Managing Errors at Saturation Point in Node.js Using DogStatsD and Hot-Shot Client

By Yanna Johansen

If you're here it's because you're looking for the secret sauce to improve reliability of your web-based product. You can follow along without the prerequisites, but it will not make as much sense unless you have all the components. As with any programming language, platform, or tool that doesn't come bundled, getting up and running takes an initial setup. Node.js has a far better installation experience than most tools or platforms; just run the installer and you're good to go.

The Hot-shots library is used as a use case here because it integrates well with Node.js and the statistics collection methods. We're choosing something other than Python because we wanted to show another library provided by Datadog community, which might not be as well-known.

Prerequisites

For this example, we are using Vagrant hashicorp/precise64 template.

Installing Node.js

Following Installing Node.js via package manager - Debian and Ubuntu based Linux distributions.

NOTE: Since we are using Ubuntu Precise, we will read about running Node.js >= 6.x on older distros.

First ensure curl and certificates are up-to-date. This may help prevent SSL transport issues.

```
    $ sudo apt-get update
    $ sudo apt-get -y install curl apt-transport-https ca-certificates
```

Install Clang

```
    $ sudo apt-get install -y clang-3.4
```

Install Node.js

```
    $ curl -sL https://deb.nodesource.com/setup_8.x | sudo -E bash -
```

Note: if there are issue installing Node.js or later packages, see [Troubleshooting][#troubleshooting] below.

Test with hello.js.

Forward VM ports to host in the `Vagrantfile` configuration

```
    config.vm.network "forwarded_port", guest: 8081, host: 8081, host_ip: "127.0.0.1"
```

Configure DogStatsD

Follow DogStatsD documentation.

Enable and configure DogStatsD in `datadog.yaml`

```
    use_dogstatsd: yes
    ...
    dogstatsd_port: 8125
```

Restart Agent.

Test a Custom Metric

Using command line.

```
    $ echo -n "custom_metric:20|g|#shell" >/dev/udp/localhost/8125
```

Note: this is similar to using Datadog agent API, as in Python, except, here we are sending a message directly to a local UDP server.

This approach of sending to a UDP server is used by many community client libraries.

Let's now verify the custom metrics were delivered in Datadog UI:

Troubleshooting

On older Ubuntu distributions (precise), the versions of node and npm are outdated: npm v1.1.4 and node v0.6.12. This may cause conflicts with npm registry, e.g. getting an error "failed to fetch from registry".

To use `nvm` we follow instruction to Install Node and npm to an Ubuntu box.
This will install the more recent versions of node (v0.11.14) and npm (2.0.0).

However, for more recent node versions, e.g. v10.3.0 (npm v6.1.0), see details for Node Version Manager.

If after reboot or new terminal session, the old version of node and npm is default, use

```
nvm ls
nvm use v10.3.0
nvm alias default v10.3.0   # for future
```

Libraries for Metrics Collection

Agent Client

The Agent client libraries typically do not measure statistics, they are tasked to communicate the collected statistics to the Agent.

We use several criteria for the Agent client library

- Integration with Node.js
- Providing familiar standard interface such as StatsD to facilitate adoption and adapting of existing code base, as opposed to any custom API
- API features, which provide rich reporting functionality (gauges, timing, counters) as well as flexible configuration, e.g. by setting common parameters, such as tags or prefixes from all communications.

A perfect choice to satisfy these criteria is the `hot-shots` library, which is a fork of `node-statsd` providing familiar API, with enhancements for DofStatsD features.

Server Statistics

For web Server stats (requests per second, request time, number of errors, etc.) we considered the following approaches in addition to Node.js built-in functionality:

- request module
- request-stats package and chose to go along with `request-stats`, as the most flexible and straight-forward approach in terms of integration (call-back interface) and API (granulated structures for metrics).

Note: To see how to collect stats for requests originated in Node.js itself, follow Understanding & Measuring HTTP Timings with Node.js

Install Hot-shots

Following instructions at the npm repository and Github:

```
$ npm install hot-shots
```

