ALLUXIO

"Zero-Copy" Hybrid Bursting with no App Changes

What's Inside

This whitepaper details how to leverage any public cloud (AWS, Google Cloud Platform, or Microsoft Azure) to scale analytics workloads directly on on-prem data without copying and synchronizing the data into the cloud. We will show an example of what it might look like to run on-demand Starburst Presto, Spark, and Hive with Alluxio in the public cloud using on-prem HDFS.

The paper also includes a real world case study on a leading hedge fund based in New York City that deployed large clusters of Google Compute Engine VMs with Spark and Alluxio using on-prem HDFS as the underlying storage tier.

WHITEPAPER

1 / Problems with Scaling On-Premise Hadoop Clusters

Many companies have data stored in a Hadoop Distributed File System (HDFS) cluster in their on-premises environment. As part of data-driven transformation efforts, the amount of data stored and the number of queries is growing fast. This puts more load on the HDFS systems.

As the number of frameworks to derive insights from the data have increased over the past few years, platform engineering teams at enterprises have been pushed to support newer and popular frameworks on their already busy data lake. In addition, the data lakes become the landing zone for all enterprise data. It is not uncommon to see Hadoop-based data lakes running at beyond 100% utilization. All of this leads to very large and busy Hadoop clusters.

SYMPTOMS THAT REQUIRE LEVERAGING A HYBRID CLOUD DEPLOYMENT

- Hadoop clusters are running beyond 100% CPU capacity
- Hadoop cluster are running close to 100% I/O capacity
- Hadoop clusters cannot be expanded due to high load on the master named node
- No additional capacity on Hadoop cluster to support new frameworks

In spite of these issues, the other alternative of managing data across the data center and the public cloud can be daunting to enterprises. However, as architectures move to a disaggregated compute and storage stack, there are many opportunities to leverage big data in the cloud and offload the HDFS systems. Enterprises can leverage data orchestration technologies to seamlessly implement hybrid cloud approaches and get the best of both worlds.

2 / Leveraging the Power of Hybrid Cloud Data Analytics

Problems in current approaches for managing data in hybrid environments

Today's conventional wisdom states that hybrid latency prevents you from running analytic workloads in the cloud with the data on-prem. As a result, most companies copy their data into a cloud environment and maintain that duplicate data. And companies with compliance and data sovereignty requirements may even prevent organizations from copying data into the cloud. All of this means that it is challenging to make both on-prem HDFS data accessible and high performing.

TWO APPROACHES TO MANAGING DATA FOR ANALYTICS ACROSS CLOUD STACKS

There are two common approaches we see today in managing hybrid data across technology stacks.

1. Copying data from on premise to cloud storage to run analytics

Typically users use commands like distCP to copy data from Hadoop clusters to cloud stores like Google Cloud Storage. While this may make it easy to move data, there are several problems that this method creates:

- As soon as the data is moved, it is already out of sync and stale as data may change on the on-premise cluster. There is no easy way to get data in sync.
- As a result, users may only run read-only analytic workloads on the data copied into the cloud, limiting the value of hybrid deployments.
- Workloads may not directly work on cloud storage and may need application changes. In addition, performance may be significantly lower than on-premise deployments

