A Cloud Solution for Telemetry Data

Monday April 24th, 2017

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What is Telemetry?

- A collection of sensor reads over time
- Regular or Irregular Reads (eg., storm outages)
- Key-Value pairs: { “point”: 180, “epoch”: 1234567, “value”: 14.6}
- Examples: Temperature, Wind Direction, Alerts, GPS Coordinates

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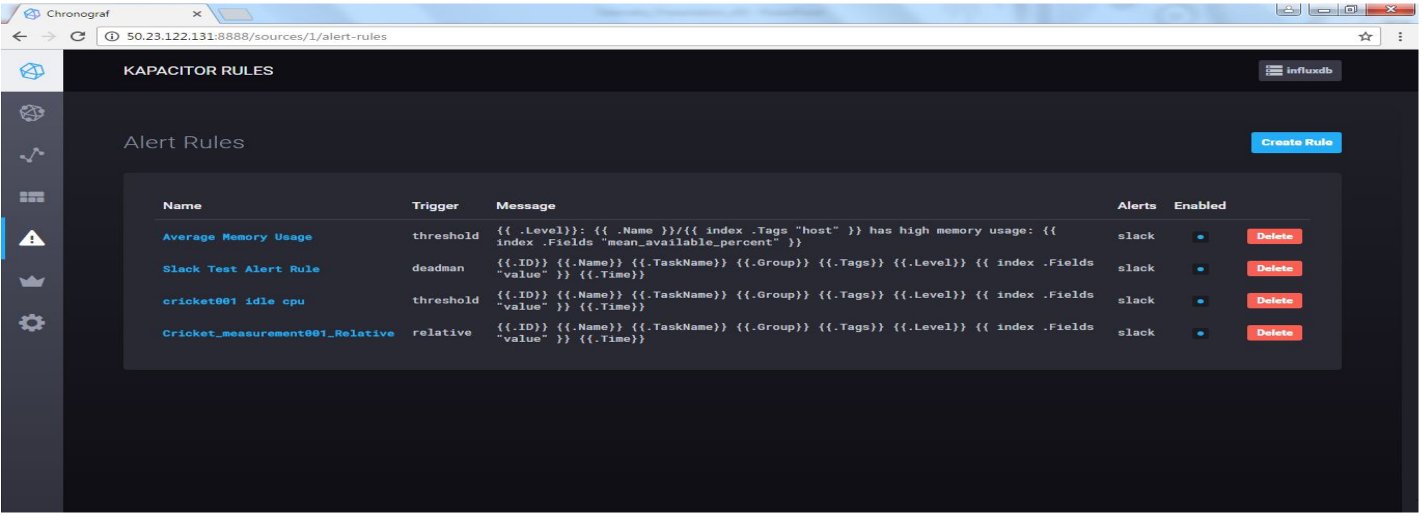
How is Telemetry used?

- Monitor and Control
- SCADA or Supervisory Control and Data Acquisition
- Alerts, Troubleshooting, Emergency Response
- Operational efficiency: KPI, Decision Support
- Predictive maintenance

KAPACITOR & SLACK

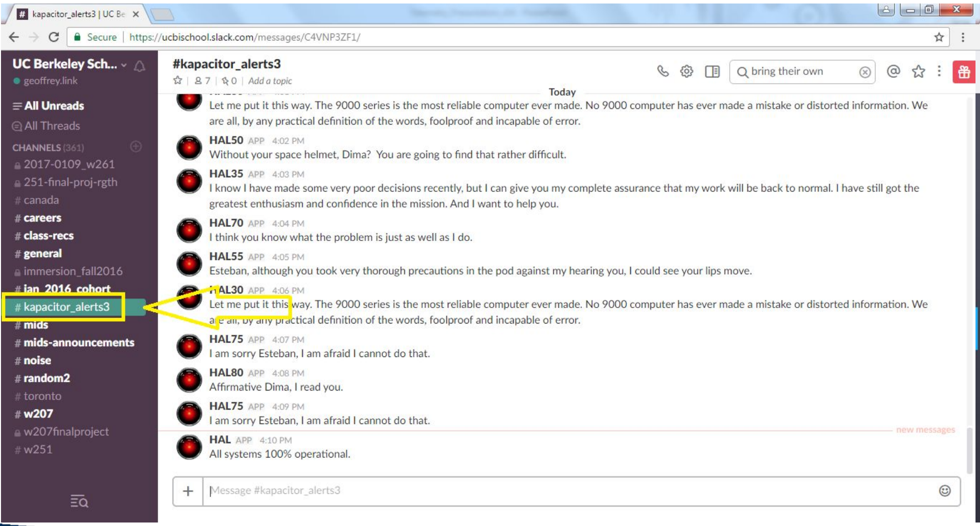
[Kapacitor Alerting Rules]



