Scaling Public Internet Data Collection With Apache Beam

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Agenda

- Cortex Xpanse, Palo Alto Networks - Overview
- Beam @ Xpanse
- Our Beam Guidelines
- A Performance Tuning case

Hi there

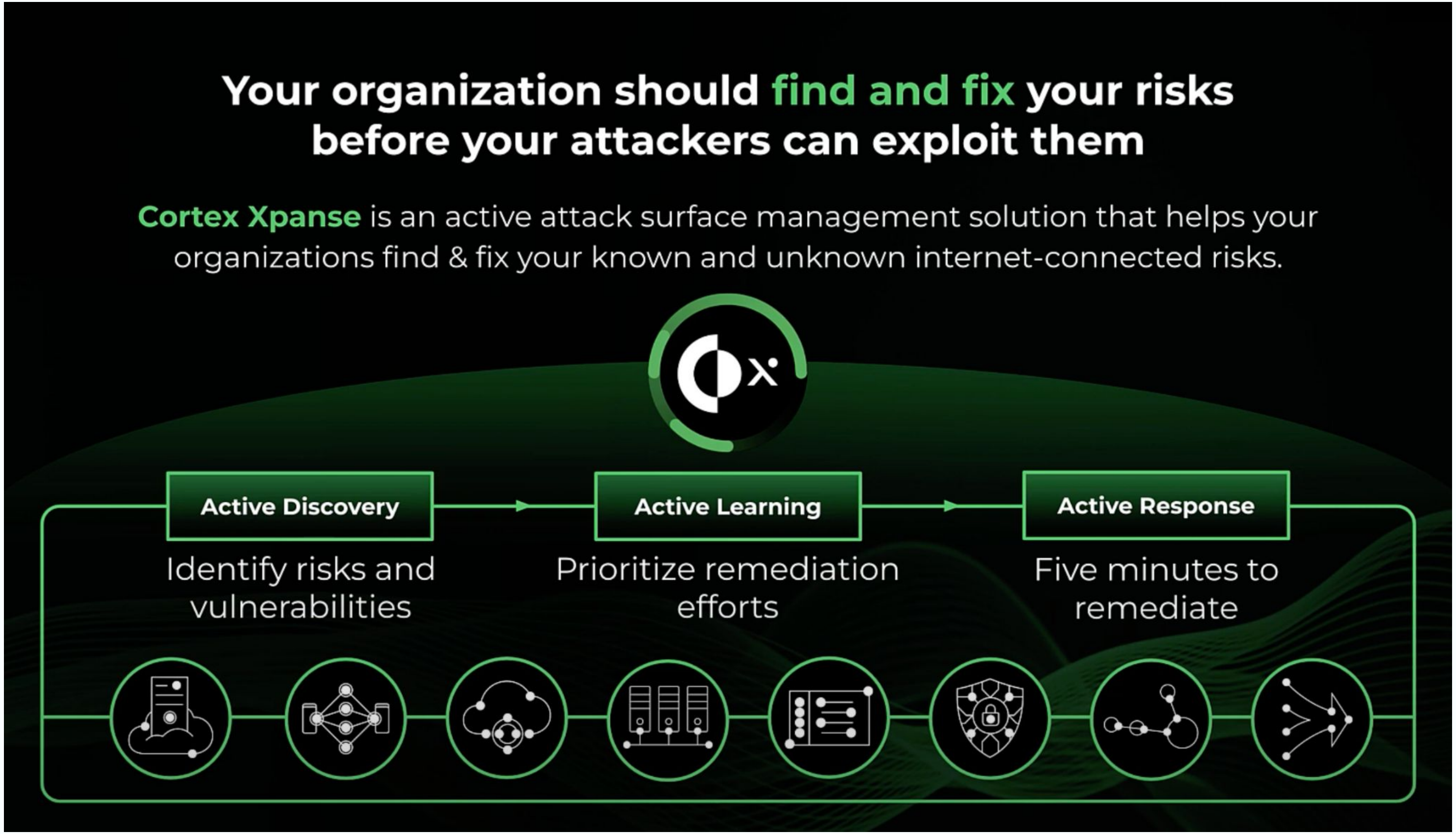
- Lior Dadosh
- Sr. Software Engineer @ Palo Alto Networks
- Based in New York

Cortex Xpanse

Attack Surface Management:

“The process of continuously discovering, identifying, inventorying, and assessing the exposures of an entity's IT asset estate."

