Flume 1.3.0 Developer Guide

Introduction

Overview

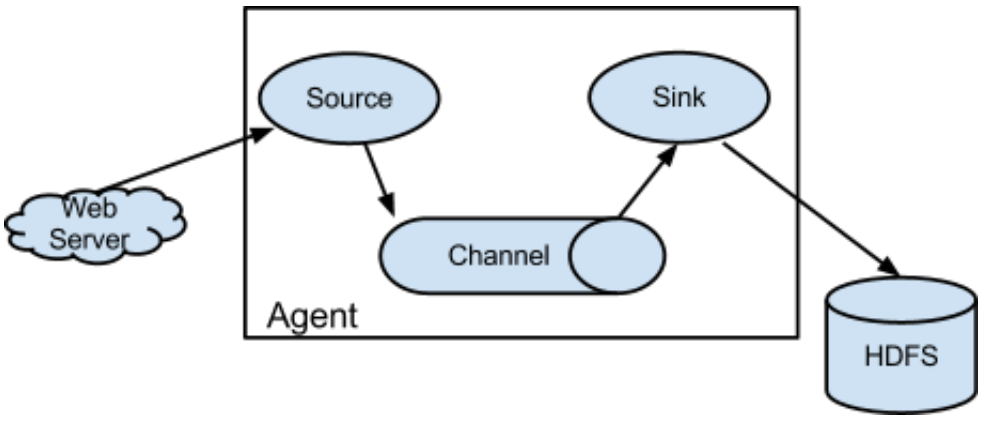
Apache Flume is a distributed, reliable, and available system for efficiently collecting, aggregating and moving large amounts of log data from many different sources to a centralized data store.

Apache Flume is a top-level project at the Apache Software Foundation. There are currently two release code lines available, versions 0.9.x and 1.x. This documentation applies to the 1.x codeline. For the 0.9.x codeline, please see the Flume 0.9.x Developer Guide.

Architecture

Data flow model

An `Event` is a unit of data that flows through a Flume agent. The `Event` flows from `Source` to `Channel` to `Sink`, and is represented by an implementation of the `Event` interface. An `Event` carries a payload (byte array) that is accompanied by an optional set of headers (string attributes). A Flume agent is a process (JVM) that hosts the components that allow `Event`s to flow from an external source to a external destination.



A `Source` consumes `Event`s having a specific format, and those `Event`s are delivered to the `Source` by an external source like a web server. For example, an `AvroSource` can be used to receive Avro `Event`s from clients or from other Flume agents in the flow. When a `Source` receives an `Event`, it stores it into one or more `Channel`s. The `Channel` is a passive store that holds the `Event` until that `Event` is consumed by a `Sink`. One type of `Channel` available in Flume is the `FileChannel` which uses the local filesystem as its backing store. A `Sink` is responsible for removing an `Event` from the `Channel` and putting it into an external repository like HDFS (in the case of an `HDFSEventSink`) or forwarding it to the `Source` at the next hop of the flow. The

`Source` and `Sink` within the given agent run asynchronously with the `Event`s staged in the `Channel`.

Reliability

An `Event` is staged in a Flume agent's `Channel`. Then it's the `Sink`'s responsibility to deliver the `Event` to the next agent or terminal repository (like HDFS) in the flow. The `Sink` removes an `Event` from the `Channel` only after the `Event` is stored into the `Channel` of the next agent or stored in the terminal repository. This is how the single-hop message delivery semantics in Flume provide end-to-end reliability of the flow. Flume uses a transactional approach to guarantee the reliable delivery of the `Event`s. The `Source`s and `Sink`s encapsulate the storage/retrieval of the `Event`s in a `Transaction` provided by the `Channel`. This ensures that the set of `Event`s are reliably passed from point to point in the flow. In the case of a multi-hop flow, the `Sink` from the previous hop and the `Source` of the next hop both have their `Transaction`s open to ensure that the `Event` data is safely stored in the `Channel` of the next hop.