KAPACITOR RULES

Alert Rules

Name	Trigger	Message	Alerts	Enabled
Average Memory Usage	threshold	{{ .Level}}: {{ .Name }}/{{ index .Tags "host" }} has high memory usage: {{ index .Fields "mean_available_percent" }}	slack	●
Slack Test Alert Rule	deadman	{{.ID}} {{.Name}} {{.TaskName}} {{.Group}} {{.Tags}} {{.Level}} {{ index .Fields "value" }} {{.Time}}	slack	●
cricket001 idle cpu	threshold	{{.ID}} {{.Name}} {{.TaskName}} {{.Group}} {{.Tags}} {{.Level}} {{ index .Fields "value" }} {{.Time}}	slack	●
Cricket_measurement001_Relative	relative	{{.ID}} {{.Name}} {{.TaskName}} {{.Group}} {{.Tags}} {{.Level}} {{ index .Fields "value" }} {{.Time}}	slack	●



#kapacitor_alerts3

Today

Let me put it this way. The 9000 series is the most reliable computer ever made. No 9000 computer has ever made a mistake or distorted information. We are all, by any practical definition of the words, foolproof and incapable of error.

HAL50 APP 4:02 PM
Without your space helmet, Dima? You are going to find that rather difficult.

HAL35 APP 4:03 PM
I know I have made some very poor decisions recently, but I can give you my complete assurance that my work will be back to normal. I have still got the greatest enthusiasm and confidence in the mission. And I want to help you.

HAL70 APP 4:04 PM
I think you know what the problem is just as well as I do.

HAL55 APP 4:05 PM
Esteban, although you took very thorough precautions in the pod against my hearing you, I could see your lips move.

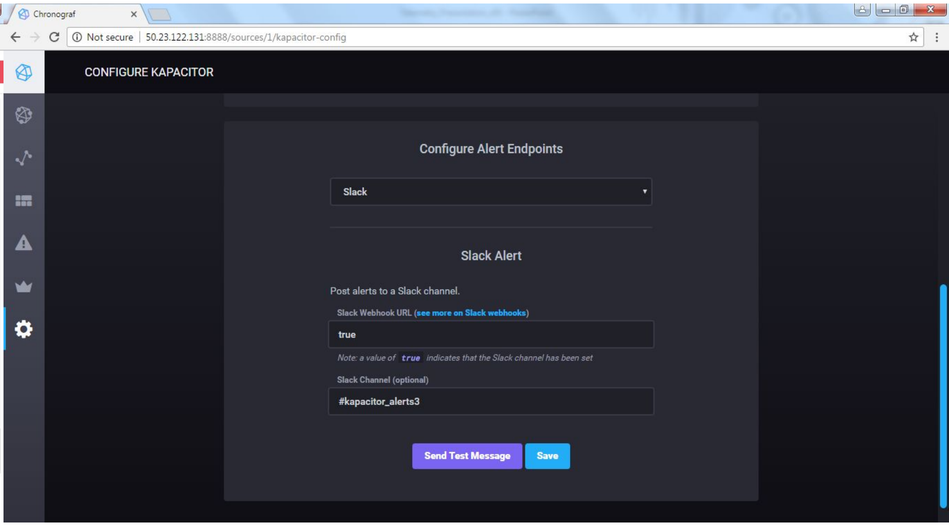
HAL30 APP 4:06 PM
Let me put it this way. The 9000 series is the most reliable computer ever made. No 9000 computer has ever made a mistake or distorted information. We are all, by any practical definition of the words, foolproof and incapable of error.

HAL75 APP 4:07 PM
I am sorry Esteban, I am afraid I cannot do that.

HAL80 APP 4:08 PM
Affirmative Dima, I read you.

HAL75 APP 4:09 PM
I am sorry Esteban, I am afraid I cannot do that.

HAL APP 4:10 PM
All systems 100% operational.



CONFIGURE KAPACITOR

Configure Alert Endpoints

Slack

Slack Alert

Post alerts to a Slack channel.