Attack Surface Management



Your organization should **find and fix** your risks before your attackers can exploit them

Cortex Xpanse is an active attack surface management solution that helps your organizations find & fix your known and unknown internet-connected risks.

Active Discovery → **Active Learning** → **Active Response**

Identify risks and vulnerabilities

Prioritize remediation efforts

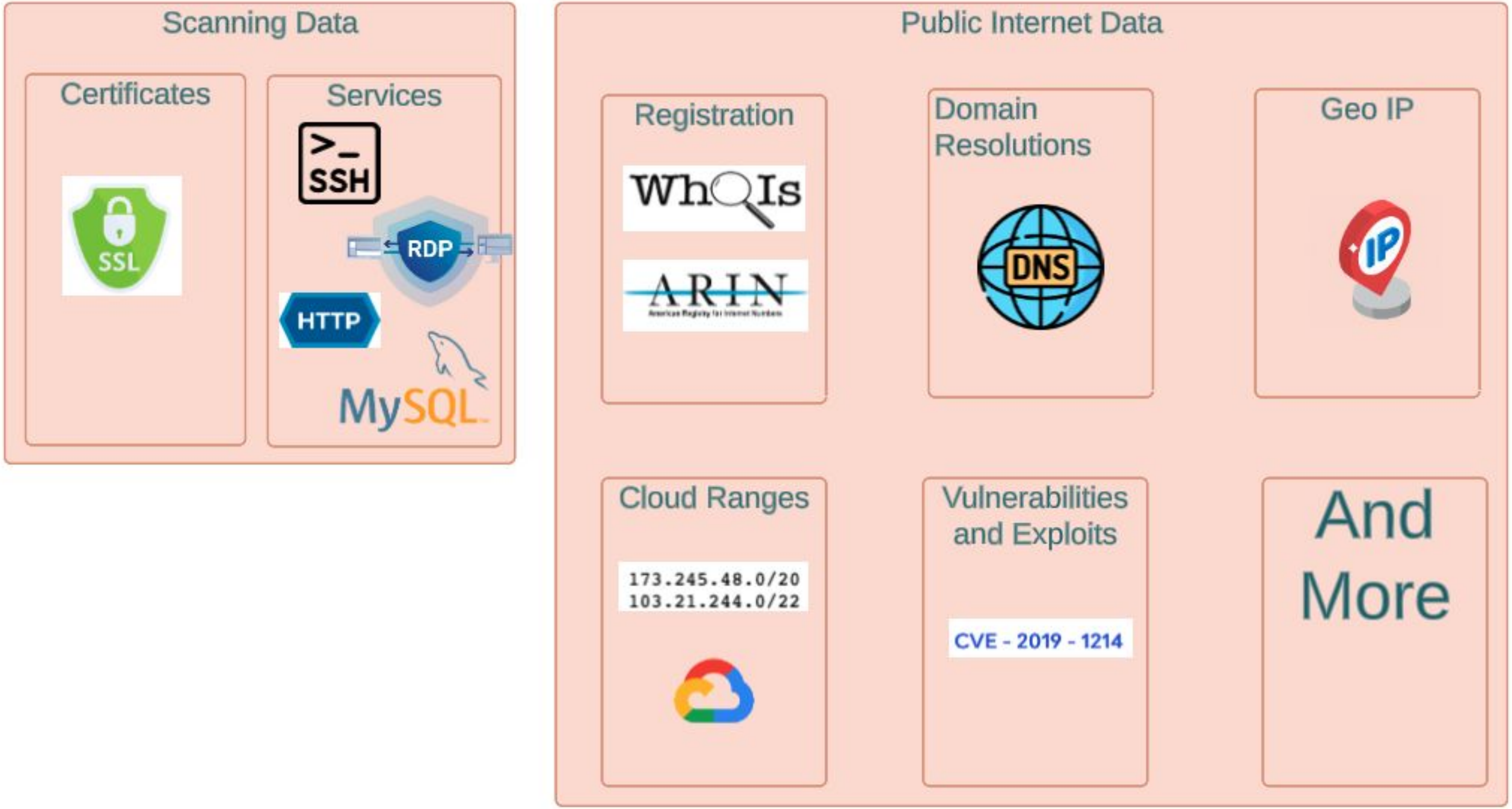
Five minutes to remediate

The Data

The Internet is Small

5.27B	4.4B	2^{128}
Webpages	IPv4 addresses	Potential IPv6 addresses

What data do we have?