2. Using cloud network services like Netapp ONTAP

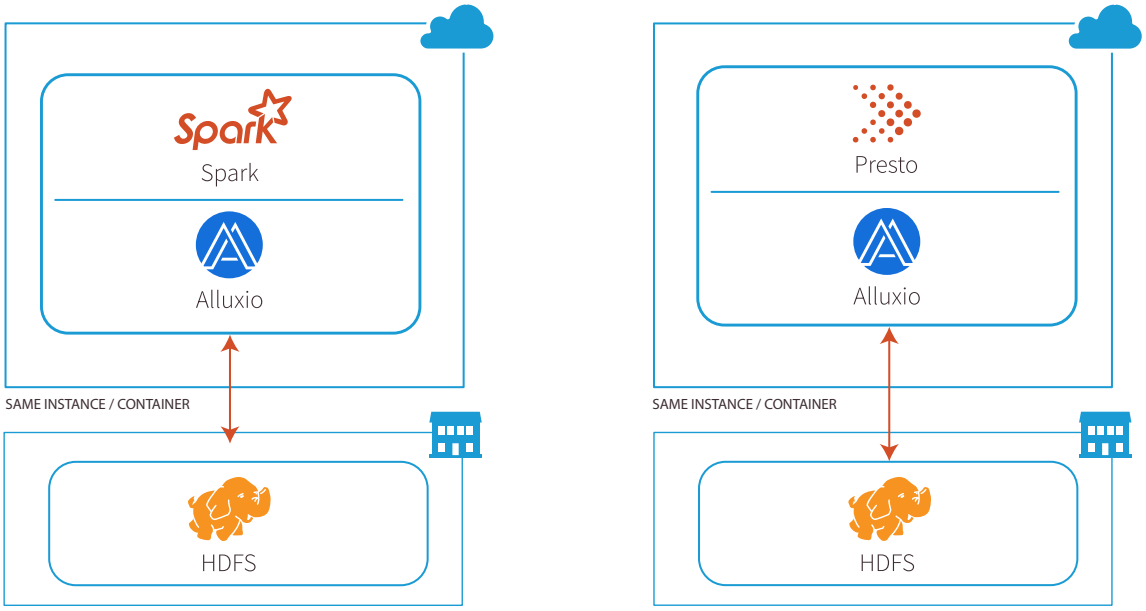
Users can move file and object data in an automated tool-driven manner using a product like Netapp ONTAP. There are a few challenges with this approach as well:

- These technologies can be expensive and only work with limited APIs like network file system API (NFS).
- After moving data, users still need to leverage cloud storage in addition to on-premise storage to run the analytical workloads.

3 / Solution Overview

Alluxio is a data orchestration platform for analytics and machine learning applications. Counter to conventional wisdom, you *can* create high performance hybrid cloud data analytics systems with Alluxio data orchestration. How? By mounting the on-prem data stores into Alluxio. Alluxio data orchestration provides caching, API translation, and a unified namespace to the applications.

Alluxio works with cloud stores like AWS S3, Google Compute Engine, and Microsoft Azure to provide you with an enterprise hybrid cloud analytics strategy to burst compute that spans on-prem and cloud data stores. By bringing the data to the analytics and machine learning applications, the performance is the same as having the data co-located in the cloud. Also, the on-prem data stores will have offloaded the computation and minimized the additional I/O overhead.



Alluxio brings your data to compute, on demand. It's a data orchestration platform for analytics and AI/ML workloads in the cloud, enabling data locality, data accessibility, and data elasticity. Alluxio is designed not for persistence but to address the concerns of data access as required by computational frameworks. It depends on the persistence layer below - HDFS or GCS - as the system of truth. There are a few core capabilities it provides:

DATA LOCALITY

With Alluxio, your on-premise data gets moved closer to compute, directly co-located within the same instance as the Apache Spark or Presto executor / node that needs that piece of data in Alluxio, providing a highly distributed caching capability.

