is critical for hands-free cloud storage and live streaming, is not provided by any vendor and is offered only by ElastiStream from Vega Systems.

Needs

A cloud solution must provide the following capabilities:

1. Upload with Uplink adaptation: Adapt footage quality going into the cloud
2. Store/Retrieve: Store video footage, retrieve from storage on demand.
3. Live Stream with downlink adaptation: Dispatch cloud footage to remote viewers. Ideally, through HLS/DASH/Smooth Streaming/HDS
4. Analysis: Use AI methods to analyze stored/live content

Compliance Matrix

For all providers, a custom solution that satisfies needs by using object storage, is an option. AWS provides an additional option though Kinesis Video Streams (KVS) (Amazon, 2018).

Table 1 lists compliance of vendors to surveillance needs.

Vendor	Upload with Uplink Adaptation	Object Storage and Retrieval	Live Stream (HLS/DASH/Smooth Streaming/HDS)	Analysis
AWS	Very minimal adaptation, if any (Amazon, 2018). KVS' Producer API for video upload, eases adoption barrier.	Two ways: KVS and S3.	Inbuilt HLS in KVS provides low latency live view. If not using KVS, custom implementations needed with S3.	Amazon Rekognition Video.
Azure	No video specific API. No adaptation support is present.	Blob Storage.	Custom implementations for adaptive streaming needed with Blob Storage.	Video Analysis.
Google Cloud	No specific API for Video. No adaptation is present.	Google Cloud Storage.	Custom implementations needed for adaptive streaming.	Cloud Video Intelligence.
IBM Cloud	No specific API for Video. No adaptation support is present.	IBM Cloud storage.	Custom implementation needed for adaptive streaming.	Watson Video Enrichment.

Table 1: Compliance to surveillance needs

Services Not Considered

All vendors considered, have a media solution that ingests media streams and transcodes these for delivery through a CDN. These solutions are built for mass media broadcast. At present, the costs for these are prohibitive for use in surveillance. We do not consider these here. Likewise, we do not consider event/telemetry data stream solutions such as Google Pub/Sub, Azure Events.

Absent: Uplink Video Adaptation

Noticeably absent from all vendors is a way to adapt video quality to link quality during uploads. Without this, video uploads are not hands-free, can have unpredictable latency and may work only with the most conservative video quality settings.

Cost Comparison

Terminology

The following terms are used in this section:

- Source Site: The site from which camera content is dispatched to the cloud
- Ingress: Move of data from outside a cloud provider's service to the inside
- Storage: Store video data on the cloud
- Data Retrieval: Read data out of storage
- Egress: Move data from inside a cloud provider's service to the outside. This could be for e.g., to view a cloud stored video stream on a smartphone
- API: API use for GET, PUT operations. Other API calls are significantly less frequent than GET/PUT and are ignored
- Destination Site: The site at which video content from the source is retrieved
- AI: Artificial intelligence analysis of video

Solution Set Up

Our solution is set up as below.

Object Storage solution:

1. Custom software at the source site integrates object storage API's and dispatches source content to object storage
2. Custom software at the destination site integrates object storage API's and retrieves video content from object storage for live and archived streams

KVS Solution:

1. KVS libraries are used for upload and retrieval of streams
2. KVS is used for HLS Live Streaming

Cost

Assumptions:

1. We assume that a single video stream's data rate is 1Mbps. This approximately translates to a 1024X768 stream at 5fps
2. In all figures, API costs are computed assuming 1MB block writes and 1MB block reads
3. The per GB storage costs used, assume 1TB of stored content
4. For cold storage, we assume minimum storage time, per tier requirements
5. Each vendor provides many options for object storage and the ones considered are a small sample
6. We assume that video data is at a bitrate of 1Mbps. So, 1GB of video is 8192 s (136.5 minutes) of video. Since AI costs are specified in terms of minutes of video, the above conversion is used for computation of AI /GB costs
7. We were unable to obtain costs for IBM Watson video enrichment

About figures:

1. Figure 1 includes the cost/GB of AI processing of 1Mbps video, along with other costs. All other figures do not include AI cost
2. Figure 2 shows cost/GB incurred when all stored video egresses one time
3. Figure 3 assumes that 10% of stored video egresses
4. Figure 4 assumes that no stored video egresses
5. Figure 5 is Figure 2 converted into a monthly cost/stream
6. Figure 6 is Figure 4 converted to a monthly cost/stream
7. Figure 7 is Figure 6 when the stream contains 10% motion and Video Motion Detection (VMD) is performed before cloud upload
8. Figure 8 is Figure 2 when the stream contains 10% motion and Video Motion Detection (VMD) is performed before cloud upload

Observations from figures:

1. Cloud based AI for video is extremely expensive and dwarfs all other costs, as seen in Figure 1. It is thus impractical for constant live use at scale
2. Leaving out AI, across all providers, egress costs are the most expensive component. Impacts live streaming from the cloud:
 - i. Egress costs multiply with remote live viewers served from the cloud
 - ii. Pre-processing streams with VMD before cloud upload can help achieve significant cost savings
3. The above two reasons tell us that the most economical use of a cloud solution is for storage with rare playback download
4. Significant cost savings are achieved for cameras that have low motion activity when their streams are preprocessed with VMD prior to cloud upload. For the example considered a sub \$1/stream/month cloud cost is achievable. A sub \$5 solution is possible if a single cloud based live stream is added