Testing from the command line using an ad-hoc Node.js session:

```
$ node
```

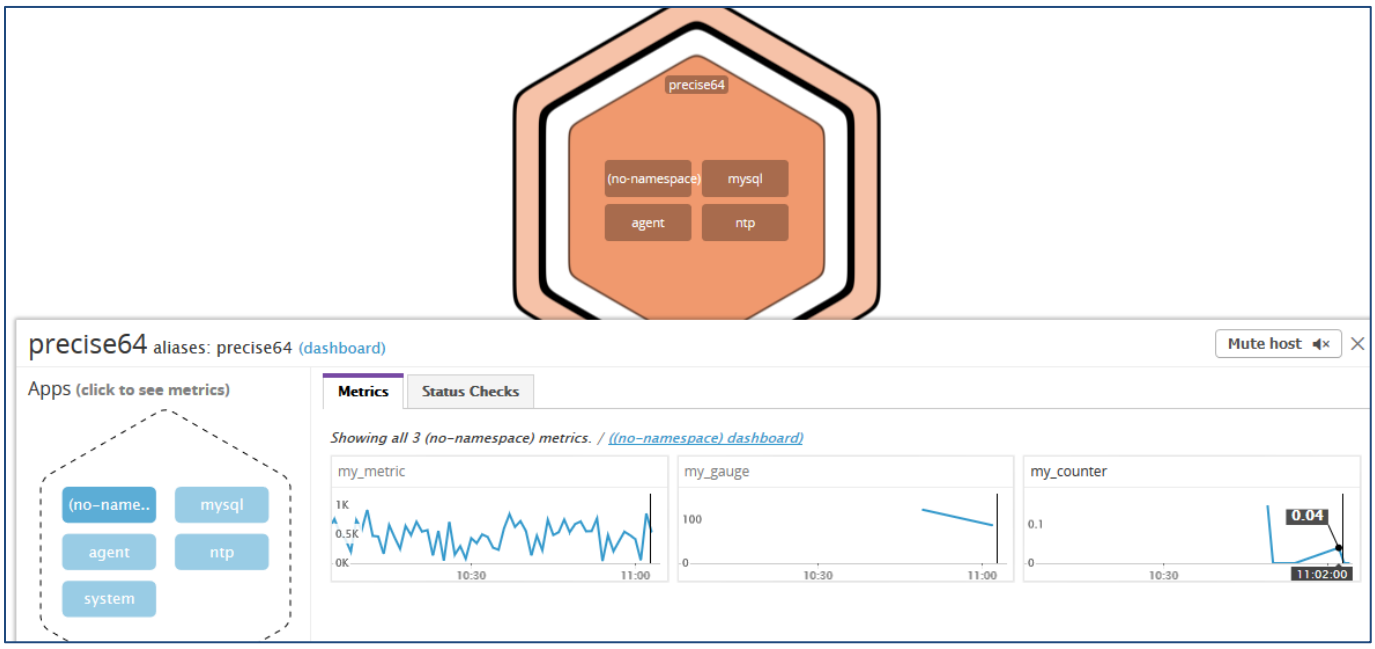
Initialize Agent client:

```
var StatsD = require('hot-shots')
client = new StatsD()
```

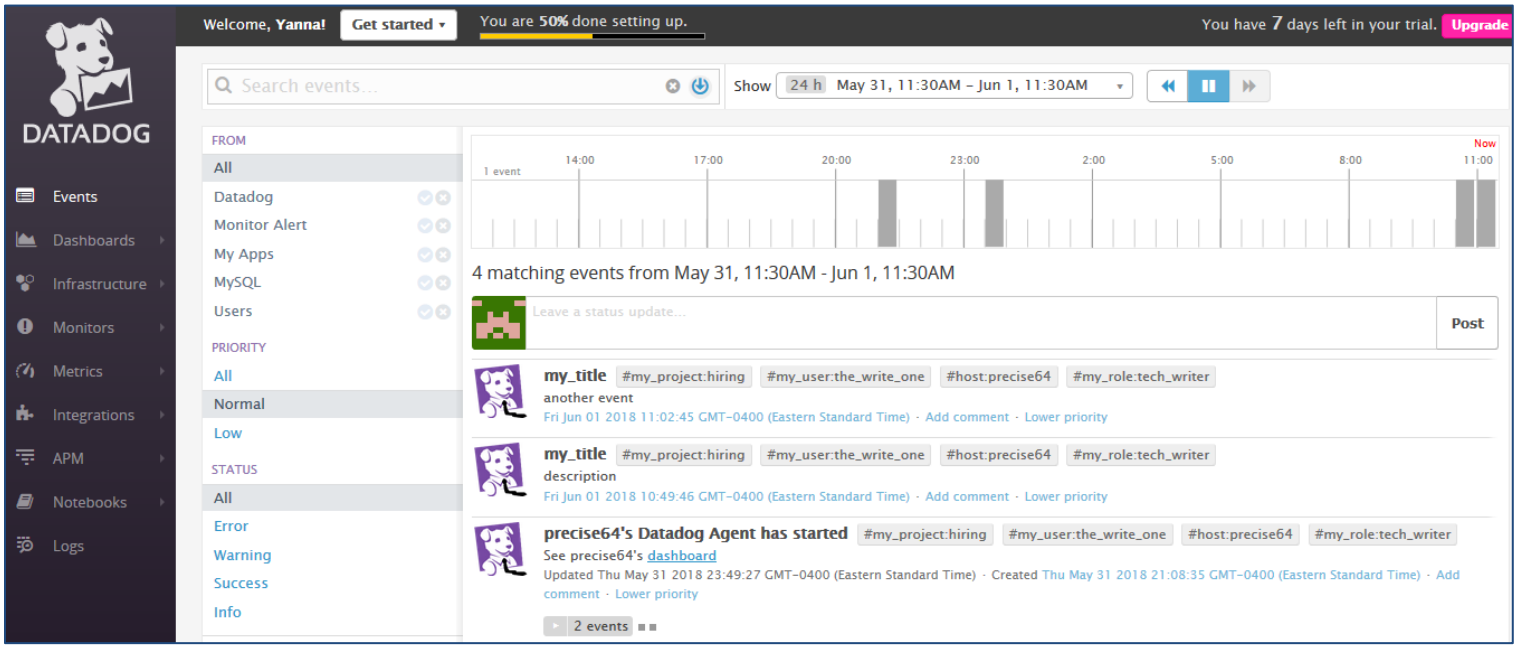
Generate stats:

```
client.gauge('my_gauge', 123.45)
client.event('my_title', 'description')
client.increment('my_counter')
```

Verify the custom metrics in Datadog UI



And custom Event in the Events dashboard:



Sample Node.js Web Application

Although a small model application is used here for demonstration purposes, in real production environments, it makes sense to have such a small model application with configurable processing and resource consumption parameters. This would allow dry-running the environment to verify the instrumentation infrastructure and verify the correct topology assumptions.

Below we will look into some details. Complete source of the Node.js sample app is available here:

- View source: stats_hot.js

To model real life behavior, we will use a random complexity parameter *(n)*, which will determine the size and time of the response.