Scanning Data

Certificates

Services

Public Internet Data

Registration

Domain Resolutions

Geo IP

Cloud Ranges

```
173.245.48.0/20
103.21.244.0/22
```

Vulnerabilities and Exploits

CVE - 2019 - 1214

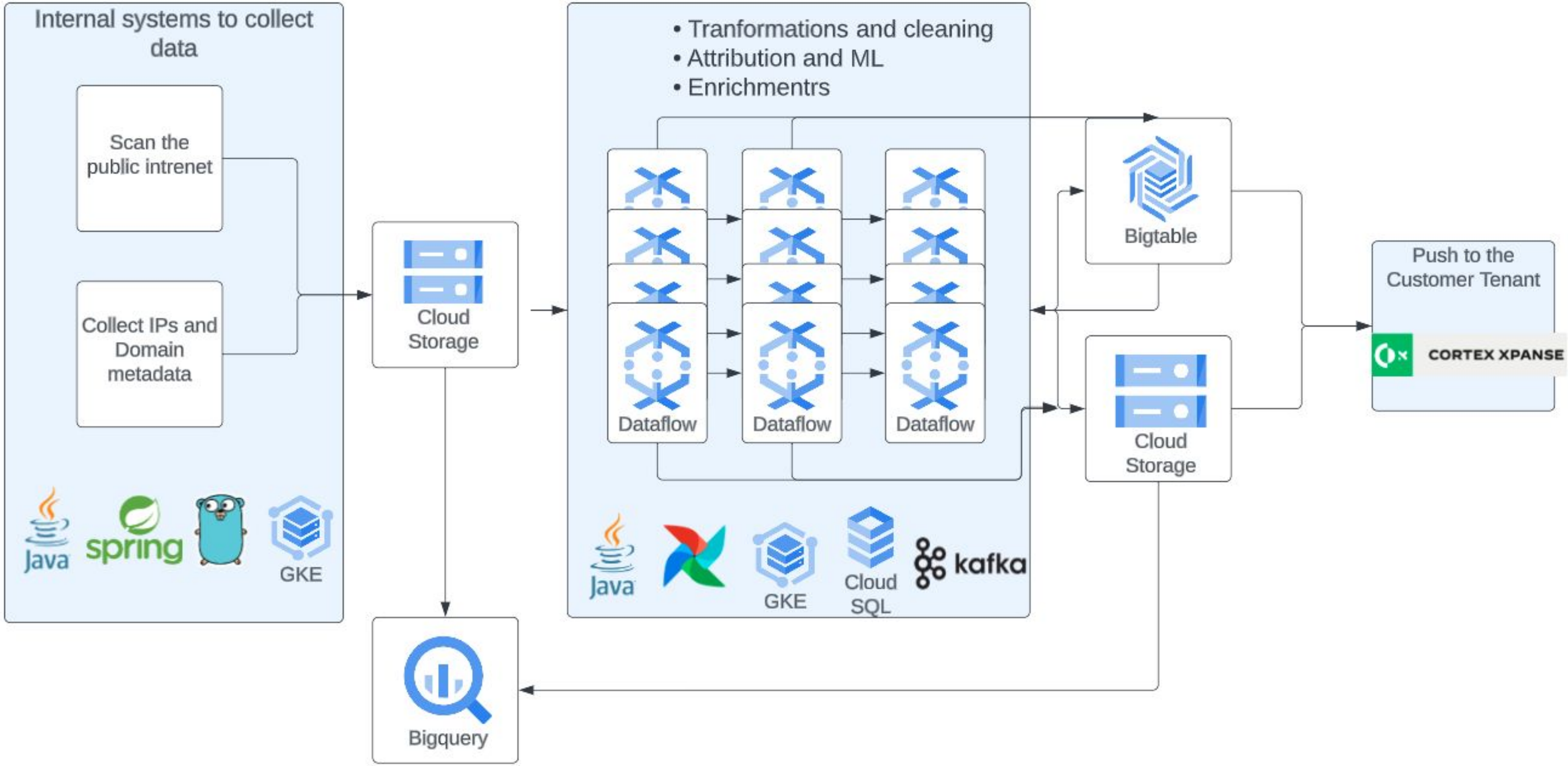
And More

Beam @ Xpanse, Palo Alto Networks

Beam @ Xpanse, Palo Alto Networks

- We Process **10 Petabytes** Daily with Apache Beam
- 200+ daily Pipelines
- Dataflow Runner, Java SDK
- Using Kubernetes (GKE) to run the Jobs
- If you're backend developer at Xpanse, you're a Beam developer

