ton.events – Notifications Provider for the Free TON Network

Performant, scalable and fault-tolerant system which relays encrypted blockchain events to its clients.

Submission info

Name	ton.events
Description	Notifications Provider for the Free TON Network
Telegram	https://t.me/tonevents
Github	https://github.com/ton-events
Logo	https://ton.events/images/logo.png

Also obtainable through https://ton.events/about.

Design considerations

Receiving data from the Queue Provider and dealing with that unbounded stream of notifications, conditionally routed to various destinations, is by definition a data stream processing task.
There are well-known frameworks for solving tasks like this and one of them is Apache Flink, which has been chosen as a tool for the job.

The dataflow program (Flink App for short) run by Flink does the following:

- natively and seamlessly communicates with Kafka to get notifications from the Queue Provider:
  - automatically reconnects in case of connection issues;
  - replays the stream in case of any failures to guarantee that every notification will be processed *exactly once*.
- manages state in a distributed and fault-tolerant manner:
  - no external database is used since everything needed for notifications routing and delivery is stored in a regularly checkpointed job's state;
  - provides reliable and transparent ways for updating the job without losing any data;
  - allows to configure TTL for each stored entity for a fine-grained control over the size of the state, which is useful, for example, for filtering out duplicated notifications by storing idempotency keys encountered in a given time window.
- provides asynchronous means of sending notifications over HTTP(S) with retries on errors, being performed using configurable retry strategy (see Appendix A for the details on configuration);
- gathers and exposes a huge number of both built-in and user-defined (application-specific) metrics for increased observability of the system; visit this page to see some of them visualized on the dashboard (username: `spectator` , password: `spectator`).

To process Notification DeBot requests, i.e. register the webhooks, there's a web service (Node.js) with an API gateway (HAProxy) in front of it (for TLS offloading, CORS and stuff like load balancing and rate limiting).
The web service itself is quite straight-forward and provides only one API route used by Notification DeBot (see Appendix B for a reference).
Specific feature of the web server, worth mentioning, is a webhook ownership confirmation, which technically is a *Challenge-Response Check (CRC)* based on *HMAC-SHA256* algorithm. It requires an additional GET-handler for each POST-route (i.e. webhook) on the client's side (see Appendix C for details).
When CRC is successfully completed, the web service sends a "subscribe command" to the control stream, communicating with the Flink App through RabbitMQ.

When the webhook is successfully registered, a client will start receiving notifications. In case of delivery failure, the Flink App will retry, exponentially increasing the delay between attempts (max delay duration is capped so that it won't increase after reaching a configured threshold). Retry process is asynchronous which allows other notifications to be sent without delay.
If every attempt of notification delivery fails, the Flink App will send an "unsubscribe command" to the control stream, effectively forgetting a failing webhook to prevent such struggle in the future. The client will have to add this webhook again, if it's still relevant, or just happily forget about it as well, otherwise.

If the client doesn't receive any messages for a reasonably long time (e.g. due to resetting subscription rules via Notification DeBot), all of their subscriptions are going to be forgotten for good. This is configurable, though, and is a measure which has to be taken, given that Notification DeBot doesn't notify Providers when clients reset their subscription rules.

Those are main design considerations.
In the future, those decisions, hopefully, will allow extending the functionality with new means of notifications delivery such as MQTT, for example, or scale it alongside with the growing client base using Flink's great parallelism capabilities.

Appendix D contains an annotated sequence diagram that visualizes everything said above.

Notes on testing

Globally available, fully functional version of the Provider lives at https://ton.events.
You can test it by registering webhooks implemented in your own software or those provided for your convenience by a Telegram bot called `@ton_events_playground_bot` .
You might wish to build, deploy and test the system from scratch, which is also possible using a local instance of Kafka (to mock the Queue Provider) and that same Playground Bot.
See Appendix E for details.

Appendix A

Configuration of both API service and the Flink App is achieved via environment variables, some of which have default values.