For the purposes of this demo, our sample application will generate random text whose size is proportionate to the response complexity, i.e. *O(n)*. The time will be defined as *square* of the complexity parameter, $O(n^2)$.

Here's the section of code, responsible for generating the output and determining the size and time based on random complexity.

```
function rnd(n, m) {  // inclusive
    return n + Math.floor(Math.random() * (m - n + 1));
}
function strFill(n, a) {
    return Array(n + 1).join(a || " ");
}
function rndWord(n, m) {
    return strFill(rnd(n, m)).replace(/ /g, x => String.fromCharCode(rnd(0, 25) + 65 + 32));
}
function rndLine(n, m, nw, mw) {
    return strFill(rnd(n, m)).replace(/ /g, x => rndWord(nw, mw) + " ");
}
function rndText(n, m, nl, ml, nw, mw) {
    return strFill(rnd(n, m)).replace(/ /g, x => rndLine(nl, ml, nw, mw) + "\n");
}

var server = http.createServer(function (request, response) {

   var r = Math.random() * 10;   // random complexity 0..10
   var n = Math.floor(4*r) + 1;  // data size 1..40
   var t = Math.floor(r*r) + 10; // time      10..109
   var text = rndText(3, 10+n, 8, 12, 2, 8)
```

The sample output of the web page looks like

```
Hello Stats
from port 8081 taking 92 ms for data size 37

isl amo uorat pne yg bogfd lejnb wivipt yxazz oxu
spjespq ea en xnjkiyxd fwlwxzx ah zknkea qyxym urhnl pc
gpfmba emzygkdz updfipp vywae sabh vmyqudrc njfwsi asaarug uuq
qirggewk bpv azgshrtr mkkzr wsgnc uxozsx fxrqck ddxxa xyb
bgndxrp jynxdm zis fqinvb chq ythkyyd ka fcrk zjqhmzol cufnuvu uiaixez imhbxa
wrfmsaz lugrha aywob qvq yku zju ouk nyhy dfaig wqmwalp hpwa
tfu zg tbzktv ktt sn us nae ecalkko zlmcvfld tffsqxb rmugppir
ku cl eevcmiwe nqzoycc px trdaikt xfbitfox jxs hv lviy
bfmco tjfqq prnwwux whb ffskr ysmwpcux ljl ububavdc lh gkzsyqv whnvidei zit
bb fls anl ms aaocy mtfmqwmg ykgwma vblwtl nnmj yeq ixkiroqq
```

Load Testing

The command-line tool `loadtest` allows you to configure and tweak requests to simulate real world loads. It runs a load test on the selected HTTP or WebSockets URL. The API allows for easy integration in your own tests.
To install `loadtest`, see the details at the npm repository.

```
npm install -g loadtest
```

Verify a simple test

```
$ loadtest -n 200 -c 10 --rps 20 http://127.0.0.1:8081/
```

See loadtest_test.txt for sample output.

Note: To warm up Node.js server, the load should be increased gradually. The above parameters is a good starting point.

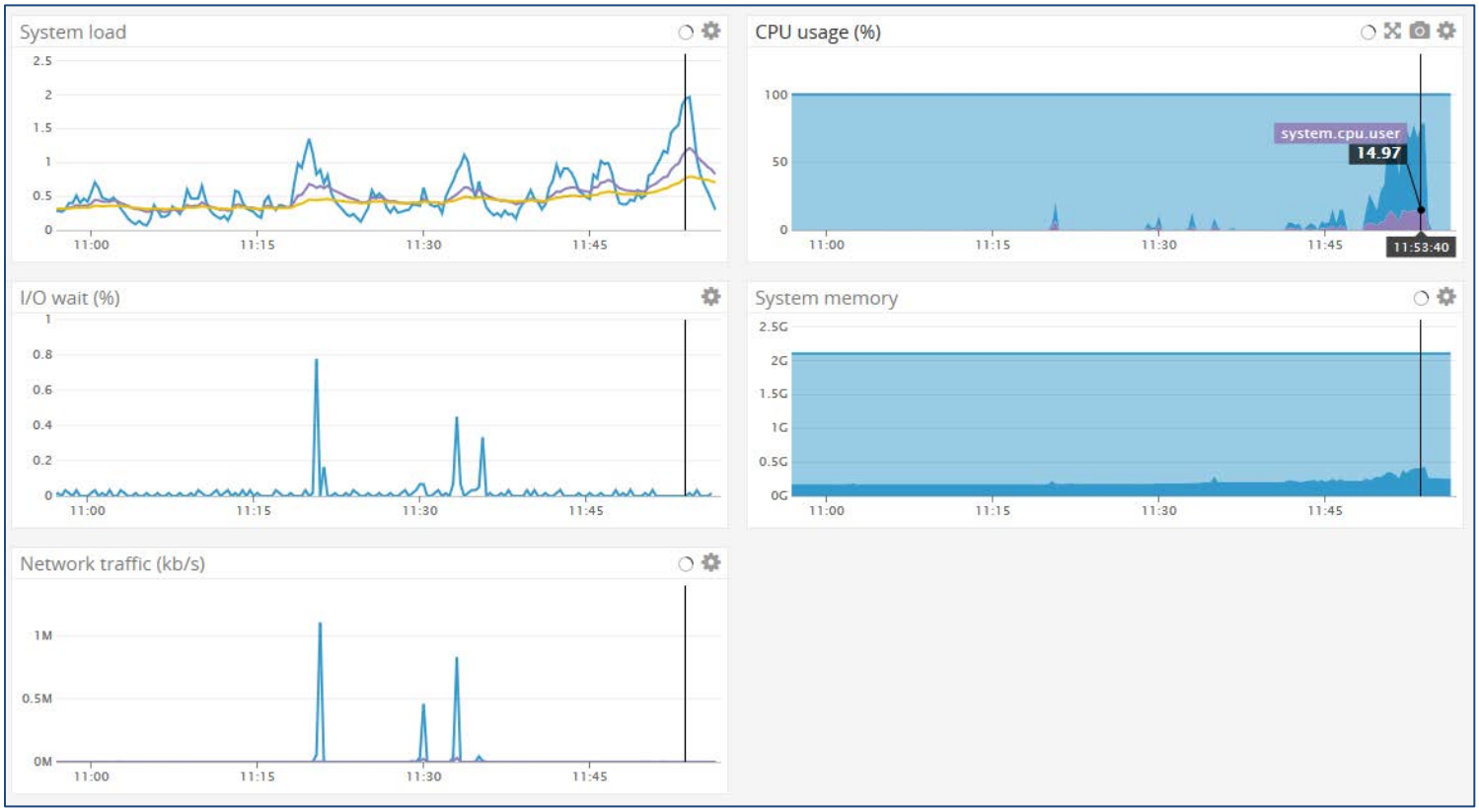
Lower load rate (before saturation)

```
$ loadtest -n 2000 -c 200 --rps 500 http://127.0.0.1:8081/
```