Cloud Costs/GB, 100% Egress, with AI Video Analysis

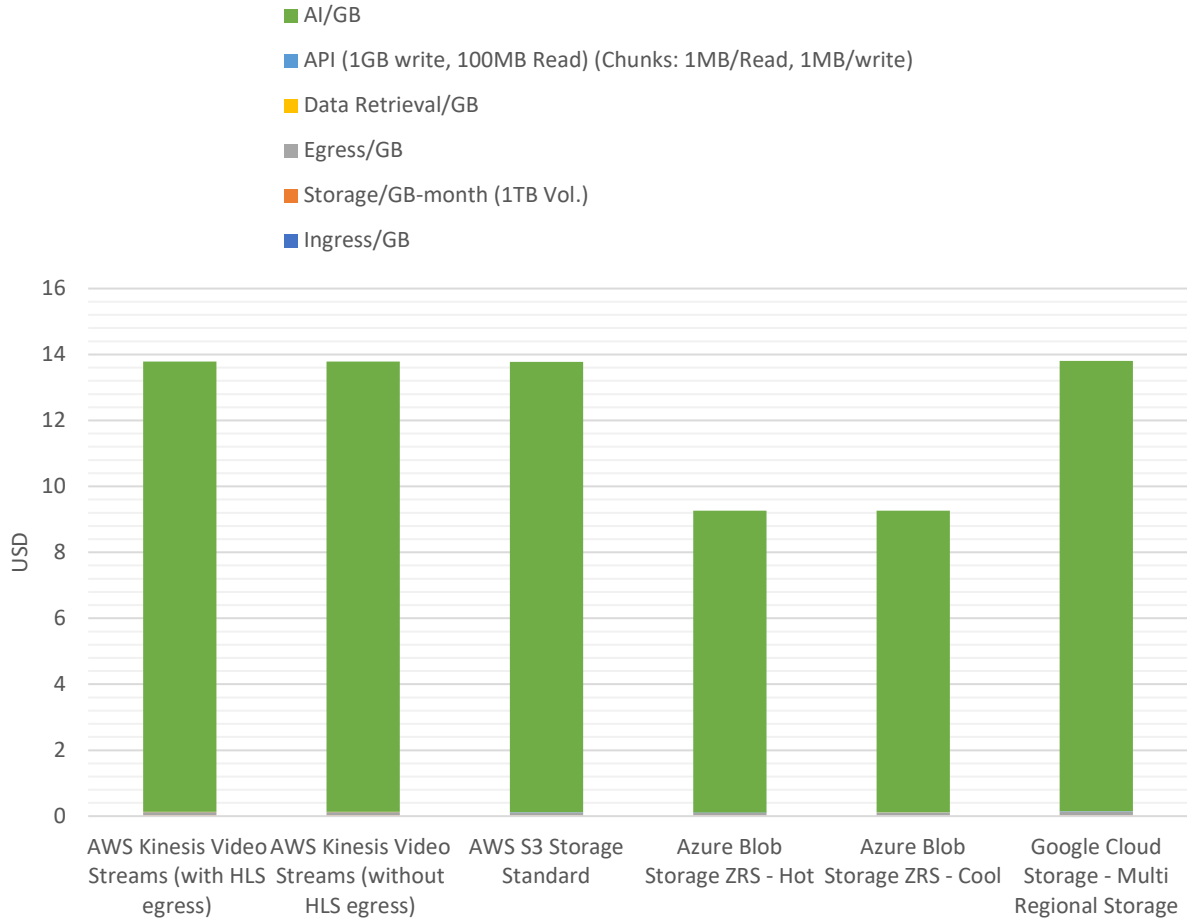


Figure 1: High Video Analysis costs