Architecture



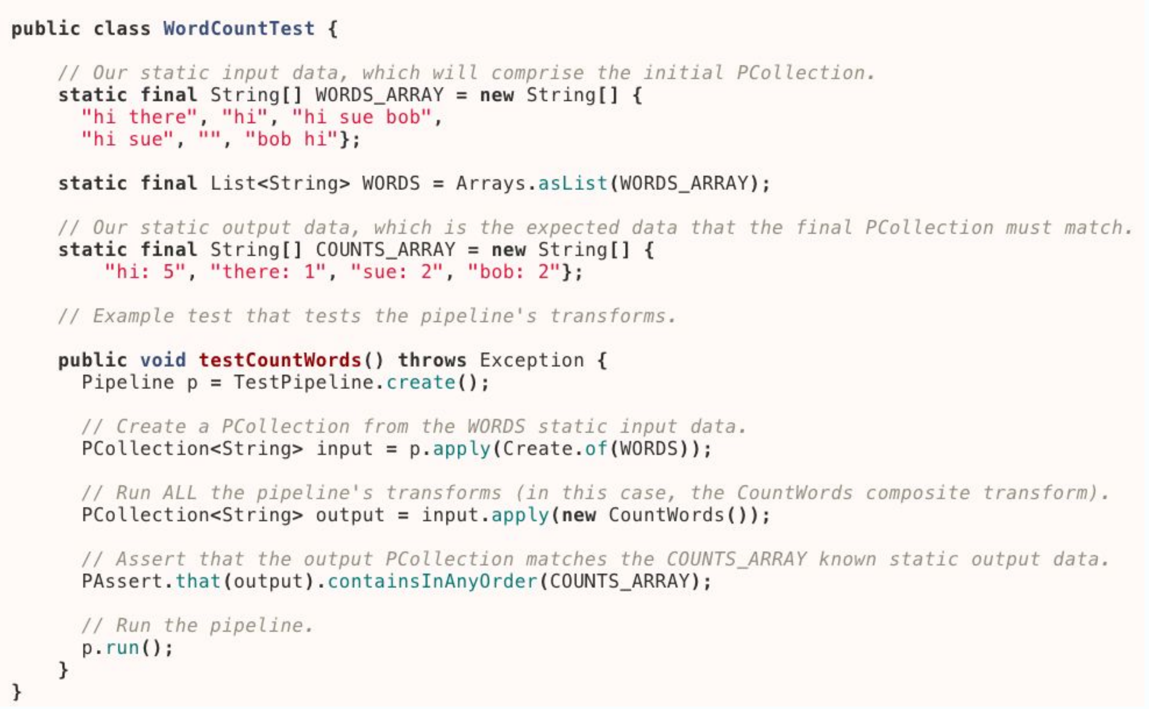
Guidelines - PTransforms

- If you can, use Beam provided transforms
- Common Xpanse Beam library
  - Common company Transform operation
  - For example, all BigTable Writes and Reads are in the common library

The complete list of beam transforms:
https://beam.apache.org/releases/javadoc/2.48.0/index.html?org/apache/beam/sdk/transforms/package-summary.html