Higher load rate (after saturation)

```
$ loadtest -n 4000 -c 500 --rps 1000 http://127.0.0.1:8081/
```

After increasing the load on the test web page, we can observe increased resource consumption in the Datadog System Dashboard. In particular, System Load, CPU Usage and System Memory show visible increase.



We should expect that after further increase of the load, the server performance would suffer, and errors will start to appear. However, to get more specific insight into performance of individual requests, such as response time and error counts, we need to capture certain request-processing statistics.

Note: there are several ways for capturing performance indicators of a web application, such as in the transport layer, load testing client, etc. However, here we'll be capturing statistics from inside the Node.js code itself. Doing so we can configure the complexity of responses (time and size in particular), and the error triggering mechanism.

Collecting Node.js Stats

Installing `request-stats`

```
npm install request-stats --save
```

Test using a simple web app and console output.

The statistics captured by `request-stats` are represented in nested JSON structures.

```
vagrant@precise64:~/nodes$ node stats_test.js
Server running at http://127.0.0.1:8081/
Request starts
{ ok: true,
  time: 6,
  req:
   { bytes: 345,
     headers:
      { host: '127.0.0.1:8081',
        'user-agent':
         'Mozilla/5.0 (Windows NT 10.0; WOW64; rv:52.0) Gecko/20100101 Firefox/52.0',
        accept:
         'text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8',
        'accept-language': 'en-US,en;q=0.5',
        'accept-encoding': 'gzip, deflate',
        connection: 'keep-alive',
        'upgrade-insecure-requests': '1',
        'cache-control': 'max-age=0' },
     method: 'GET',
     path: '/' },
  res:
   { bytes: 176,
     headers:
      { 'content-type': 'text/plain',
        date: 'Sat, 02 Jun 2018 00:34:20 GMT',
        connection: 'keep-alive',
        'transfer-encoding': 'chunked' },
     status: 200 } }
```

The statistics we are interested in are:

- response size
- response time
- error count

In our code, the statistics will be captured as follows:

```
var requestStats = require('request-stats')
    requestStats(server, function (stats) {
        // called every time request completes

        report(stats);
        // if (!stats.ok) console.log(stats);
    })

var count = 1;
function report(s) {
    console.log(sprintf(
            '%4d %4s %3s  %4d %6s %6d %6s',
            ++count, s.time, s.ok?'OK':'ERR', s.req.bytes, s.req.method, s.res.bytes,
s.res.status));

    statsD.gauge('reponse.size', s.res.bytes);
    statsD.timing('response.time', s.time);
}
```

which results in tabular console output:

```
vagrant@precise64:~/nodes$ node stats_hot.js
Server running at http://127.0.0.1:8081/


  No Time OK? < Size Method > Size Status
   2   51  OK   345    GET   1013    200
   3   60  OK   345    GET   1144    200
   4   33  OK   345    GET   1312    200
   5   94  OK   345    GET    845    200
```

Integrating with DogStatsD Using Hot-shots

Thanks to the design insight on the `hot-shots` library, the API is familiar to StatsD and Datadog community. So integration is easy and intuitive.
We will be using the following Datadog metrics:

- counter: `request.count`
- counter: `error.count`
- timing: `response.time`
- gauge: `reponse.size`
- tag: `node_js`, `load_rate: 'low' | 'high'`

First we instanciate the `DogStatsD` client with optional common parameters

```
var StatsD = require('hot-shots'),
    statsD = new StatsD({
        prefix: 'my_node.',
        globalTags: { node_js: '', load_rate: 'low' }
    });
```

We integrate capturing response size with `request-stats` reporting mechanism

```
function report(s) {
    ...
    statsD.gauge('reponse.size', s.res.bytes);
    statsD.timing('response.time', s.time);
}
```

Finally, we will be capturing error count for every situation when the ratio of the allocated and actual processing time exceed a certain threashold:

```
    var start = Date.now()
    setTimeout(function() {
        var actual = Date.now() - start;
        var r = t / actual;
        if (r < 0.10) {  // threashold: 0.10 automated load testing, 0.50 manual browser testing
            console.error(`Respose for ${t} ms takes ${actual} ms ratio ${(r*100).toFixed(2)}%`);
            statsD.increment('error.count');
        ...
    }, t);  //  t is the allocated processing time
```