Cloud Costs/GB, 100% Egress, No AI

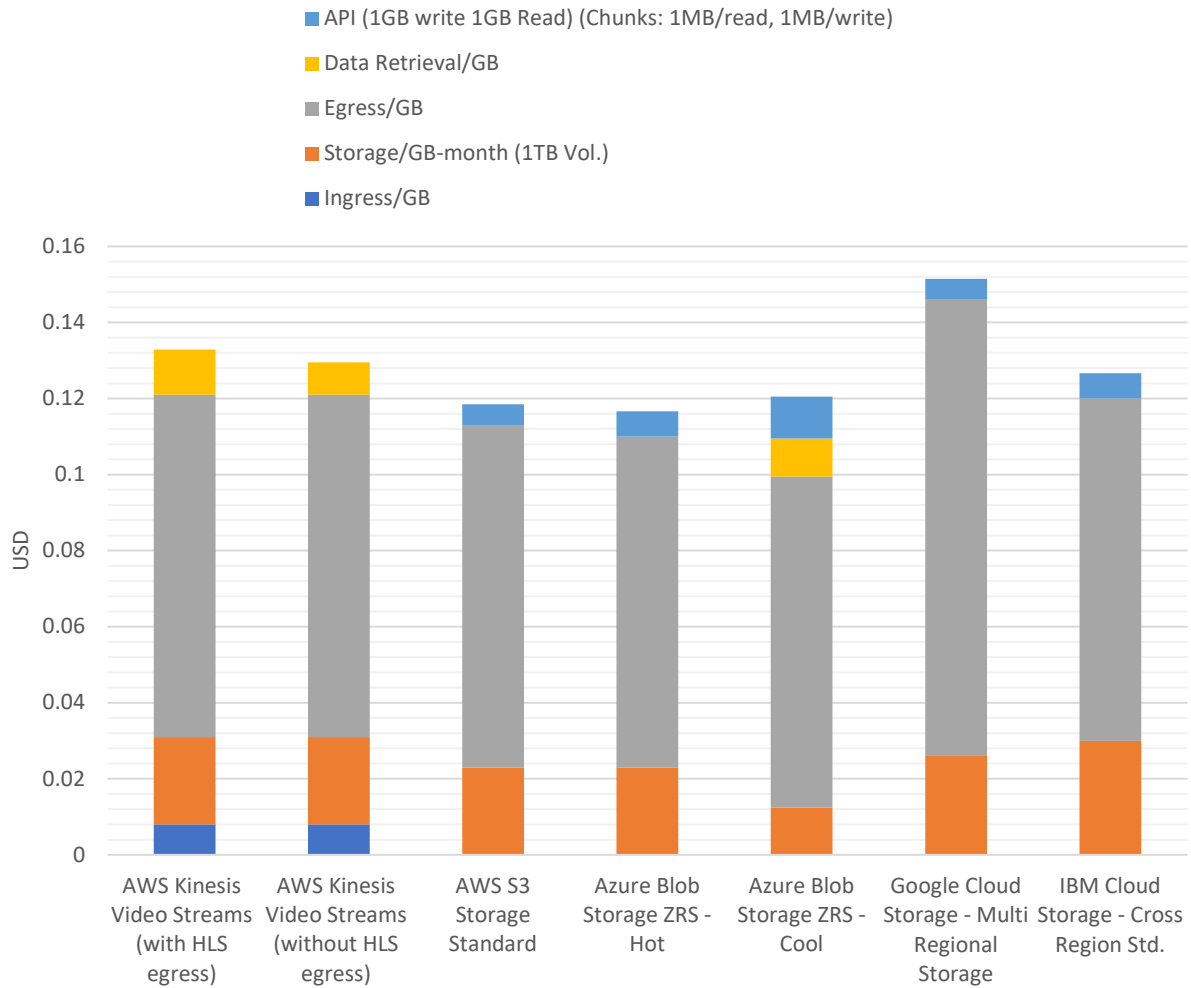


Figure 2: Cost for Storage + 100 % Egress

Cloud Costs/GB, 10% Egress, no AI