Guidelines

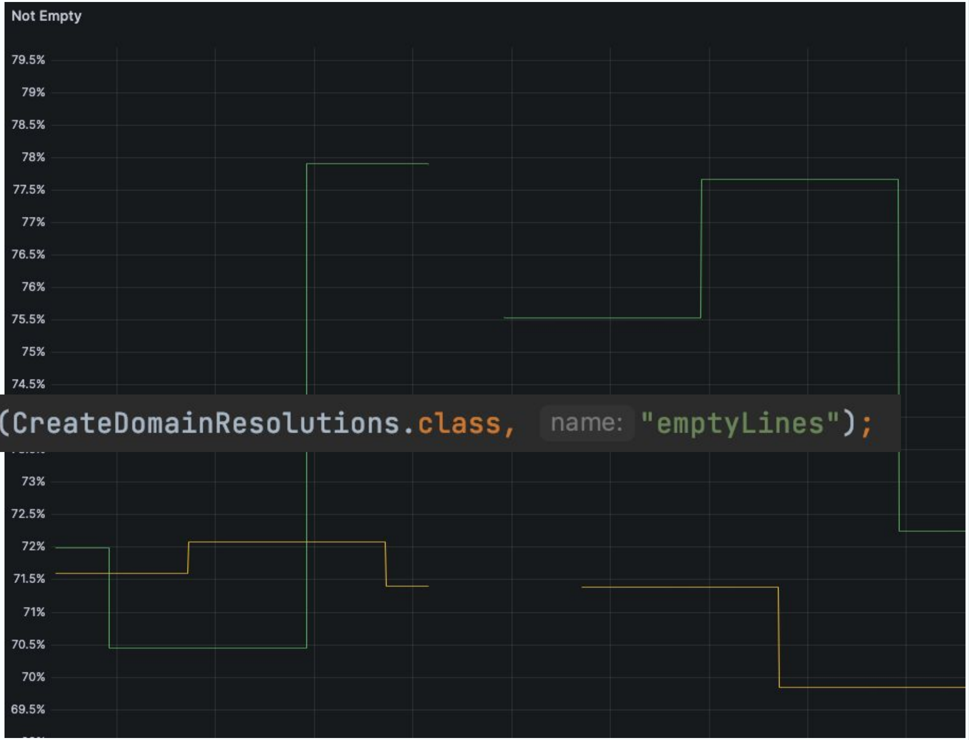
- Test your pipeline!
  - Test every PTransform individually
  - Test your pipeline



```
public class WordCountTest {

    // Our static input data, which will comprise the initial PCollection.
    static final String[] WORDS_ARRAY = new String[] {
      "hi there", "hi", "hi sue bob",
      "hi sue", "", "bob hi"};

    static final List<String> WORDS = Arrays.asList(WORDS_ARRAY);

    // Our static output data, which is the expected data that the final PCollection must match.
    static final String[] COUNTS_ARRAY = new String[] {
        "hi: 5", "there: 1", "sue: 2", "bob: 2"};

    // Example test that tests the pipeline's transforms.

    public void testCountWords() throws Exception {
      Pipeline p = TestPipeline.create();

      // Create a PCollection from the WORDS static input data.
      PCollection<String> input = p.apply(Create.of(WORDS));

      // Run ALL the pipeline's transforms (in this case, the CountWords composite transform).
      PCollection<String> output = input.apply(new CountWords());

      // Assert that the output PCollection matches the COUNTS_ARRAY known static output data.
      PAssert.that(output).containsInAnyOrder(COUNTS_ARRAY);

      // Run the pipeline.
      p.run();
    }
}
```

Guidelines

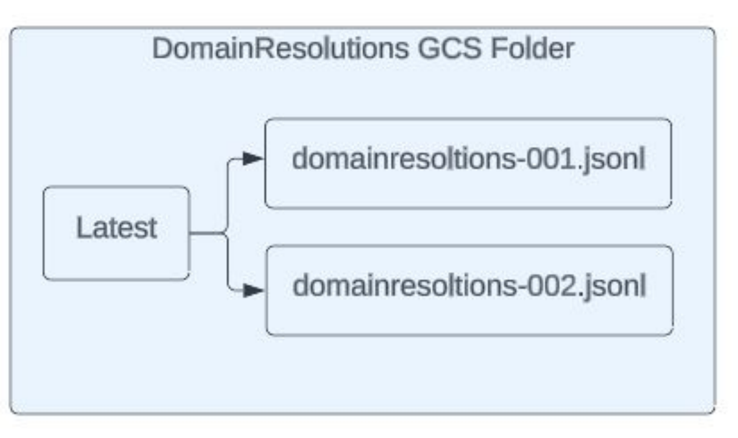
- Monitor your pipeline!
  - Use Beam metrics
  - Track the jobs run time



```java
private final Counter emptyLines = Metrics.counter(CreateDomainResolutions.class, name: "emptyLines");
```

Guidelines - GCS Write

- Write to Cloud Storage (GCS) a “latest file”
- The latest file content references to GCS files
- Batch pipelines can read the latest files easily