Variable	Scope	Default value	Description
QUEUE_PROVIDER_ADDRESS	Flink App	*None*	Kafka Bootstrap Server URL
QUEUE_PROVIDER_GROUPID	Flink App	ton.events	Kafka Consumer Group ID
QUEUE_PROVIDER_TOPIC	Flink App	*None*	Kafka topic to receive notifications from
QUEUE_PROVIDER_USERNAME	Flink App	*None*	Kafka username
QUEUE_PROVIDER_PASSWORD	Flink App	*None*	Kafka password
RETRIABLE_NOTIFICATION_SENDING_ATTEMPTS	Flink App	3	How many notification sending attempts to perform after the first failure
RETRIABLE_NOTIFICATION_SENDING_INITIAL_DELAY	Flink App	30	Delay between the first failure and subsequent retry attempt (in seconds)
RETRIABLE_NOTIFICATION_SENDING_MAX_DELAY	Flink App	600	Delay will be doubled on each attempt but won't exceed this threshold (in seconds)

Variable	Scope	Default value	Description
CRC_RETRY_LIMIT	API	4	How many attempts of CRC will be performed
CRC_RETRY_INIT_DELAY	API	30000	Delay between the first CRC failure and subsequent retry attempt (in milliseconds)
CRC_SALT	API	446f..7921	Cryptographic salt used to derive client's secret from its *hash*
AMQP_URI	Flink App & API	amqp://rabbitmq.ton.events	See this for reference

Appendix B

/api/v1/subscribe

verb: POST	Response code: 202 Accepted

Request:

```
{
    "hash": "<string>",
    "data": "<base64 encoded webhook URL>"
}
```

Response:

```
{
    "secret": "<64 hexadecimal digits>"
}
```

Appendix C

Inspired by Twitter and LinkedIn.

The webhook registration process ends with a *secret* being returned to the client. After that, a CRC will be performed.

A `GET` request will be sent to the webhook URL with a query string, containing a parameter called `crc_token`. In response, the client must send that token signed with the *secret* using *HMAC-SHA256* algorithm.

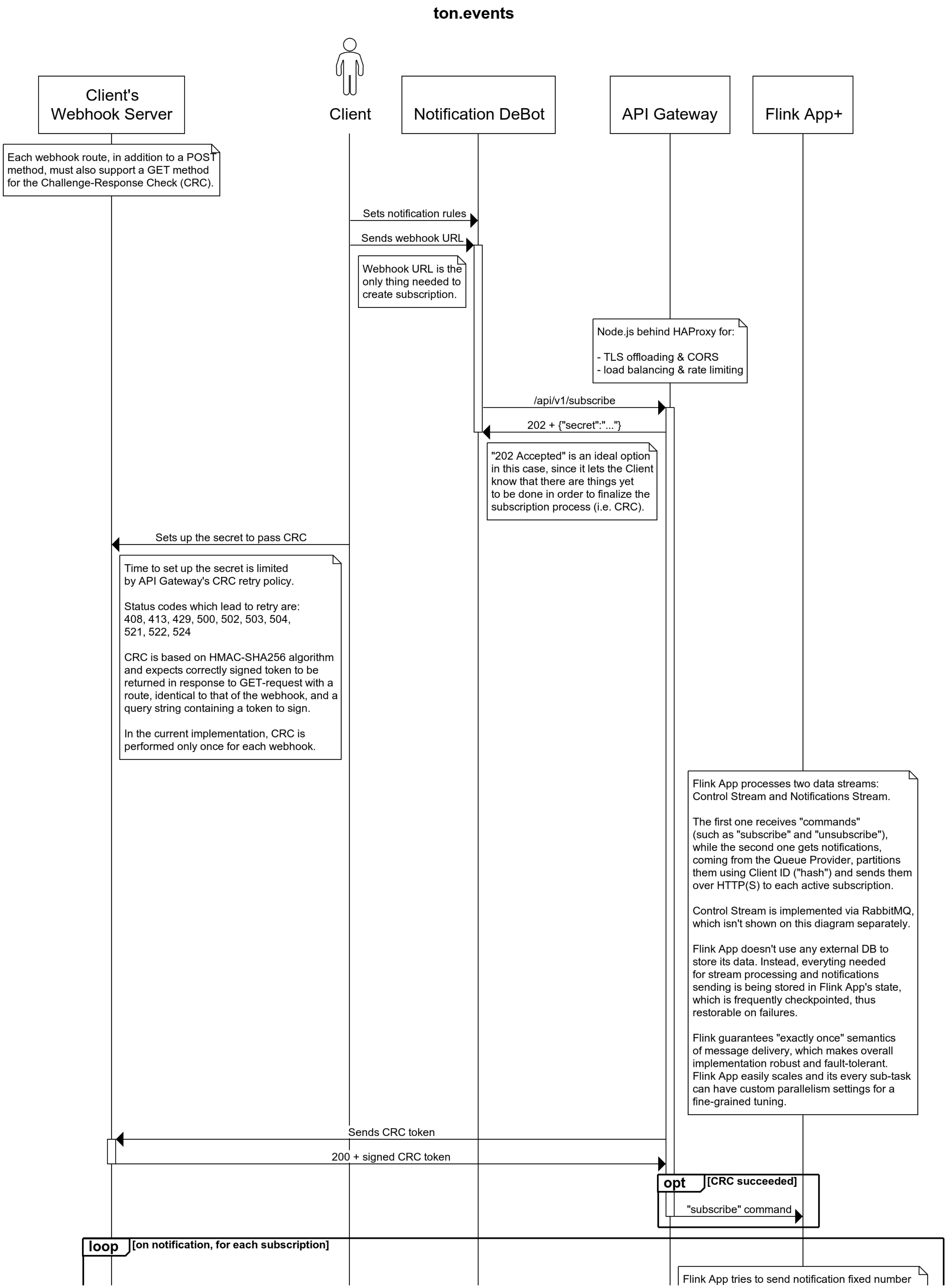
Here goes a sample Node.js code that prepares the response:

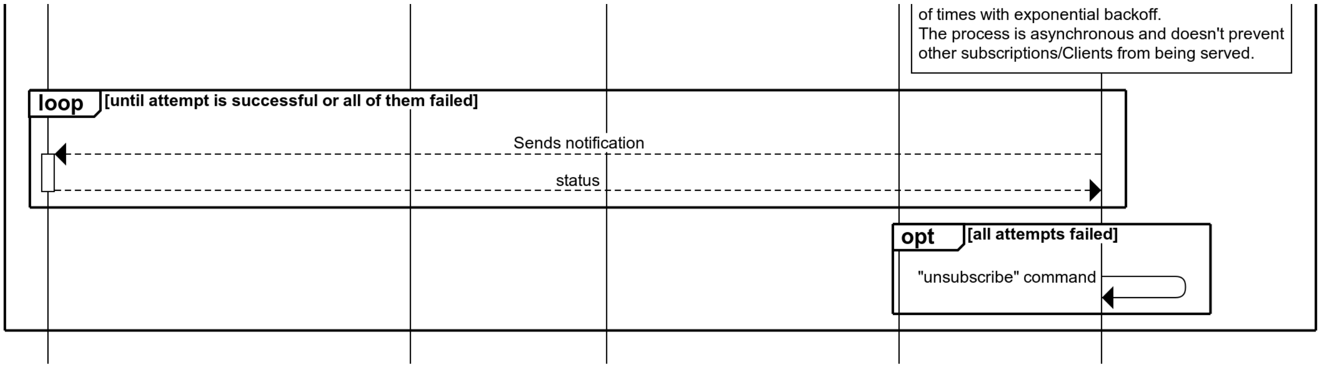
```
const crypto = require('crypto');
const hmac = crypto.createHmac('sha256', Buffer.from(secret, 'hex'));

hmac.update(crc_token);

const response = hmac.digest('hex'); // that's important to encode response as HEX
```

Replying with correctly signed token and status code 200 will enable notifications being sent to the client.

Additionally, each notification contains an `x-te-signature` header set to the *HMAC-SHA256* signature of its body prepended with `hmacsha256=` string. That header is there for the client to make sure notifications are coming from the one and only ton.events and for integrity checks, of course.

Appendix D


ton.events
Client's Webhook Server
Client
Notification DeBot
API Gateway
Flink App+
Each webhook route, in addition to a POST method, must also support a GET method for the Challenge-Response Check (CRC).
Sets notification rules
Sends webhook URL
Webhook URL is the only thing needed to create subscription.
Node.js behind HAProxy for:
- TLS offloading & CORS
- load balancing & rate limiting
/api/v1/subscribe
202 + {"secret":"..."}
"202 Accepted" is an ideal option in this case, since it lets the Client know that there are things yet to be done in order to finalize the subscription process (i.e. CRC).
Sets up the secret to pass CRC
Time to set up the secret is limited by API Gateway's CRC retry policy.
Status codes which lead to retry are: 408, 413, 429, 500, 502, 503, 504, 521, 522, 524
CRC is based on HMAC-SHA256 algorithm and expects correctly signed token to be returned in response to GET-request with a route, identical to that of the webhook, and a query string containing a token to sign.
In the current implementation, CRC is performed only once for each webhook.
Flink App processes two data streams: Control Stream and Notifications Stream.
The first one receives "commands" (such as "subscribe" and "unsubscribe"), while the second one gets notifications, coming from the Queue Provider, partitions them using Client ID ("hash") and sends them over HTTP(S) to each active subscription.
Control Stream is implemented via RabbitMQ, which isn't shown on this diagram separately.
Flink App doesn't use any external DB to store its data. Instead, everyting needed for stream processing and notifications sending is being stored in Flink App's state, which is frequently checkpointed, thus restorable on failures.
Flink guarantees "exactly once" semantics of message delivery, which makes overall implementation robust and fault-tolerant. Flink App easily scales and its every sub-task can have custom parallelism settings for a fine-grained tuning.
Sends CRC token
200 + signed CRC token
opt [CRC succeeded]
"subscribe" command
loop [on notification, for each subscription]
Flink App tries to send notification fixed number