Building Flume

Getting the source

Check-out the code using Git. Click here for the git repository root.

The Flume 1.x development happens under the branch "trunk" so this command line can be used:

```
git clone https://git-wip-us.apache.org/repos/asf/flume.git
```

Compile/test Flume

The Flume build is mavenized. You can compile Flume using the standard Maven commands:

1. Compile only: `mvn clean compile`
2. Compile and run unit tests: `mvn clean test`
3. Run individual test(s): `mvn clean test -Dtest=<Test1>,<Test2>,... -DfailIfNoTests=false`
4. Create tarball package: `mvn clean install`
5. Create tarball package (skip unit tests): `mvn clean install -DskipTests`

Please note that Flume builds requires that the Google Protocol Buffers compiler be in the path. You can download and install it by following the instructions here.

Developing custom components

Client

The client operates at the point of origin of events and delivers them to a Flume agent. Clients typically operate in the process space of the application they are consuming data from. Flume currently supports Avro, log4j, syslog, and Http POST (with a JSON body) as ways to transfer data from a external source. Additionally, there's an `ExecSource` that can consume the output of a local process as input to Flume.

It's quite possible to have a use case where these existing options are not sufficient. In this case you can build a custom mechanism to send data to Flume. There are two ways of achieving this. The first option is to create a custom client that communicates with one of Flume's existing `Source`s like `AvroSource` or `SyslogTcpSource`. Here the client should convert its data into messages understood by these Flume `Source`s. The other option is to write a custom Flume `Source` that directly talks with your existing client application using some IPC or RPC protocol, and then converts the client data into Flume `Event`s to be sent downstream. Note that all events stored within the `Channel` of a Flume agent must exist as Flume `Event`s.

Client SDK

Though Flume contains a number of built-in mechanisms (i.e. `Source`s) to ingest data, often one wants the ability to communicate with Flume directly from a custom application. The Flume Client SDK is a library that enables applications to connect to Flume and send data into Flume's data flow over RPC.

RPC client interface

An implementation of Flume's RpcClient interface encapsulates the RPC mechanism supported by Flume. The user's application can simply call the Flume Client SDK's `append(Event)` or `appendBatch(List<Event>)` to send data and not worry about the underlying message exchange details. The user can provide the required `Event` arg by either directly implementing the `Event` interface, by using a convenience implementation such as the SimpleEvent class, or by using `EventBuilder`'s overloaded `withBody()` static helper methods.

Avro RPC default client

As of Flume 1.1.0, Avro is the only supported RPC protocol. The `NettyAvroRpcClient` implements the `RpcClient` interface. The client needs to create this object with the host and port of the target Flume agent, and can then use the `RpcClient` to send data into the agent. The following example shows how to use the Flume Client SDK API within a user's data-generating application:

```
import org.apache.flume.Event;
import org.apache.flume.EventDeliveryException;
import org.apache.flume.api.RpcClient;
import org.apache.flume.api.RpcClientFactory;
```

```
import org.apache.flume.event.EventBuilder;
import java.nio.charset.Charset;

public class MyApp {
  public static void main(String[] args) {
    MyRpcClientFacade client = new MyRpcClientFacade();
    // Initialize client with the remote Flume agent's host and port
    client.init("host.example.org", 41414);

    // Send 10 events to the remote Flume agent. That agent should be
    // configured to listen with an AvroSource.
    String sampleData = "Hello Flume!";
    for (int i = 0; i < 10; i++) {
      client.sendDataToFlume(sampleData);
    }

    client.cleanUp();
  }
}

class MyRpcClientFacade {
  private RpcClient client;
  private String hostname;
  private int port;

  public void init(String hostname, int port) {
    // Setup the RPC connection
    this.hostname = hostname;
    this.port = port;
    this.client = RpcClientFactory.getDefaultInstance(hostname, port);
  }

  public void sendDataToFlume(String data) {
    // Create a Flume Event object that encapsulates the sample data
    Event event = EventBuilder.withBody(data, Charset.forName("UTF-8"));

    // Send the event
    try {
      client.append(event);
    } catch (EventDeliveryException e) {
      // clean up and recreate the client
      client.close();
      client = null;
      client = RpcClientFactory.getDefaultInstance(hostname, port);
    }
  }

  public void cleanUp() {
    // Close the RPC connection
    client.close();
  }

}
```