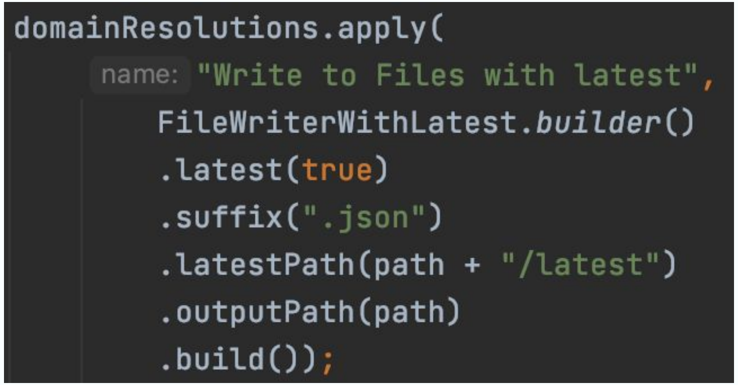
DomainResolutions GCS Folder

Latest

domainresoltions-001.jsonl

domainresoltions-002.jsonl

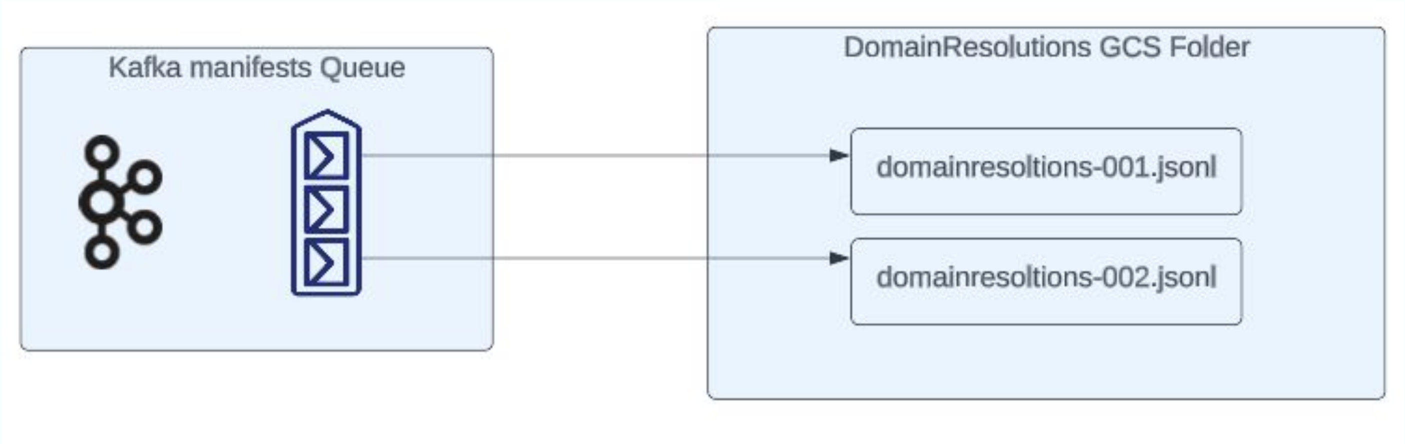
Using our common writer transform:



```
domainResolutions.apply(
        name: "Write to Files with latest",
            FileWriterWithLatest.builder()
            .latest(true)
            .suffix(".json")
            .latestPath(path + "/latest")
            .outputPath(path)
            .build());
```

Guidelines - Kafka Manifests

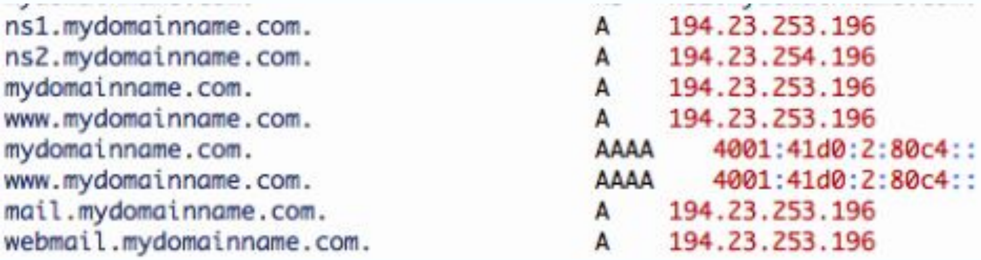
- Use GCS as external storage to Kafka
- Send to kafka references the GCS files


Kafka manifests Queue
DomainResolutions GCS Folder
domainresoltions-001.jsonl
domainresoltions-002.jsonl

Guidelines Usage–
A Performance Tuning Case

The story of the DNS Pipeline

- **Domain Resolutions** data has a lot of garbage in it!
- We have a pipeline to aggregate similar subdomains and cleaning