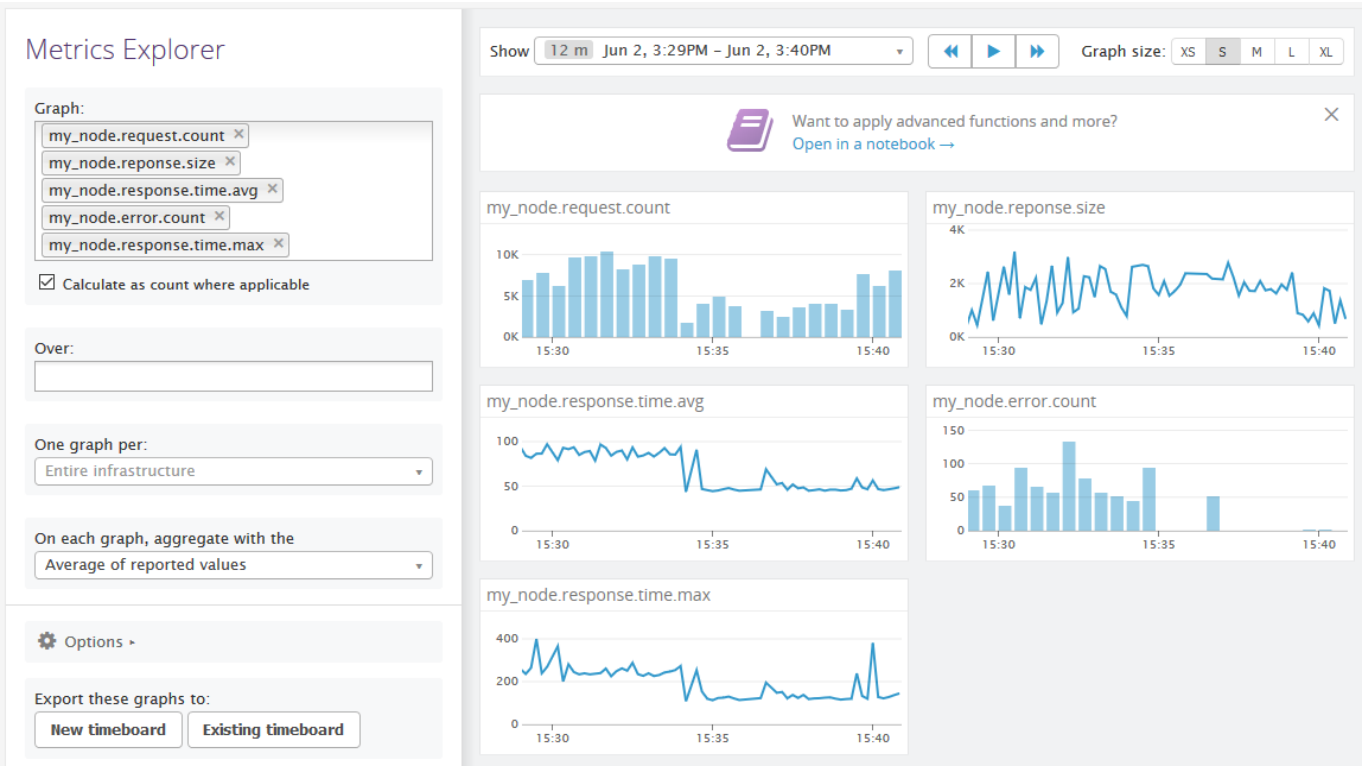
Visualizing Saturation Point with Datadog Dashboard Metrics

Applying the same load testing as shown (earlier)[#load-testing], we determine the saturation point as such when errors first start to appear.

Then we excute the pre- and post- saturation load tests with different metrics tags, which will help in visualization:

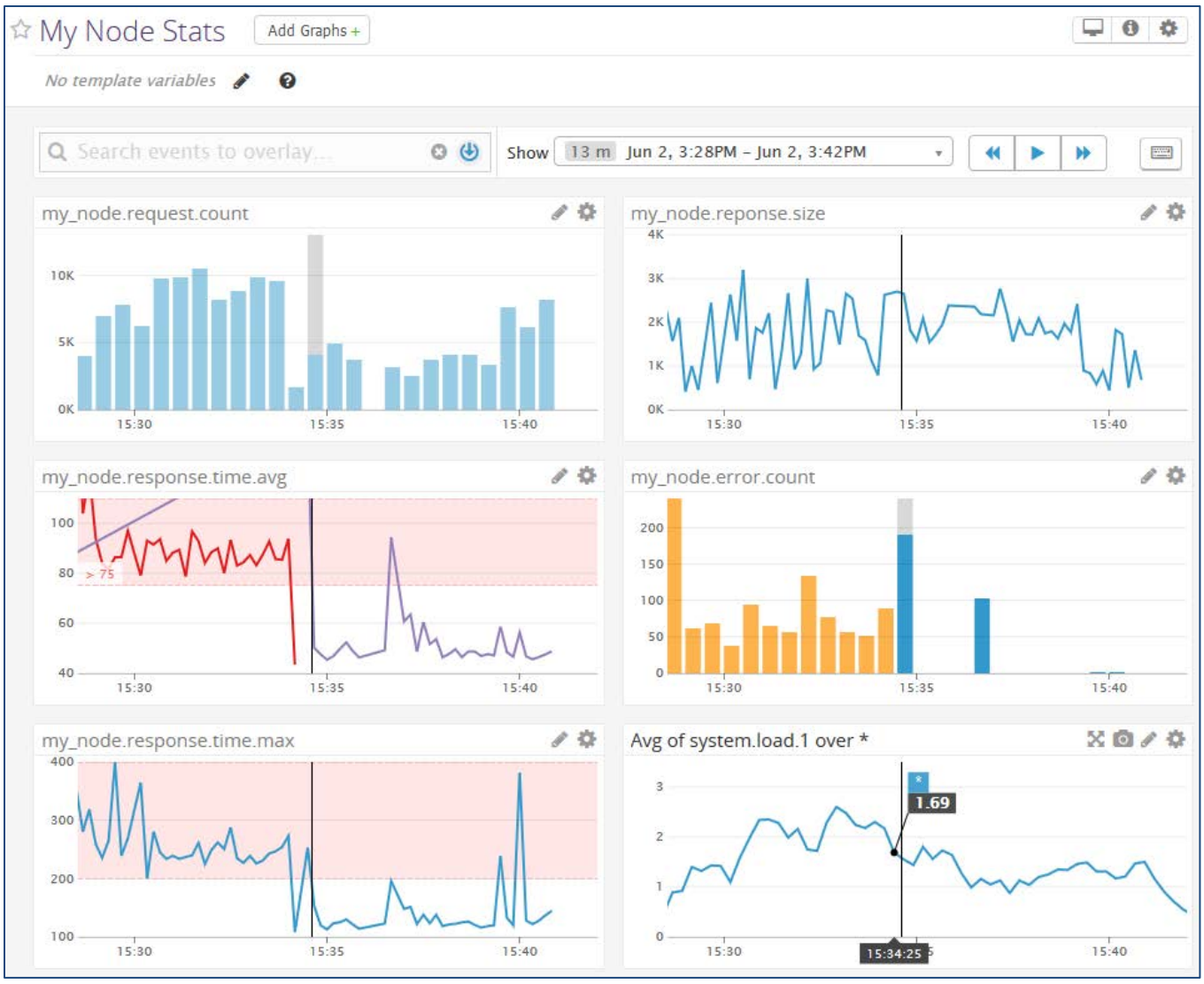
- Lower load rate (before saturation), with tag: `load_rate: low`
- `$ loadtest -n 2000 -c 200 --rps 500 http://127.0.0.1:8081/`
- Higher load rate (after saturation), with tag: `load_rate: high`
- `$ loadtest -n 4000 -c 500 --rps 1000 http://127.0.0.1:8081/`

Next we observe the generated DogStatsD metrics in the Datadog Metrics Explorer:



To help illustrate the relationship between various metrics around the saturation point, we create a custom Dashbaord "My Node Stats".

The `response.time` chart show high load in red, indicating 75ms line between high and low load areas. The `error.count` chart show high error count area in orange, and mostly no errors in low saturation area.



Note: The spikes of errors at the start of each load period indicate warm-up problem of our configuration after server restart -- a good insight for real life applications.

Analysis of Pre-Error Metrics

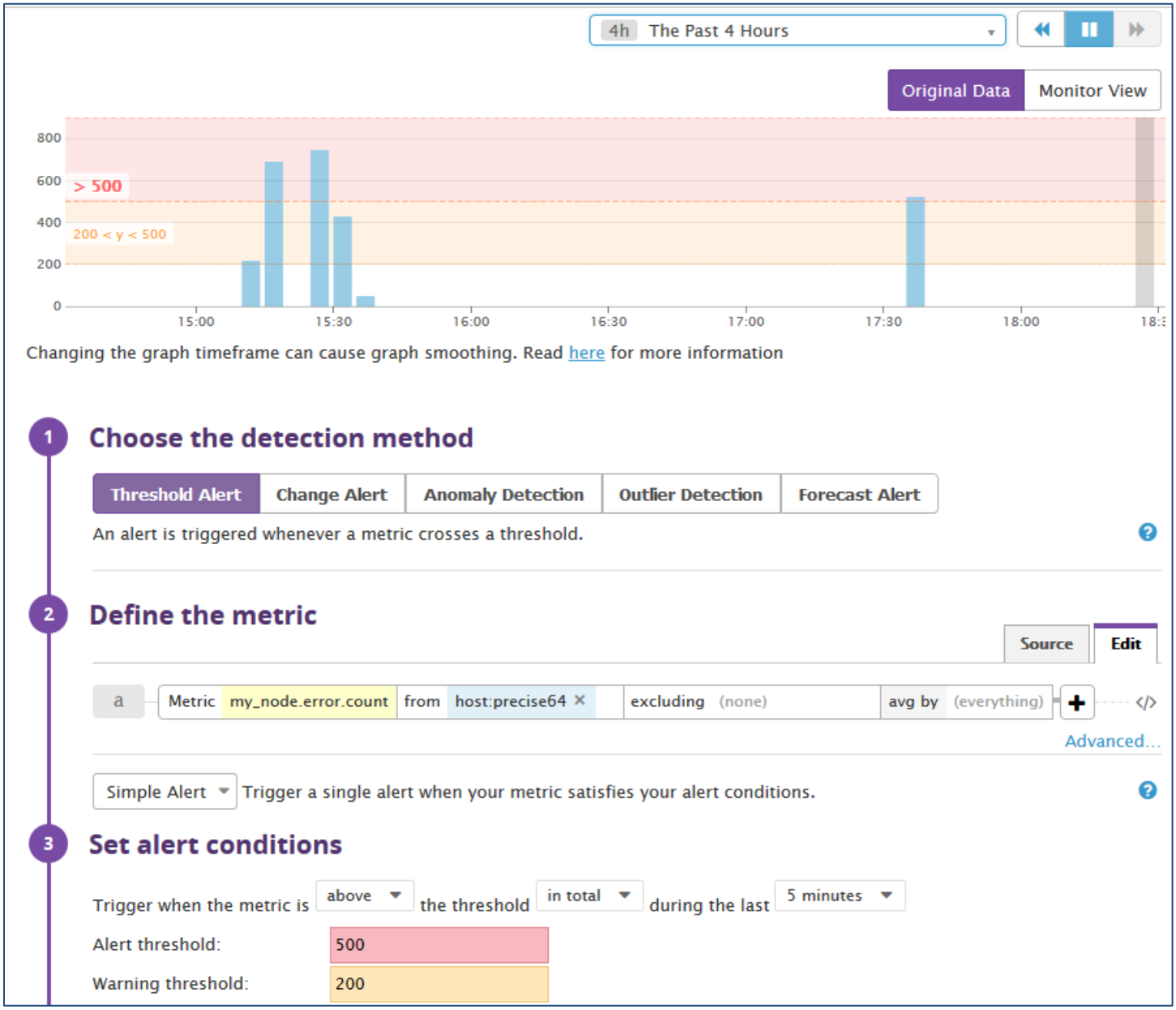
Looking at related metrics, such as requests rate, system load etc., in the time before the errors start occurring, would give some insight into pre-error behavior near the saturation point.