The remote Flume agent needs to have an `AvroSource` listening on some port. Below is an example Flume agent configuration that's waiting for a connection from MyApp:

```
a1.channels = c1
a1.sources = r1
```

```
a1.sinks = k1

a1.channels.c1.type = memory

a1.sources.r1.channels = c1
a1.sources.r1.type = avro
a1.sources.r1.bind = 0.0.0.0
a1.sources.r1.port = 41414

a1.sinks.k1.channel = c1
a1.sinks.k1.type = logger
```

For more flexibility, the default Flume client implementation (`NettyAvroRpcClient`) can be configured with these properties:

```
client.type = default

hosts = h1                              # default client accepts only 1 host
                                        # (additional hosts will be ignored)

hosts.h1 = host1.example.org:41414      # host and port must both be specified
                                        # (neither has a default)

batch-size = 100                        # Must be >=1 (default: 100)

connect-timeout = 20000                 # Must be >=1000 (default: 20000)

request-timeout = 20000                 # Must be >=1000 (default: 20000)
```

Failover Client

This class wraps the default Avro RPC client to provide failover handling capability to clients. This takes a whitespace-separated list of <host>:<port> representing the Flume agents that make-up a failover group. If there's a communication error with the currently selected host (i.e. agent) agent, then the failover client automatically fails-over to the next host in the list. For example:

```
// Setup properties for the failover
Properties props = new Properties();
props.put("client.type", "default_failover");

// List of hosts (space-separated list of user-chosen host aliases)
props.put("hosts", "h1 h2 h3");

// host/port pair for each host alias
String host1 = "host1.example.org:41414";
String host2 = "host2.example.org:41414";
String host3 = "host3.example.org:41414";
props.put("hosts.h1", host1);
props.put("hosts.h2", host2);
props.put("hosts.h3", host3);

// create the client with failover properties
RpcClient client = RpcClientFactory.getInstance(props);
```

For more flexibility, the failover Flume client implementation (`FailoverRpcClient`) can be configured with these properties:

```
client.type = default_failover

hosts = h1 h2 h3                        # at least one is required, but 2 or
                                        # more makes better sense

hosts.h1 = host1.example.org:41414

hosts.h2 = host2.example.org:41414

hosts.h3 = host3.example.org:41414

max-attempts = 3                        # Must be >=0 (default: number of hosts
                                        # specified, 3 in this case). A '0'
                                        # value doesn't make much sense because
                                        # it will just cause an append call to
                                        # immmediately fail. A '1' value means
                                        # that the failover client will try only
                                        # once to send the Event, and if it
                                        # fails then there will be no failover
                                        # to a second client, so this value
                                        # causes the failover client to
                                        # degenerate into just a default client.
                                        # It makes sense to set this value to at
                                        # least the number of hosts that you
                                        # specified.

batch-size = 100                        # Must be >=1 (default: 100)

connect-timeout = 20000                 # Must be >=1000 (default: 20000)

request-timeout = 20000                 # Must be >=1000 (default: 20000)
```

LoadBalancing RPC client

The Flume Client SDK also supports an RpcClient which load-balances among multiple hosts. This type of client takes a whitespace-separated list of <host>:<port> representing the Flume agents that make-up a load-balancing group. This client can be configured with a load balancing strategy that either randomly selects one of the configured hosts, or selects a host in a round-robin fashion. You can also specify your own custom class that implements the `LoadBalancingRpcClient$HostSelector` interface so that a custom selection order is used. In that case, the FQCN of the custom class needs to be specified as the value of the `host-selector` property.