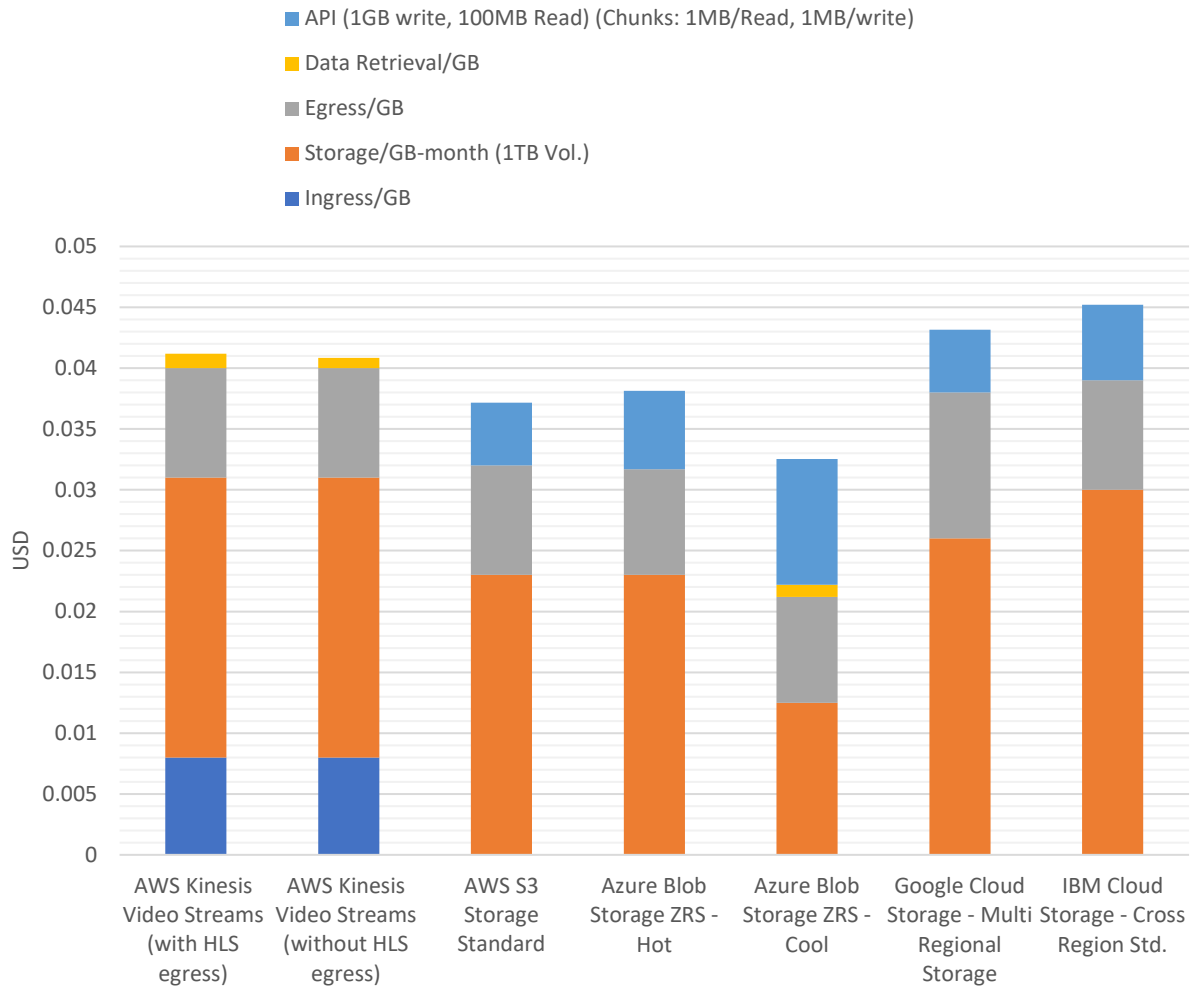


Figure 3: Cost for Storage + 10% Egress

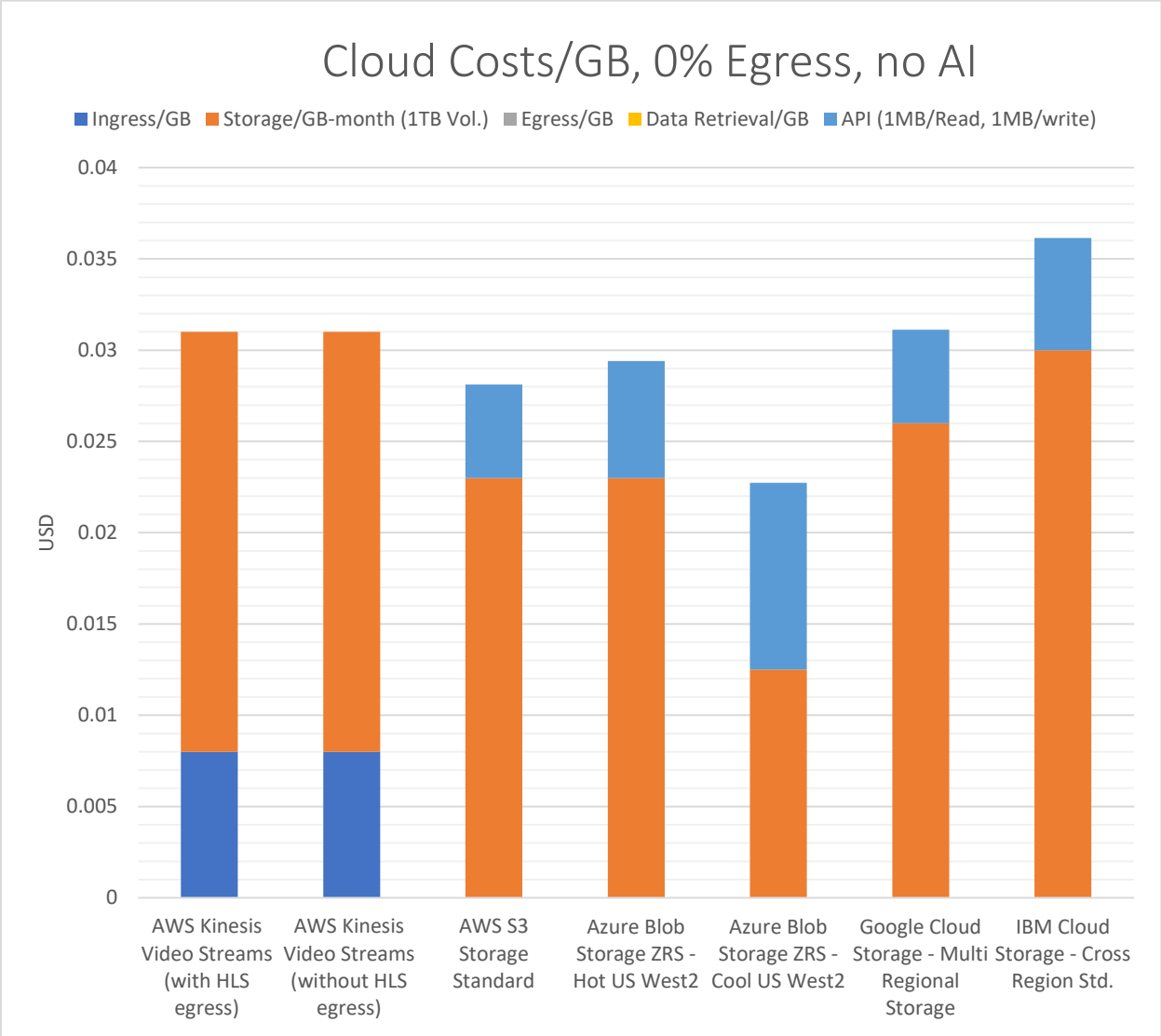