Creating Monitor Warnings, which look into such related metrics, would allow alerting about potential server overload and allow taking preventing measures to avoid errors, such as increasing server resources or improving load balancing.

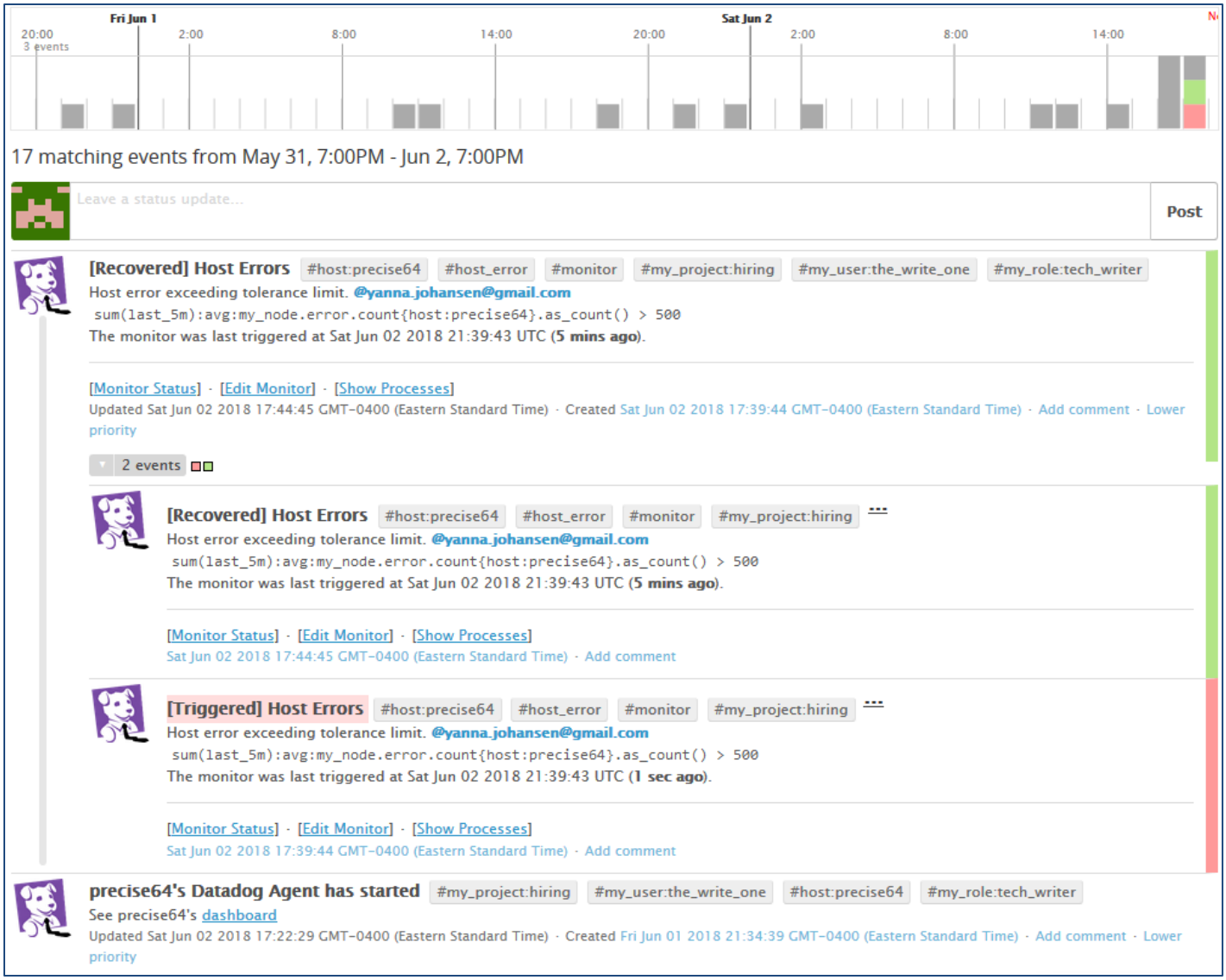
Error Events created by Datadog Monitor

It is a good idea to receive a notification that error rate exceeds a certain threshold, to indicate potential problems and allow responding to the situation.