3 /

DATA ACCESSIBILITY

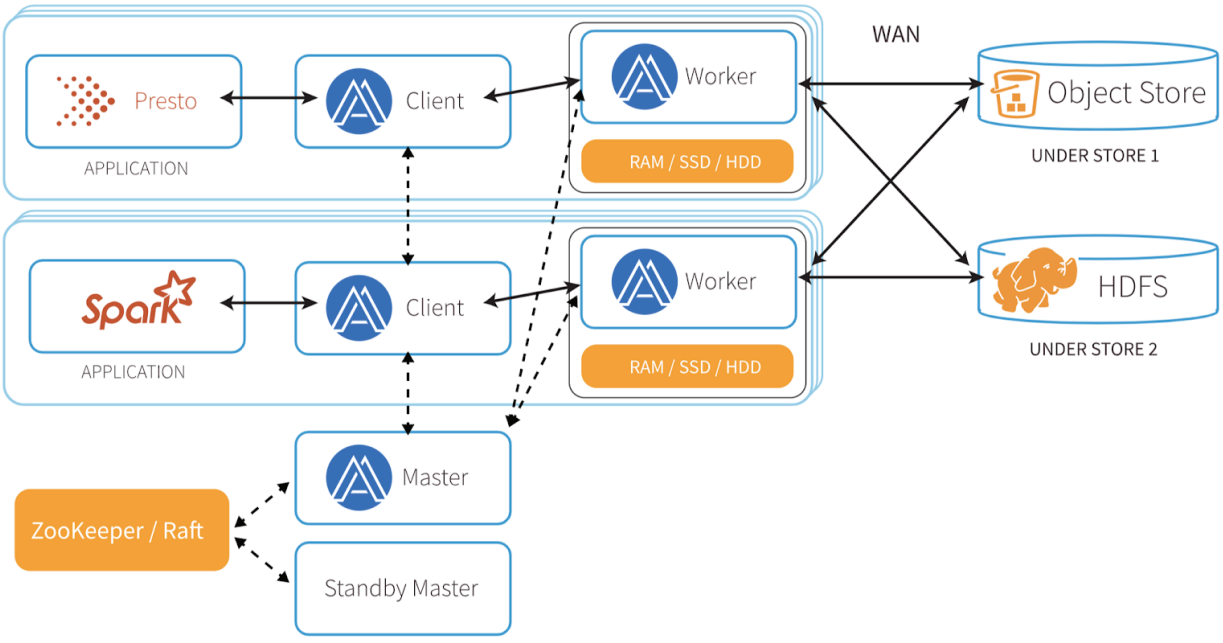
Once data from on-premise Hadoop clusters are in Alluxio, the same data can be accessible in many different ways using many different APIs including the HDFS API, S3 API, POSIX API and others. This means all existing applications built for analytical and AI workloads can run directly on this data without any changes to the application itself.

DATA ELASTICITY

Alluxio can be elastically scaled along with the analytics frameworks, including in container orchestrated environments. Data can also be replicated within the Alluxio cluster with each file being replicated as many times as needed.

COMPUTE-DRIVEN DATA ON-DEMAND

Any folder or bucket can be mounted into Alluxio and immediately the data from that location can be pulled into Alluxio as the workload demands. Some of the folders' metadata made accessible to Alluxio is initially read, but the data itself will get pulled only when the compute framework asks for a specific file. Data can also be pretched, pinned or expired depending on the workload.



Alluxio Architecture

ALLUXIO

4 / Example: How Leading Hedge Funds are Leveraging the Hybrid Cloud

The Challenge for Quantitative Hedge Funds

Quantitative hedge funds rely on financial models to manage their business and drive investment strategy. The ongoing business challenge is to develop more powerful models so they can make intelligent investment decisions in a shorter period of time and at the lowest possible cost. The development and testing of investment models relies on Machine Learning techniques applied to vast amounts of data – the more data, the better the model. Data is collected from thousands of public and proprietary sources and totals many petabytes. The speed at which this data is processed is critical, as faster model runs enable multiple iterations and improved decision making.

Typically, model runs are performed on-premise with a typical run taking about one hour on few hundreds to thousands of data processing nodes. Apache Spark is commonly used for the compute framework and data is typically stored using the Hadoop Distributed File System (HDFS). The workload profile can be variable, with periodic load bursts significantly higher than average. Because of the challenges around overprovisioning of the infrastructure and constraints around peak loads, many hedge funds leverage hybrid cloud data bursting.

But remotely running computational frameworks like Apache Spark on data on-premises presents challenges:

- For security reasons data may not be allowed to be stored in the cloud, requiring model data to be transferred from the on-premise data center prior to each run.
- Due to the size of the data and the physical transfer requirement, model run time in the cloud can increase significantly resulting in fewer models built per day.
- Any change to the model parameters requires a restart of the data loading process.