Figure 4: Storage only

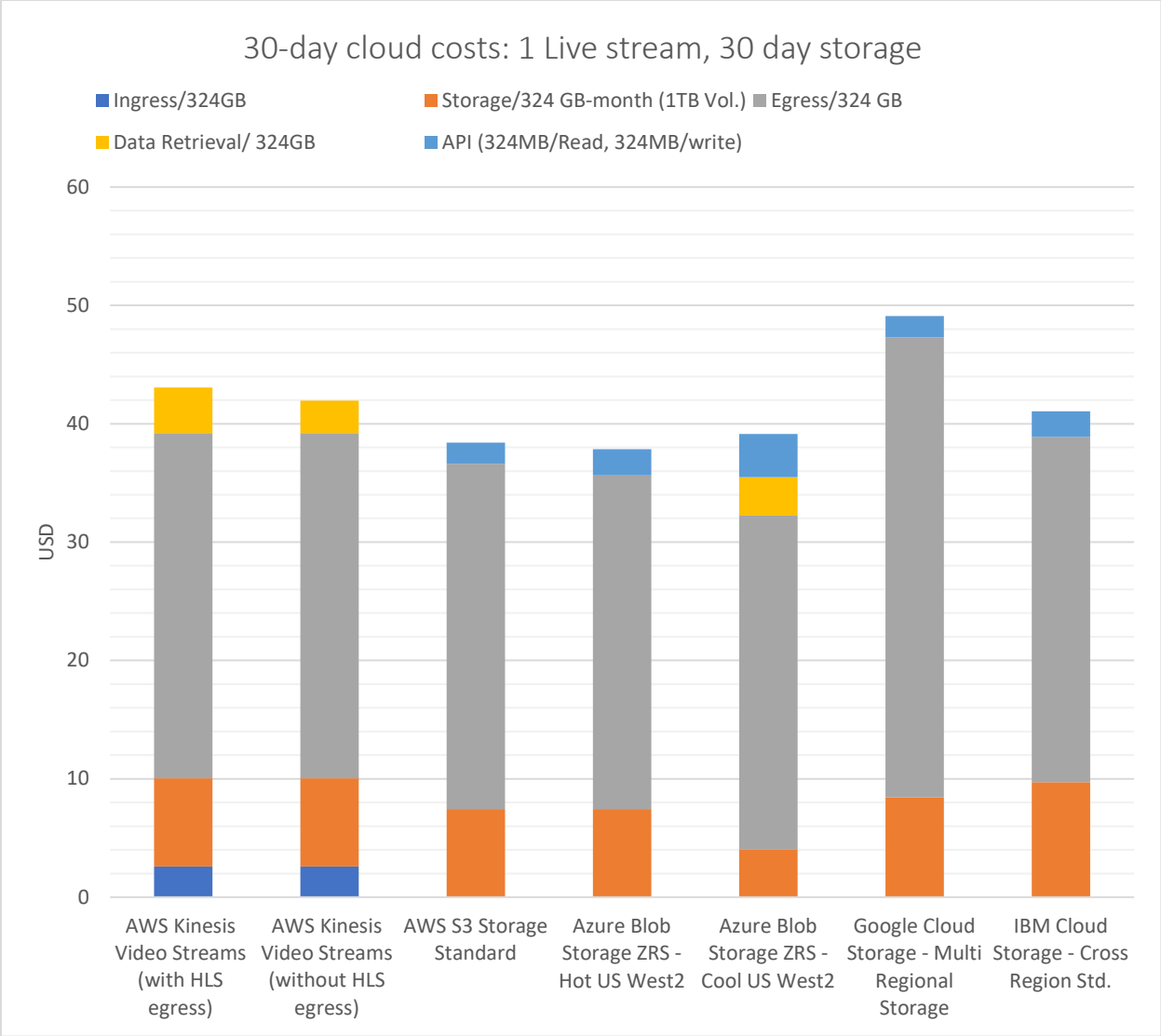


Figure 5: 30-day cloud costs, single 1Mbps stream, 1 live stream from the cloud, no AI

