Enable Dynamic Topic Destinations Using Java pub/subIO writeMessageDynamic() in Python pipelines

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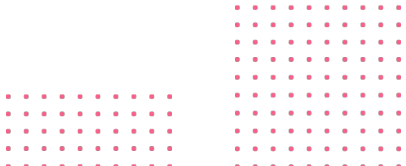
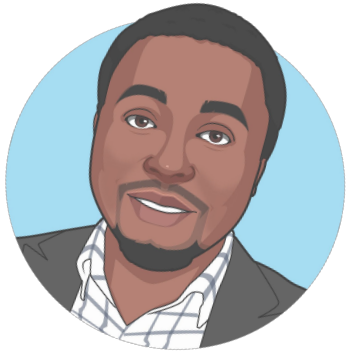


About Myself

- Data & Cloud Enthusiast
- Based in Montreal, Canada
- Data Engineer with DoIT International
  - Primary Focus in Data processing in GCP
    - Data pipelining with Apache Beam
  - Collaborate on Projects related to Google's GenAI applications
    - Deliver workshops relating to these.



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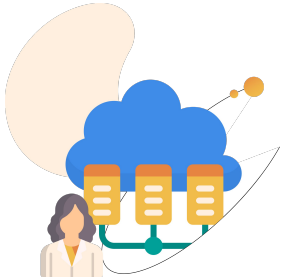
What do we do at doit International?



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Background information

USE-CASE

- Python Real-time Pipeline running on Cloud Dataflow
  - Data Ingestion through the Google Cloud pub/sub
  - Pub/Sub ingests data from multiple data sources
    - messages being published to multiple topics
    - based on particular message attributes in real-time
  - The necessity to handle this in real-time

write to a single Cloud pub/sub topic

Java SDK

```
public static void main(String[] args) {
  var options = PipelineOptionsFactory.fromArgs(args).withValidation().as(Options.class);
  var pipeline = Pipeline.create(options);
  pipeline
      // Create some data to write to Pub/Sub; the variable messages below being the message payload
      .apply(Create.of(messages))
      // Convert the data to Pub/Sub messages.
      .apply(MapElements
          .into(TypeDescriptor.of(PubsubMessage.class))
          .via((message -> {
            byte[] payload = message.product.getBytes(StandardCharsets.UTF_8);
            // Create attributes for each message.
            HashMap<String, String> attributes = new HashMap<String, String>();
            attributes.put("buyer", message.name);
            attributes.put("timestamp", Long.toString(message.timestamp));
            return new PubsubMessage(payload, attributes);
          })))
      // Write the messages to Pub/Sub.
      .apply(PubsubIO.writeMessages().to(options.getTopic()));
  pipeline.run().waitUntilFinish();
 }
```

write to a single Cloud pub/sub topic

Python SDK

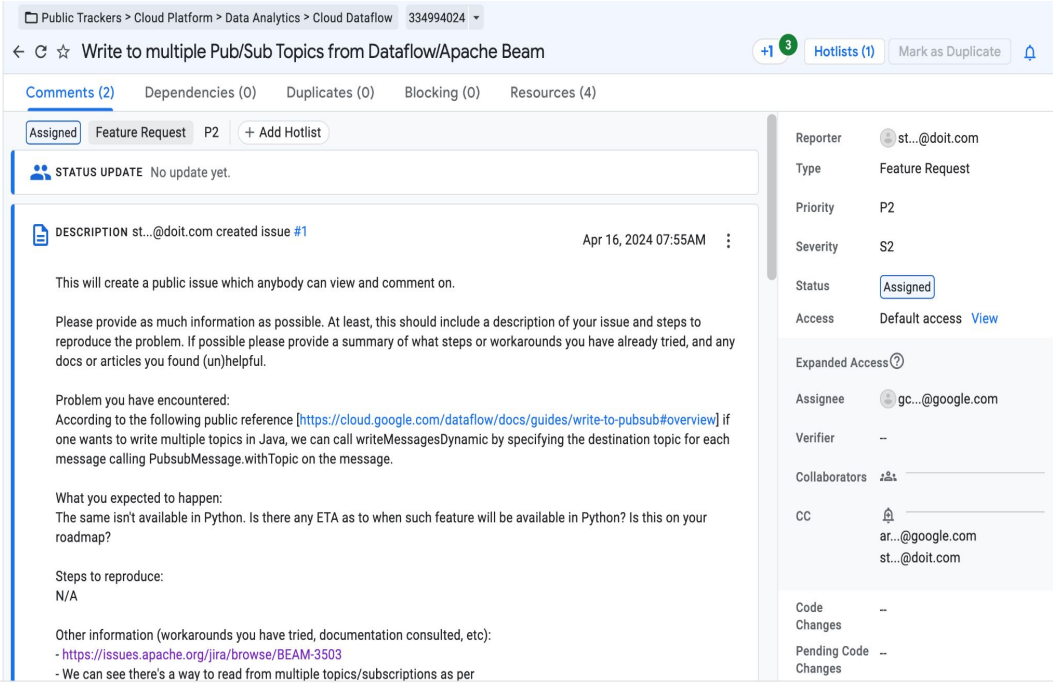
```
with beam.Pipeline(options=options) as pipeline:
    (
        pipeline
        | "Create elements" >> beam.Create(example_data)
        | "Convert to Pub/Sub messages" >> beam.Map(item_to_message)
        | WriteToPubSub(
            topic=options.topic,
            with_attributes=True)
    )

print('Pipeline ran successfully.')