The Hybrid Cloud Analytics Solution with Alluxio & Google Compute Platform

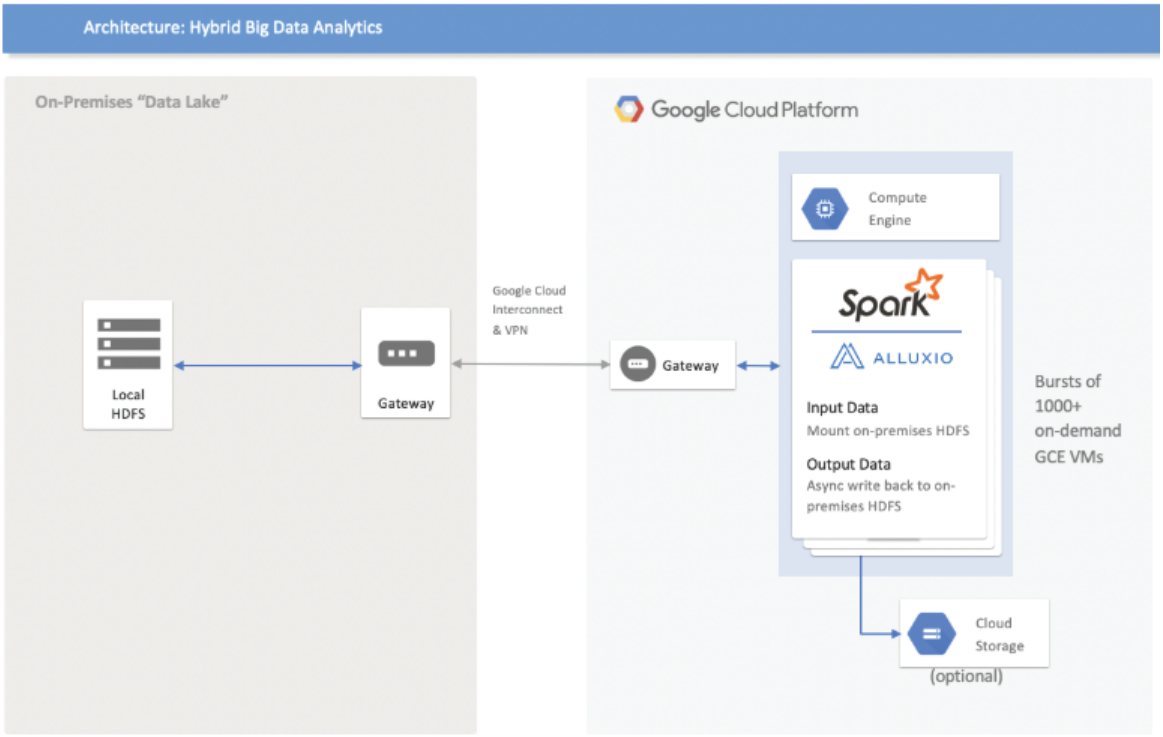
Alluxio running with compute frameworks on Google Cloud Platform solves the challenges listed above. An Alluxio cluster can deployed on GCP and data can be loaded into Alluxio once. Subsequent data requests by the application are served from Alluxio memory.

The Alluxio cluster provides temporary, non-persistent storage of the data in memory so when the Alluxio instances are brought down, the data is effectively removed. Additionally, the data in Alluxio in encrypted (by the client), so even if the cluster is compromised, the data is still secure.

Leading Hedge Fund Example

A leading hedge fund with more than $50 billion under management, turned to Alluxio for help with bursting Spark workloads in a public cloud to enable hybrid workloads for on-premise HDFS. With Alluxio, the hedge fund sees better performance, increased flexibility and dramatically lower costs with the number of model runs per day increased by 4x and the cost of compute reduced by 95%.

The following image shows how they run hybrid cloud analytics, bursting additional Google Compute Engine VMs, directly using on-prem data.



With Alluxio deployed, Machine Learning run time was reduced by 75% the number of model iterations per day increased from two to eight. As the data sets grow in size Alluxio will be able to scale linearly to deliver the same performance. With the dramatic reduction in data access time enabling the use of spot instances, the company achieved a 95% reduction in cost of compute. Alluxio integrated seamlessly with the existing infrastructure, presenting the same API to the application and requiring no changes to applications or storage. All security requirements were met with data encrypted in Alluxio and no persistent storage in the cloud.

5 / Additional Resources

- Hybrid Cloud Analytics with Alluxio
- White Paper: Using Alluxio to Improve the Performance and Consistency of HDFS Clusters