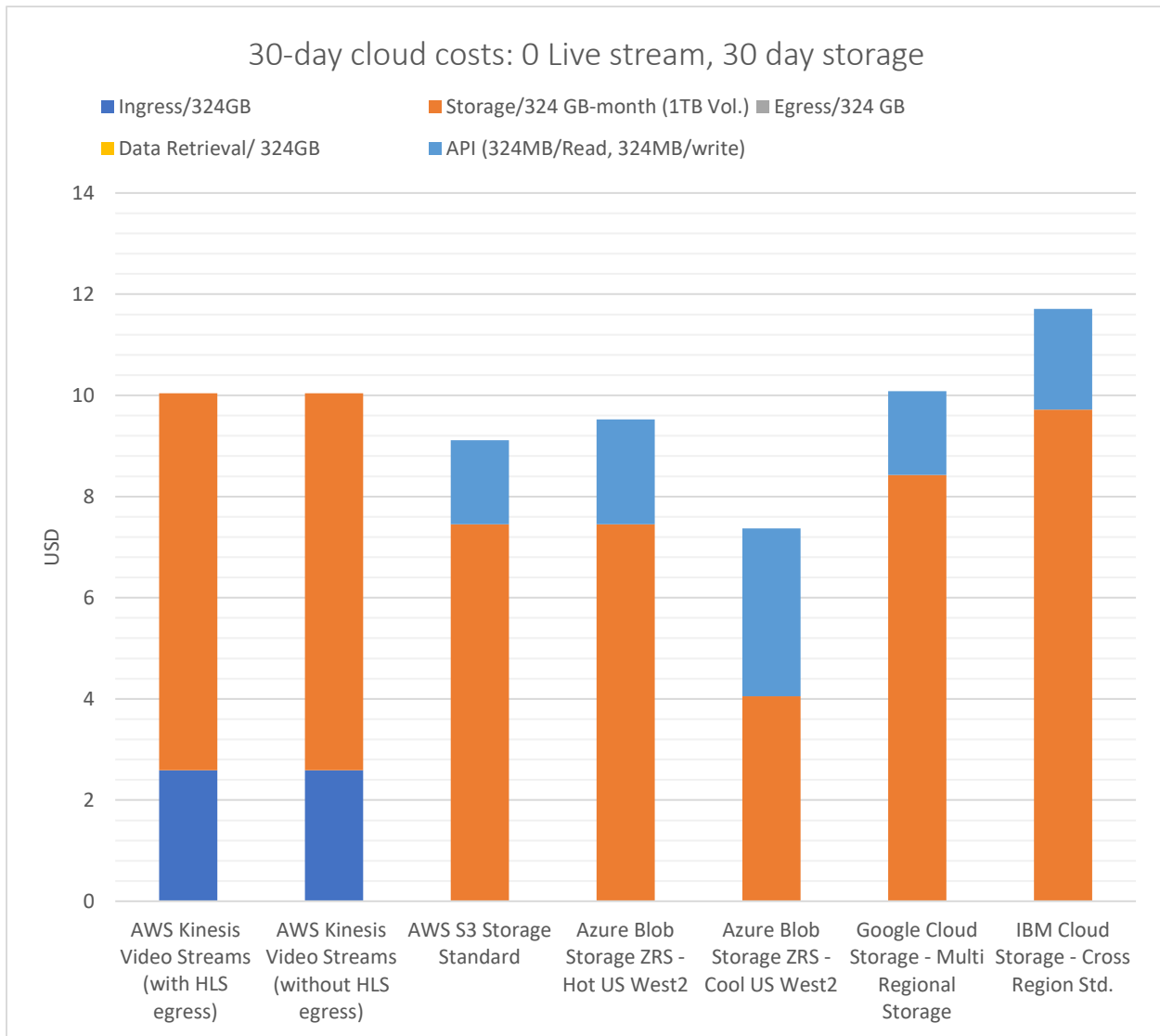


Figure 6: 30-day, single 1Mbps camera stream, no cloud based live stream, no AI