If `backoff` is enabled then the client will temporarily blacklist hosts that fail, causing them to be excluded from being selected as a failover host until a given timeout. When the timeout elapses, if the host is still unresponsive then this is considered a sequential failure, and the timeout is increased exponentially to avoid potentially getting stuck in long waits on unresponsive hosts.

The maximum backoff time can be configured by setting `maxBackoff` (in milliseconds). The

maxBackoff default is 30 seconds (specified in the `OrderSelector` class that's the superclass of both load balancing strategies). The backoff timeout will increase exponentially with each sequential failure up to the maximum possible backoff timeout. The maximum possible backoff is limited to 65536 seconds (about 18.2 hours). For example:

```
// Setup properties for the load balancing
Properties props = new Properties();
props.put("client.type", "default_loadbalance");

// List of hosts (space-separated list of user-chosen host aliases)
props.put("hosts", "h1 h2 h3");

// host/port pair for each host alias
String host1 = "host1.example.org:41414";
String host2 = "host2.example.org:41414";
String host3 = "host3.example.org:41414";
props.put("hosts.h1", host1);
props.put("hosts.h2", host2);
props.put("hosts.h3", host3);

props.put("host-selector", "random"); // For random host selection
// props.put("host-selector", "round_robin"); // For round-robin host
//                                            // selection
props.put("backoff", "true"); // Disabled by default.

props.put("maxBackoff", "10000"); // Defaults 0, which effectively
                                  // becomes 30000 ms

// Create the client with load balancing properties
RpcClient client = RpcClientFactory.getInstance(props);
```

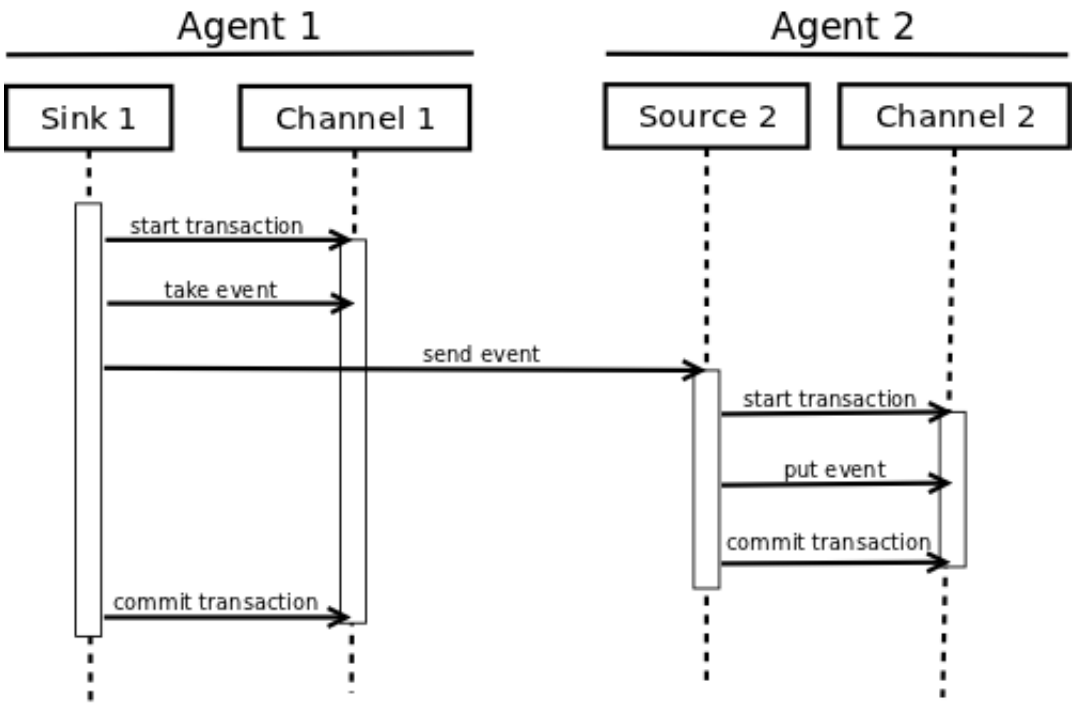
For more flexibility, the load-balancing Flume client implementation (`LoadBalancingRpcClient`) can be configured with these properties:

```
client.type = default_loadbalance

hosts = h1 h2 h3                        # At least 2 hosts are required

hosts.h1 = host1.example.org:41414

hosts.h2 = host2.example.org:41414

hosts.h3 = host3.example.org:41414

backoff = false                         # Specifies whether the client should
                                        # back-off from (i.e. temporarily
                                        # blacklist) a failed host
                                        # (default: false).

maxBackoff = 0                          # Max timeout in millis that a will
                                        # remain inactive due to a previous
                                        # failure with that host (default: 0,
                                        # which effectively becomes 30000)

host-selector = round_robin             # The host selection strategy used
                                        # when load-balancing among hosts
                                        # (default: round_robin).
```

```
                                    # Other values are include "random"
                                    # or the FQCN of a custom class
                                    # that implements
                                    # LoadBalancingRpcClient$HostSelector

batch-size = 100                    # Must be >=1 (default: 100)

connect-timeout = 20000             # Must be >=1000 (default: 20000)

request-timeout = 20000             # Must be >=1000 (default: 20000)
```