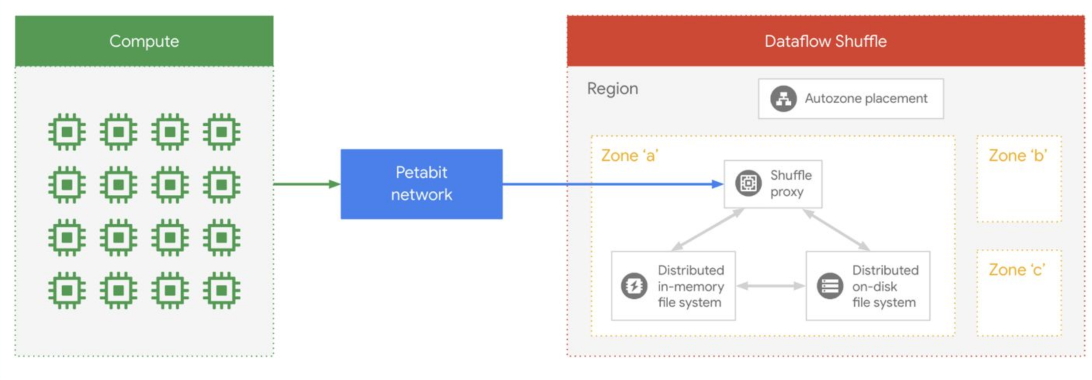
```
ns1.mydomainname.com.           A     194.23.253.196
ns2.mydomainname.com.           A     194.23.254.196
mydomainname.com.               A     194.23.253.196
www.mydomainname.com.           A     194.23.253.196
mydomainname.com.               AAAA     4001:41d0:2:80c4::
www.mydomainname.com.           AAAA     4001:41d0:2:80c4::
mail.mydomainname.com.          A     194.23.253.196
webmail.mydomainname.com.       A     194.23.253.196
```

The story of the DNS Pipeline

- The pipeline kept getting more records, increasing run time and cost
- 75% of the cost was due to shuffles!

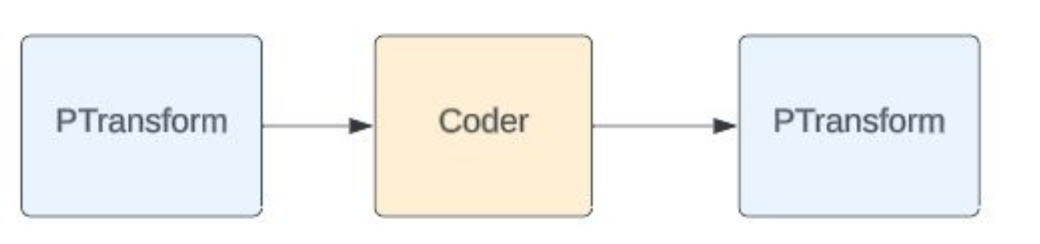
Shuffles

- The data in Beam moves
- The dataflow shuffle service
  - Available for batch jobs
  - moves the shuffle operation out of the worker VMs and into the Dataflow service backend