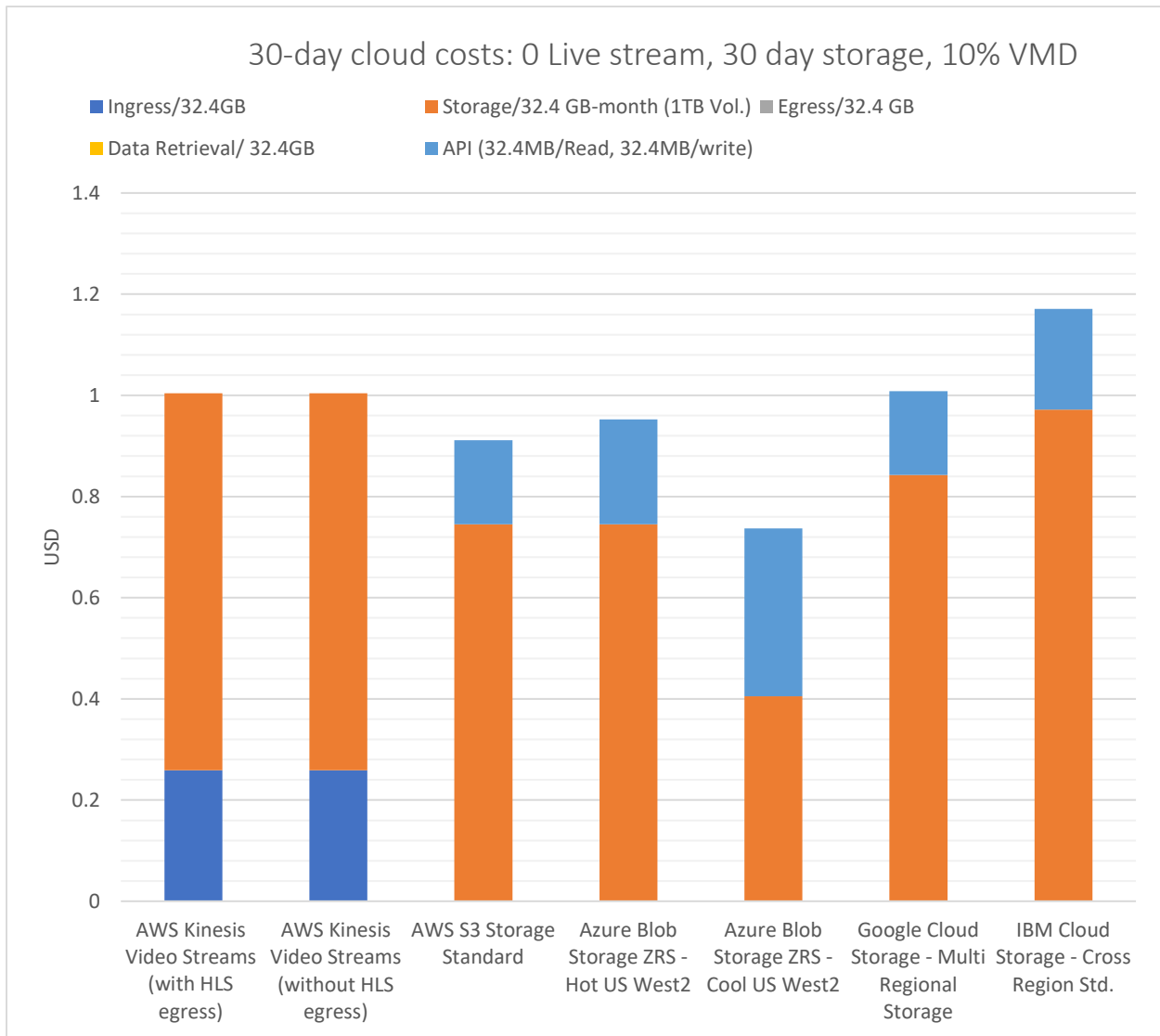


Figure 7: Cloud costs for a 1Mbps stream, 30-day storage, no retrieval, no AI, 10% VMD preprocessed