Transaction interface

The `Transaction` interface is the basis of reliability for Flume. All the major components (ie. `Source`s, `Sink`s and `Channel`s) must use a Flume `Transaction`.



A `Transaction` is implemented within a `Channel` implementation. Each `Source` and `Sink` that is connected to `Channel` must obtain a `Transaction` object. The `Source`s actually use a `ChannelSelector` interface to encapsulate the `Transaction`. The operation to stage an `Event` (put it into a `Channel`) or extract an `Event` (take it out of a `Channel`) is done inside an active `Transaction`. For example:

```
Channel ch = new MemoryChannel();
Transaction txn = ch.getTransaction();
txn.begin();
try {
  // This try clause includes whatever Channel operations you want to do

  Event eventToStage = EventBuilder.withBody("Hello Flume!",
                       Charset.forName("UTF-8"));
  ch.put(eventToStage);
  // Event takenEvent = ch.take();
  // ...
```

```
    txn.commit();
  } catch (Throwable t) {
    txn.rollback();

    // Log exception, handle individual exceptions as needed

    // re-throw all Errors
    if (t instanceof Error) {
      throw (Error)t;
    }
  } finally {
    txn.close();
  }
```

Here we get hold of a `Transaction` from a `Channel`. After `begin()` returns, the `Transaction` is now active/open and the `Event` is then put into the `Channel`. If the put is successful, then the `Transaction` is committed and closed.

Sink

The purpose of a `Sink` to extract `Event`s from the `Channel` and forward them to the next Flume Agent in the flow or store them in an external repository. A `Sink` is associated with one or more `Channel`s, as configured in the Flume properties file. There's one `SinkRunner` instance associated with every configured `Sink`, and when the Flume framework calls `SinkRunner.start()`, a new thread is created to drive the `Sink` (using `SinkRunner.PollingRunner` as the thread's `Runnable`). This thread manages the `Sink`'s lifecycle. The `Sink` needs to implement the `start()` and `stop()` methods that are part of the `LifecycleAware` interface. The `Sink.start()` method should initialize the `Sink` and bring it to a state where it can forward the `Event`s to its next destination. The `Sink.process()` method should do the core processing of extracting the `Event` from the `Channel` and forwarding it. The `Sink.stop()` method should do the necessary cleanup (e.g. releasing resources). The `Sink` implementation also needs to implement the `Configurable` interface for processing its own configuration settings. For example:

```
public class MySink extends AbstractSink implements Configurable {
  private String myProp;

  @Override
  public void configure(Context context) {
    String myProp = context.getString("myProp", "defaultValue");

    // Process the myProp value (e.g. validation)

    // Store myProp for later retrieval by process() method
    this.myProp = myProp;
  }

  @Override
  public void start() {
    // Initialize the connection to the external repository (e.g. HDFS) that
    // this Sink will forward Events to ..
  }
```

```
  @Override
  public void stop () {
    // Disconnect from the external respository and do any
    // additional cleanup (e.g. releasing resources or nulling-out
    // field values) ..
  }

  @Override
  public Status process() throws EventDeliveryException {
    Status status = null;

    // Start transaction
    Channel ch = getChannel();
    Transaction txn = ch.getTransaction();
    txn.begin();
    try {
      // This try clause includes whatever Channel operations you want to do

      Event event = ch.take();

      // Send the Event to the external repository.
      // storeSomeData(e);

      txn.commit();
      status = Status.READY;
    } catch (Throwable t) {
      txn.rollback();

      // Log exception, handle individual exceptions as needed

      status = Status.BACKOFF;

      // re-throw all Errors
      if (t instanceof Error) {
        throw (Error)t;
      }
    } finally {
      txn.close();
    }
    return status;
  }
}
```