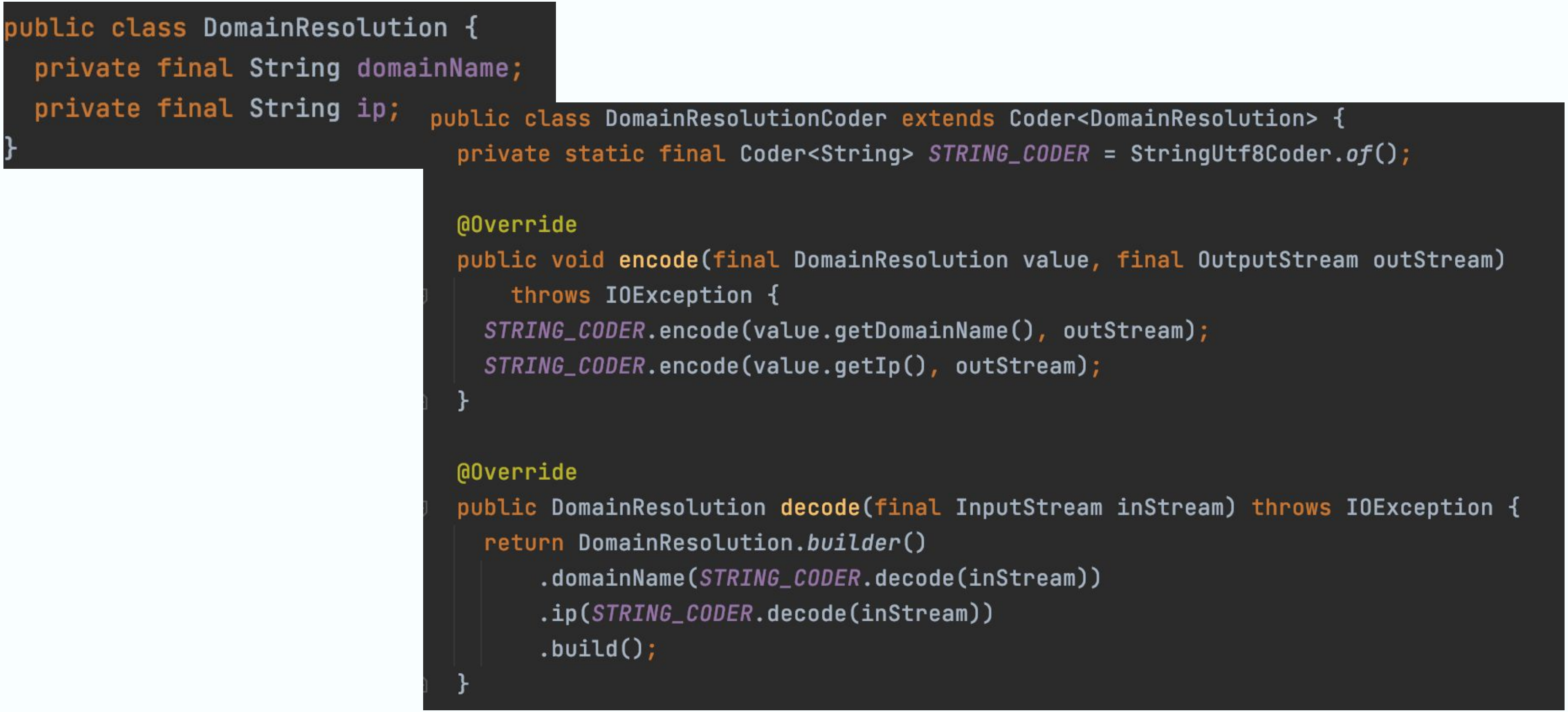


Beam Coders

- Java Object - > Byte array - > Java Object
- Beam has some efficient Coders implementations, for example:
  - ProtoCoder
  - AvroCoder
  - SchemaCoder
- The idea:
  - SerializableCoder (Default coder) —> Custom Coder



Custom Coder!



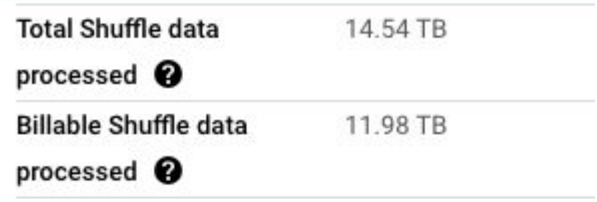
```java
public class DomainResolution {
  private final String domainName;
  private final String ip;
}
```

```java
public class DomainResolutionCoder extends Coder<DomainResolution> {
  private static final Coder<String> STRING_CODER = StringUtf8Coder.of();

  @Override
  public void encode(final DomainResolution value, final OutputStream outStream)
      throws IOException {
    STRING_CODER.encode(value.getDomainName(), outStream);
    STRING_CODER.encode(value.getIp(), outStream);
  }

  @Override
  public DomainResolution decode(final InputStream inStream) throws IOException {
    return DomainResolution.builder()
        .domainName(STRING_CODER.decode(inStream))
        .ip(STRING_CODER.decode(inStream))
        .build();
  }
```

The Results

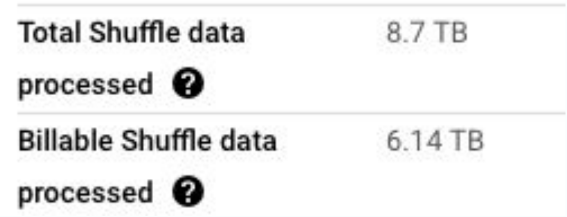
- ~50% cost improvement In shuffle!
- Tens of thousands of dollars saved yearly

Before



Total Shuffle data processed ?	14.54 TB
Billable Shuffle data processed ?	11.98 TB

After



Total Shuffle data processed ?	8.7 TB
Billable Shuffle data processed ?	6.14 TB

To Summarize the Process

- We recognized a scaling issue using our **monitoring infrastructure**
- Developed a reusable solution, exposed in our **common library**
- **Tested** the new solution
- Deployed and tracked it using our monitoring infrastructure

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QUESTIONS?

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