30-day cloud costs: 1 Live stream, 30 day storage, 10% VMD

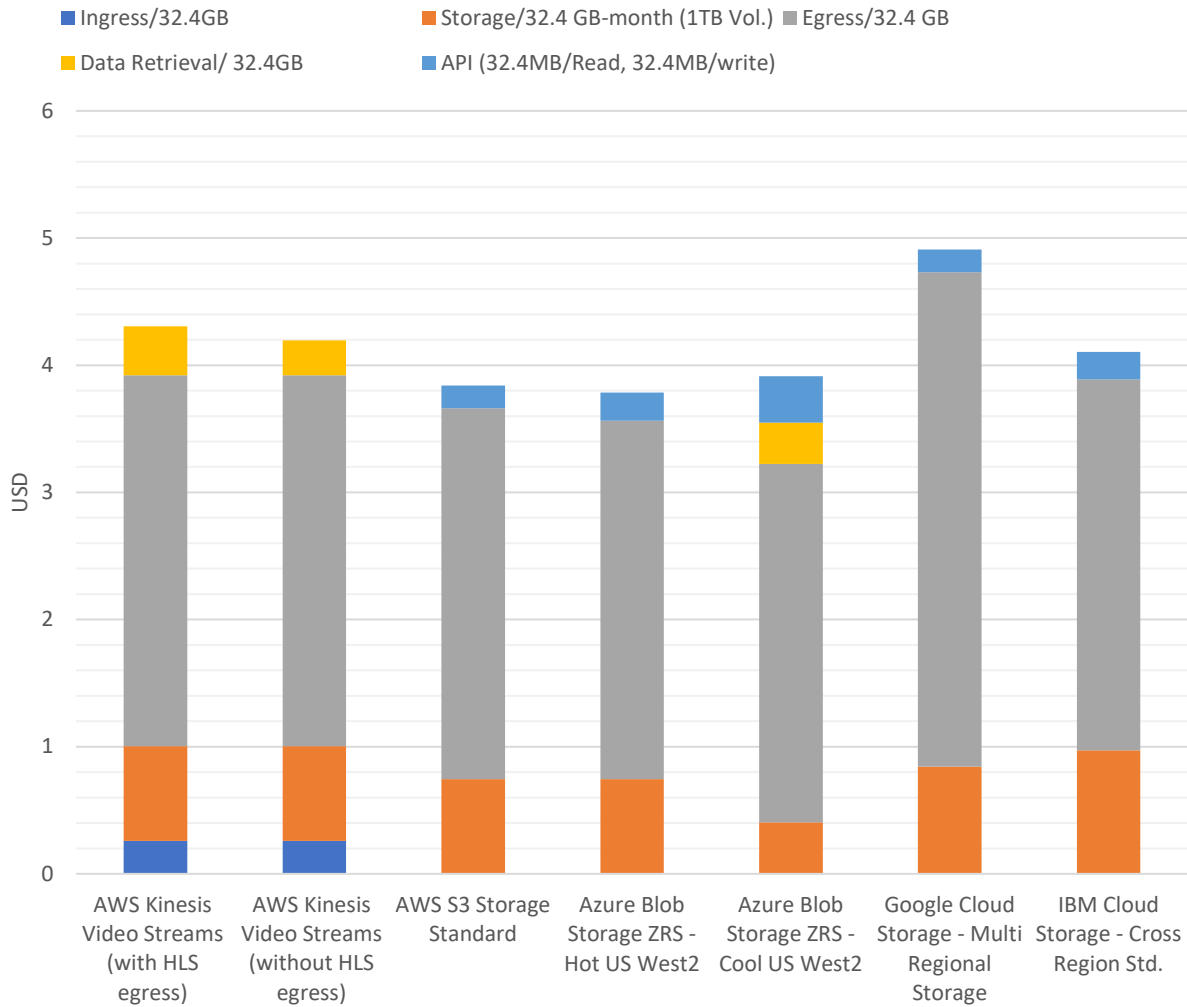
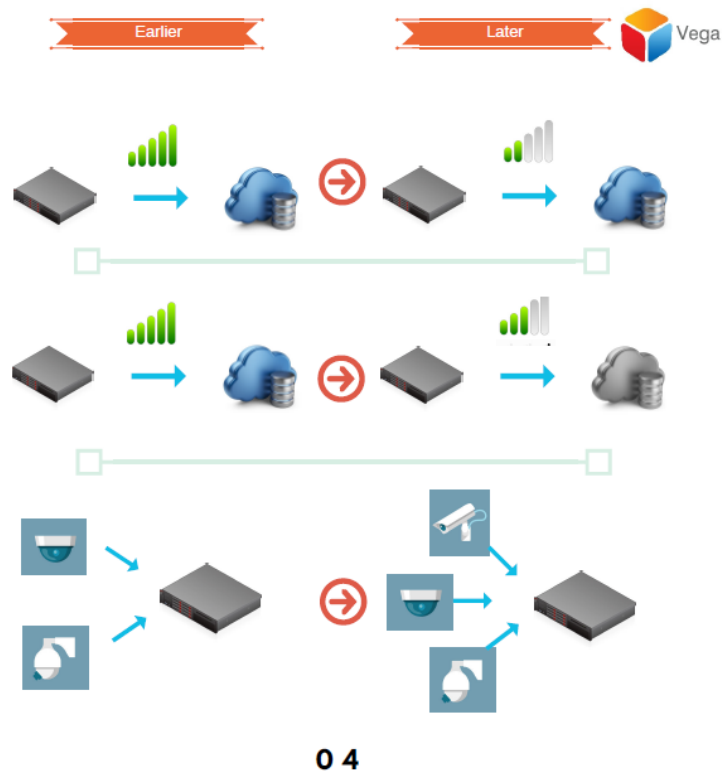


Figure 8: 30-day cloud costs for a 1 Mbps stream, 1 Live stream, 30-day storage, no AI, 10% VMD

ElastiStream provides critical and complementary functionality

Reliable 24/7 video upload to the cloud requires video stream adaptation to changing uplink quality and camera demand. The user should not have to worry about being blindsided by a sudden internet connectivity bit rate reduction, or about having to adjust bit rates of each camera due to addition/deletion of cameras, or a change in the cloud destination. Live streaming from the cloud requires low latency of video upload to the cloud.

ElastiStream's **patent-pending** technology enables adaptive video for hands-free and reliable cloud integration into surveillance. It is a must for cloud based live video streaming. See Figure 9. At present, no cloud solution provides uplink rate adaptation.



HANDS-FREE

Handles significant long-term changes
(link quality, cloud location, source
changes) without human intervention

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Figure 9: ElastiStream is reliable and hands-free

Conclusion

Options to integrate cloud services to video surveillance are presented. Costs are compared.

Cloud based AI for video surveillance is extremely expensive to use at scale. Egress cost is the second most expensive component. To save costs with cloud based live streaming, preprocessing streams with Video Motion Detection prior to cloud upload is recommended. The most economical use of a cloud solution is for storage with limited retrieval.

None of the solutions considered actively adapt video to uplink conditions. By adapting video encoding to uplink quality and camera demand, ElastiStream makes the cloud solution low latency, reliable and hands free. It is a critical feature for a cloud integrated surveillance solution.

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