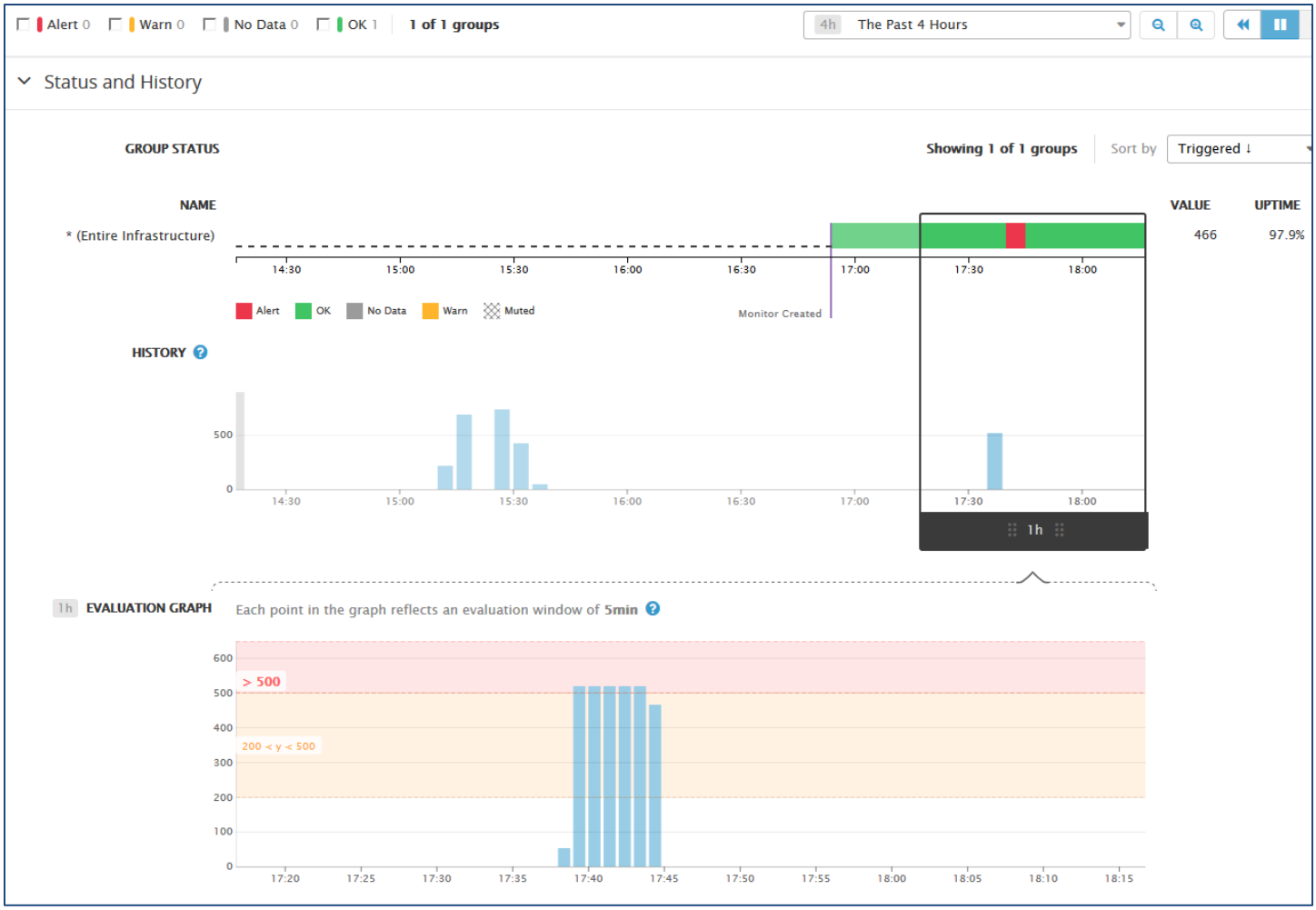
Datadog has an easy to use interface to create complex monitoring scenarios. Here we create a monitor for error events when the number of errors exceeds 500.



The resulting Error Events and the related automatic Error Resolution notification appear in the Datadog Events area.



In addition, error events can be investigated to observe related metrics in the vicinity of the event.



Acknowledgements

Using Datadog and DogStatsD wouldn't be as easy and productive without numerous community contributed integrations and libraries created for virtually any modern cloud computing infrastructure and programming language.

In particular the `hot-stats` module for Node.js was very helpful in seamless integration of Node.js into Datadog services. Big thanks to the contributors to the `hot-stats` and `node-statsd` projects!

References and Further Reading

Datadog Documentation

- Datadog getting started
- Guide to graphing in Datadog
- Guide to monitoring in Datadog
- Guide to the Agent
- Datadog API
- Datadog Help Center

Related Blog Posts and Articles

- Collecting Metrics Using StatsD, a Standard for Real-Time Monitoring, Technology / Tutorials at The New Stack
- Measure Anything, Measure Everything by Ian Malpass at Code as Craft
- How To Configure StatsD to Collect Arbitrary Stats for Graphite on Ubuntu 14.04 a Digital Ocean tutorial
- From Noob To Docker On DigitalOcean With Nginx, Node.js, DataDog Logs, DogStatsD, And LetsEncrypt SSL Certificatesby Ben Nadel