Getting Started

```
public class User {
    String name;
    int age;
}
```

```
Producer<byte[]> producer =
client.newProducer()
        .topic(topic)
        .create();
User user = new User(“Tom”, 28);
// serialize the `user` by yourself;
byte[] message = …;
producer.send(message);
```

Parse Exceptions

- The field you’re looking for doesn’t exist any more
- The type of field has changed
  - e.g. what used to be a `String` is now an `Integer`

“I am starting to think that `schemaless` just means your schema is scattered randomly throughout your code. It is almost impossible to troubleshoot anything non-trivial because there are endless assumptions, but few explicit requirements”

–Robert Kluin (@robertkluin) May 29, 2018

Introducing Schema

Schema

- Define how to serialize and deserialize data
- Define how to evolve your data format
- Handle backward compatibility

Schema Info

- `type`: the type of schema.
- `schema`: the schema data. Schema type implementation specific.
- `properties`: the properties associated with the schema. Application specific data.

```json
{
    "type": "JSON",
    "schema": "{
        \"type\":\"record\",
        \"name\":\"User\",
        \"namespace\":\"com.foo\",
        \"fields\":[
            {
                \"name\":\"file1\",
                \"type\":[\"null\",\"string\"],
                \"default\":null
            },
            {
                \"name\":\"file2\",
                \"type\":\"string\",
                \"default\":null
            },
            {
                \"name\":\"file3\",
                \"type\":[\"null\",\"string\"],
                \"default\":\"dfdf\"
            }
        ]
    }",
    "properties": {}
}
```

Schema Types

- Primitive Types
- Complex Types

Primitive Types

- `**BOOLEAN**`: a binary value

- `**INT8**`: 8-bit signed integer
- `**INT16**`: 16-bit signed integer
- `**INT32**`: 32-bit signed integer
- `**INT64**`: 64-bit signed integer

- `**FLOAT**`: single precision (32-bit) IEEE 754 floating-point number
- `**DOUBLE**`: double precision (64-bit) IEEE 754 floating-point number

- `**BYTES**`: sequence of 8-bit unsigned bytes
- `**STRING**`: unicode character sequence

- `**TIMESTAMP**` (`**DATE**`, `**TIME**`) : A logic type represents a specific instant in time, with millisecond precision. It stores the number of milliseconds since `January 1, 1970, 00:00:00 GMT` as a `INT64` value.

Primitive Types - Example

```java
// Create producer with String schema and send messages
Producer<String> producer = client.newProducer(Schema.STRING).create();
producer.newMessage().value("Hello Pulsar!").send();

// Create consumer with String schema and receive messages
Consumer<String> consumer = client.newConsumer(Schema.STRING).create();
consumer.receive();
```

Complex Types

- Key-Value
- Struct

Struct Types

- Supported Types: AVRO / JSON / PROTOBUF
- Schema Definition - AVRO
- Two approaches
  - Static - The struct is predefined. POJO, or Avro/Protobuf generated classes
  - Generic - The struct is unknown or not predefined.

Static Schema

```java
// Create producer with Struct schema and send messages
Producer<User> producer = client.newProducer(Schema.AVRO(User.class)).create();
producer.newMessage()
  .value(User.builder()
      .userName("pulsar-user")
      .userId(1L)
      .build())
  .send();

// Create consumer with Struct schema and receive messages
Consumer<User> consumer = client.newConsumer(Schema.AVRO(User.class)).create();
consumer.receive();
```

Generic Schema

- `GenericSchemaBuilder`: Build a generic schema
- `GenericRecordBuilder`: Build a generic record

Generic Schema - Example

```java
RecordSchemaBuilder recordSchemaBuilder = SchemaBuilder.record("schemaName");
recordSchemaBuilder
  .field("intField")
  .type(SchemaType.INT32);
SchemaInfo schemaInfo = recordSchemaBuilder.build(SchemaType.AVRO);

Producer<GenericRecord> producer = client.newProducer(Schema.generic(schemaInfo)).create();

producer.newMessage().value(schema.newRecordBuilder()
            .set("intField", 32)
            .build()).send();
```

Auto Schema

- AUTO_PRODUCE
  - Producers validate bytes according to the schema in the topic
- AUTO_CONSUME
  - Consumers deserialize messages into `GenericRecord`
  - Schema is unknown in advance

How does Schema work

```java
Producer<User> producer = client.newProducer(Schema.AVRO(User.class)).create();
```

1. `Schema.AVRO(User.class)` => Generates SchemaInfo
2. `newProducer` => connect to broker and send the schema info
3. Broker receives the schema info
    1. If a topic doesn’t have a schema, creates the schema
    2. If a topic already have a schema, broker verifies if the schema is compatible with existing schemas.
        1. If it is compatible and is a new schema, generates a new version of schema
        2. If it is not compatible, fail the producer

Schema Evolution

Schema Compatibility Check

- Schema Compatibility Checker
  - One checker per schema type
  - Configured by `schemaRegistryCompatibilityCheckers`
  - Only AVRO and JSON supports schema evolution for now
  - All other schema types don’t allow schema evolution