Source

The purpose of a `Source` is to receive data from an external client and store it into the `Channel`. A `Source` can get an instance of its own `ChannelProcessor` to process an `Event`. The `ChannelProcessor` in turn can get an instance of its own `ChannelSelector` that's used to get the `Channel`s associated with the `Source`, as configured in the Flume properties file. A `Transaction` can then be retrieved from each associated `Channel` so that the `Source` can place `Event`s into the `Channel` reliably, within a `Transaction`.

Similar to the `SinkRunner.PollingRunner Runnable`, there's a `PollingRunner Runnable` that executes on a thread created when the Flume framework calls `PollableSourceRunner.start()`. Each

configured `PollableSource` is associated with its own thread that runs a `PollingRunner`. This thread manages the `PollableSource`'s lifecycle, such as starting and stopping. A `PollableSource` implementation must implement the `start()` and `stop()` methods that are declared in the `LifecycleAware` interface. The runner of a `PollableSource` invokes that `Source`'s `process()` method. The `process()` method should check for new data and store it into the `Channel` as Flume `Event`s.

Note that there are actually two types of `Source`s. The `PollableSource` was already mentioned. The other is the `EventDrivenSource`. The `EventDrivenSource`, unlike the `PollableSource`, must have its own callback mechanism that captures the new data and stores it into the `Channel`. The `EventDrivenSource`s are not each driven by their own thread like the `PollableSource`s are. Below is an example of a custom `PollableSource`:

```
public class MySource extends AbstractSource implements Configurable, PollableSou
  private String myProp;

  @Override
  public void configure(Context context) {
    String myProp = context.getString("myProp", "defaultValue");

    // Process the myProp value (e.g. validation, convert to another type, ...)

    // Store myProp for later retrieval by process() method
    this.myProp = myProp;
  }

  @Override
  public void start() {
    // Initialize the connection to the external client
  }

  @Override
  public void stop () {
    // Disconnect from external client and do any additional cleanup
    // (e.g. releasing resources or nulling-out field values) ..
  }

  @Override
  public Status process() throws EventDeliveryException {
    Status status = null;

    // Start transaction
    Channel ch = getChannel();
    Transaction txn = ch.getTransaction();
    txn.begin();
    try {
      // This try clause includes whatever Channel operations you want to do

      // Receive new data
      Event e = getSomeData();

      // Store the Event into this Source's associated Channel(s)
      getChannelProcessor().processEvent(e)

      txn.commit();
      status = Status.READY;
```

```
      } catch (Throwable t) {
        txn.rollback();

        // Log exception, handle individual exceptions as needed

        status = Status.BACKOFF;

        // re-throw all Errors
        if (t instanceof Error) {
          throw (Error)t;
        }
      } finally {
        txn.close();
      }
      return status;
    }
  }
```

Channel

TBD