```

What is Dynamic Topic Destinations in Cloud pub/sub?

- This feature allows publishing pub/sub messages to multiple cloud pub/sub topics, based on particular message attributes in real-time.
- With this feature, it is possible to use a single publisher client to dictate which messages go to which topics
- Java SDK
  - pubsubIO.writeMessagesDynamic() method implements Dynamic Topic Destinations on the Dataflow Runner
- Python SDK
  - No support presently for this feature yet.
  - Beam-only fix is insufficient



Alternatives to Dynamic Topic Destinations?

- Topic Partitions:
  - predefined set of categories for the pub/sub messages
  - Feature available in cloud pub/sub lite
    - Cloud pub/sub lite is deprecated
    - Existing users: Pub/Sub Lite remains functional until March 18, 2026.
    - If Pub/Sub Lite is not used before September 24, 2024
      - No new access to Pub/Sub Lite would be permitted.
    - Consider the Google Cloud Managed Service for Apache Kafka as an alternative
- Streaming Engine Routing:
  - Streaming Engines like Apache Flink or Apache Beam offer message routing capabilities within the processing pipeline itself.

Benefits of the Dynamic Topic Destination in Cloud pub/sub

1. SIMPLIFIED MANAGEMENT:
   - use a single publisher client to send messages to various topics based on message attributes
2. IMPROVED ORGANIZATION:
   - Data segregation based on message content leads to cleaner topic structures and easier downstream processing
3. ENHANCED SECURITY:
   - By directing messages to specific topics, it is easier to enforce granular access controls on the data.

Implementation Dynamic topic destination

FUNCTION EXTRACT METHOD

```
avros.apply(PubsubIO.writeAvros(MyType.class).
    to((ValueInSingleWindow<Event> quote) -> {
        String country = quote.getCountry();
        return "projects/myproject/topics/events_" + country;
       });
```

For more details about this approach and the code details, please refer to the Introducing dynamic topic destinations in Pub/Sub using Dataflow.

Implementation Dynamic topic destination(Cont.)

PubSubIO.writeMessagesDynamic Method

```
events.apply(MapElements.into(new TypeDescriptor<PubsubMessage>() {})
                .via(e -> new PubsubMessage(
                    e.toByteString(), Collections.emptyMap()).withTopic(e.getCountry())))
            .apply(PubsubIO.writeMessagesDynamic());
```

For more details about this approach and the code details, please refer to the Introducing dynamic topic destinations in Pub/Sub using Dataflow.

PubSubIO.writeMessagesDynamic() as an external transform

- Main Java Class
  - Defines the core logic
    - In this use-case:
      - handles reading the PCollection<String> as input
      - processing each string to create a PubsubMessage
      - Writing pub/sub messages dynamically to multiple pub/sub topic
        - using PubsubIO.writeMessagesDynamic() method
- Configuration.Java Class
  - Serves the configuration settings to be used by DynamicBuilder.Java
  - This can include various configuration options, allowing for greater flexibility and customization of the transform's behavior.
    - In this use-case:
      - No specific configuration required.

PubSubIO.writeMessagesDynamic() as an external transform (Cont.)

- Registrar.Java
  - Implements an ExternalTransformRegistrar Java Interface
  - registers the Main Java transform with a unique URN, used to define the Environment to be used
    - Environments for executing Beam UDFs(such as DoFn, CombineFn)
    - Environments are chosen by the Beam Runners
    - An Environment would typically consist of :
      - A URN – which defines the type of environment and
      - A Payload – which are parameters that uniquely identify the environment.

- Builder.Java Class
  - Implements an ExternalTransformBuilder Java Interface
  - Uses the configuration from the Configuration Java object to configure and build the transform.

Quick Demo

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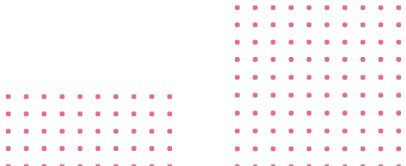
BENEFITS of MULTI Language Pipelines:

Reduced Cost of Software Development

- Develop once and offer to all SDK Languages
- I/O Connectors can be easily shared
- Easier to share codes between development teams

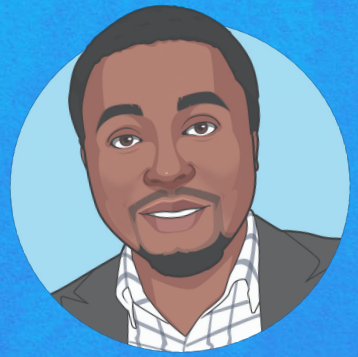
Reduced maintenance overheads

- No more multiple implementations of Complex transforms
- Evolve development teams without re-implementing
- Easily use transforms developed by third parties as you'd have more flexibility
- Uniform User experience when using multiple SDKs



Thank you!

Questions?



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Resources

Python multi language pipelines

Multi-Language Pipelines

Beam Summit 2023 | Multi-language pipelines - Chamikara Jayalath

Beam Learning: Using Java transforms in a multi language Python pipeline

Multi-language pipelines with Apache Beam

The pub/sub IO write Messages Dynamic

GCP Feature Request: Dynamic Topic Destination Function in Python SDK