Appendix E

Testing live

If you have your own webhook server, implemented in compliance with Appendix C, go and send callback URL(s) to the `tonevents` provider via Notification DeBot.

Otherwise, use the Playground Bot. Like that:

1. Firstly, make sure you have Notification DeBot prepared to receive callback URLs from you as described here.
2. Then, use `@ton_events_playground_bot` to generate a webhook for you – it happens automatically right after you start conversing with the bot.
   Keep in mind that **the callback URL is always the same for a given chat id**, so if you want to get multiple callbacks for some testing scenarios, you have to create multiple groups with the bot. Note that adding the bot to a group doesn't call the `/start` command automatically, so you need to do it manually like that:

   ```
   /start@ton_events_playground_bot
   ```

   Also keep in mind that if you decide to use an approach with groups (instead of a private chat), **you have to explicitly reply to the bot's messages**, when providing information it asks for.
3. When you got the URL, feed it to Notification DeBot (`Send callbackUrl` command, ID = `tonevents`).
4. If the URL is valid, Notification DeBot will reply with a JSON (containing a secret), which must be re-sent as-is to the Playground Bot as soon as possible. The time is limited because of the CRC, which starts at the same time the client receives the secret. There will be multiple attempts with delays so take your time but don't hesitate too long.
5. As soon as the Playground Bot receives the valid secret, it will start showing all the notifications you're subscribed for, so don't forget to set up some rules via Notification DeBot. For example, you could subscribe to `all` events for your DevNet wallet and then send some tokens to/from it.
6. *Optionally*, you can provide the Playground Bot with the key pair you received from Notification DeBot when your Notification contract was deployed for the first time. It's not recommended to share it with anybody in real life but for the testing purposes in DevNet it's quite harmless. Being provided with that key pair, the Playground Bot would be able to decrypt incoming notifications for you.

Testing locally

Prerequisites:

- OS that supports everything listed below
- Docker & Docker Compose
- jq
- ports `13000/tcp`, `18081/tcp` unoccupied on `127.0.0.1`

Inside the submission's root folder (containing `docker-compose.yml` file) execute the following command:

```
$ docker-compose up -d
```

This will build all the Docker images and bring the services up.

Now you need to build and deploy the Flink App. Do the following:

```
$ docker run --rm -v $PWD/core:/usr/src/app -w /usr/src/app clojure:openjdk-8-lein lein uberjar
$ ./flink-app-reload.sh core/target/ton-events-1.0.0-SNAPSHOT-standalone.jar
```

This is it for the setup work. Now refer to the step 2 of the Testing live section to generate a callback URL via Playground Bot. When it's ready, do the following:

```
$ ./register-callback.sh <your callback URL goes here>
```

A JSON with a *secret* will be printed in response – feed it back to the Playground Bot (full JSON, replying explicitly, if in a group).
Now everything is ready to mock some notifications:

```
$ docker-compose exec kafka produce-notifications.sh
```

The command above will send three notifications, two of which have the same idempotency key (to test deduplication). You'll receive only two notifications – go check your Telegram for new messages from the Playground Bot.
If you run the above command again, you won't receive notifications because of idempotency keys duplication. To change that, go edit produce-notifications.sh and modify those keys. Note that without any notifications being sent for approximately an hour, you'll be able to receive notifications without modifying the keys, since uniqueness of the keys is being checked in a fixed time window.

To shut everything down and/or start from scratch do the following.

```
$ docker-compose down -v
```