Compatibility Check Strategy

Strategy	Changes Allowed	Check against what schemas	Upgrade first
ALWAYS_INCOMPATIBLE	All changes are disabled	All previous versions	None
ALWAYS_COMPATIBLE	All changes are allowed	Latest version	Depends
BACKWARD	• Delete fields • Add optional fields	Latest version	Consumers
FORWARD	• Add fields • Delete optional fields	Latest version	Producers
FULL	Modify optional fields	Latest version	Any Order

Order of upgrading clients

- **BACKWARD**: Upgrade all consumers before start producing new events
- **FORWARD**:
  - Upgrade all producers to new schema
  - Make sure the data produced using old schemas are not available to consumers anymore
  - Then upgrade producers and consumers independently
- **FULL**: Upgrade producers and consumers independently
- **ALWAYS_COMPATIBLE**: Be cautious about when to upgrade clients

Managing Schemas

Schema Restful API

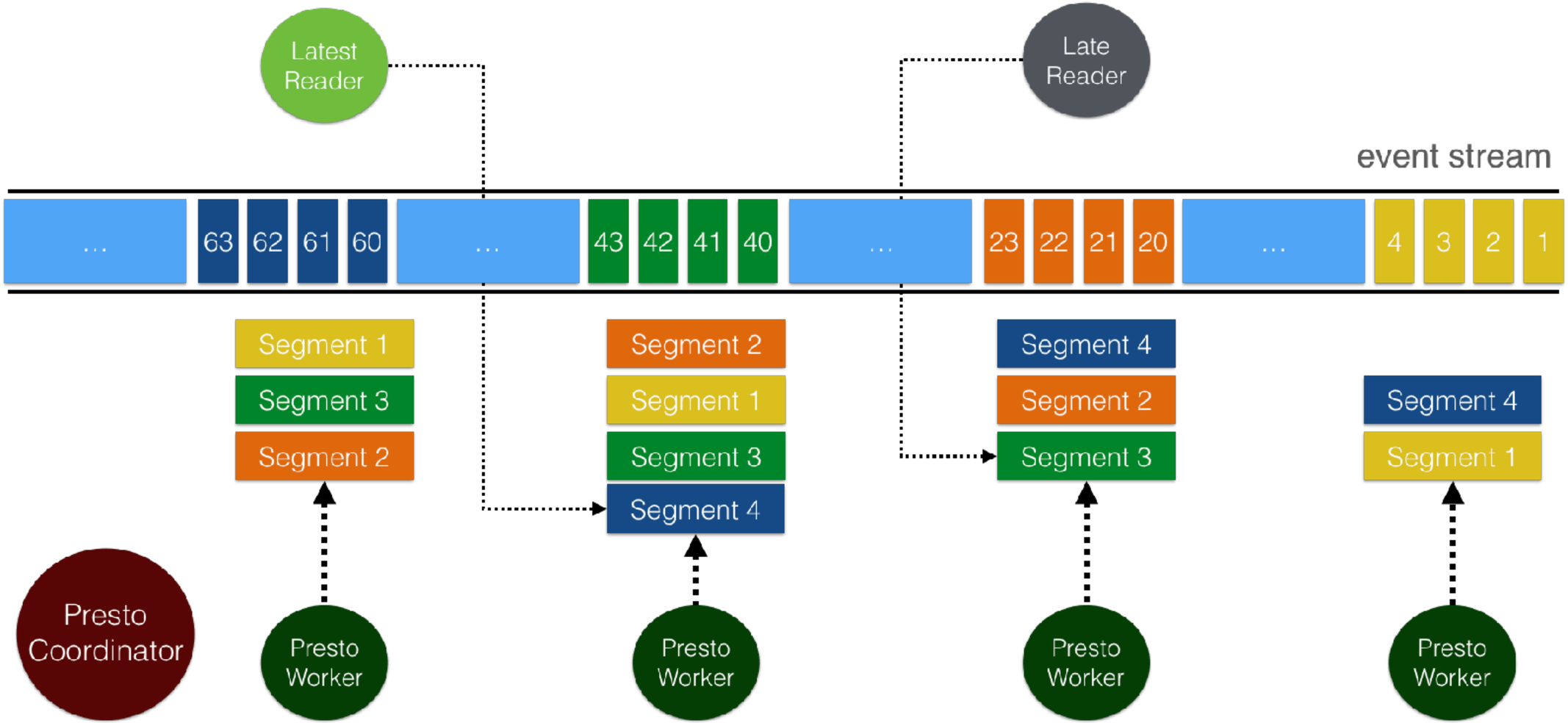
- Upload Schema
- Get Schema : latest or by version
- Delete Schema

```shell
$ pulsar-admin schemas upload -f <schema-defination-file> <topic-name>
```

Query Streams using Schema

- Presto
- Hive
- Flink SQL
- Spark SQL

Pulsar Presto SQL



Pulsar Presto SQL

```
presto> select * from pulsar."public/default".generator_test;

  firstname   | middlename   |  lastname   |              email
--------------+--------------+-------------+---------------------------------
 Genesis      | Katherine    | Wiley       | genesis.wiley@gmail.com
 Brayden      |              | Stanton     | brayden.stanton@yahoo.com
 Benjamin     | Julian       | Velasquez   | benjamin.velasquez@yahoo.com
 Michael      | Thomas       | Donovan     | donovan@mail.com
 Brooklyn     | Avery        | Roach       | brooklynroach@yahoo.com
 Skylar       |              | Bradshaw    | skylarbradshaw@yahoo.com
```