Slack Webhook URL (see more on Slack webhooks): true

Note: a value of true indicates that the Slack channel has been set

Slack Channel (optional): #kapacitor_alerts3

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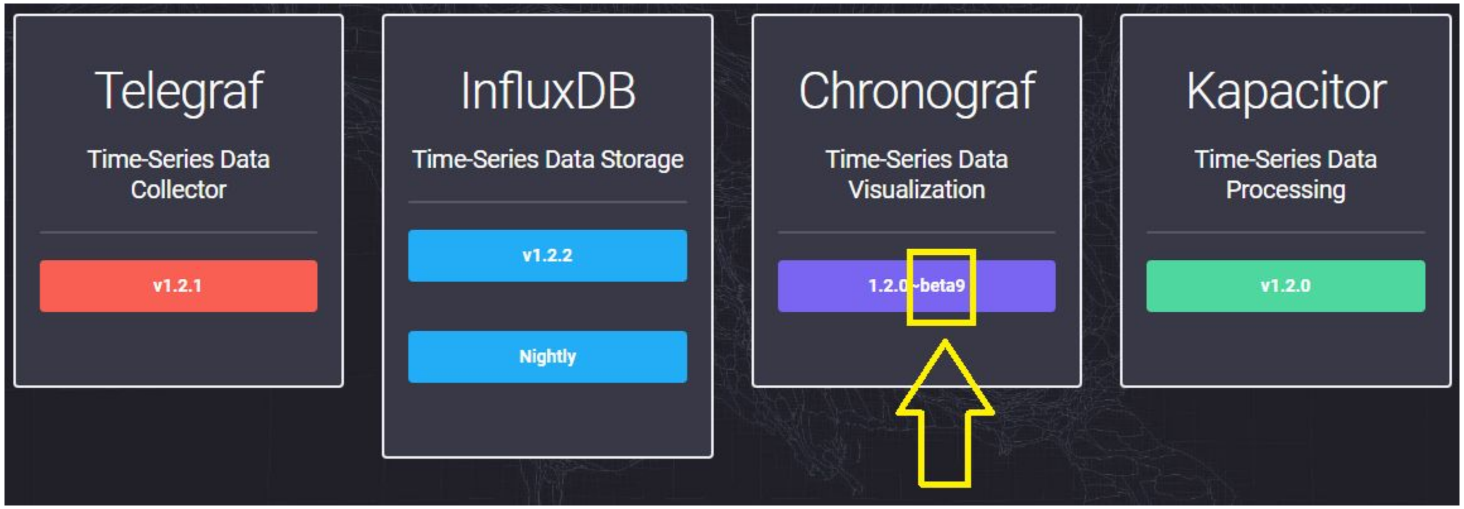
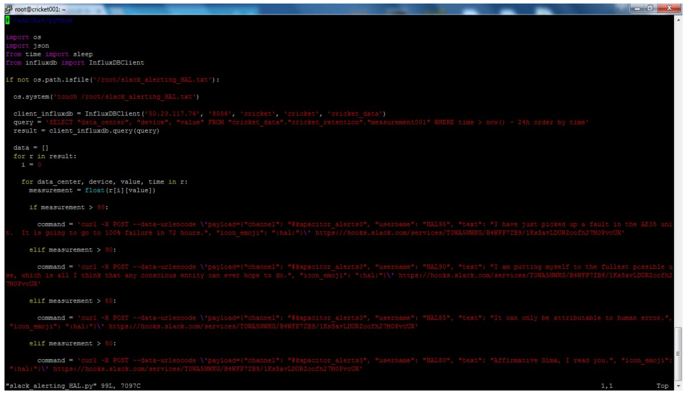
KAPACITOR & SLACK (OpenSource Lessons Learned)



Hence, build your own SLACK alerting:

[kapacitor_alerts3 Slack Channel](#)



```
#!/usr/bin/python

import os
import json
from time import sleep
from influxdb import InfluxDBClient

if not os.path.isfile('/root/slack_alerting_HAL.txt'):

  os.system('touch /root/slack_alerting_HAL.txt')

  client_influxdb = InfluxDBClient('50.23.117.76', '8086', 'cricket', 'cricket', 'cricket_data')
  query = 'SELECT "data_center", "device", "value" FROM "cricket_data"."cricket_retention"."measurement001" WHERE time > now() - 24h order by time'
  result = client_influxdb.query(query)

  data = []
  for r in result:
    i = 0

    for data_center, device, value, time in r:
      measurement = float(r[i][value])

      if measurement > 95:

        command = 'curl -X POST --data-urlencode \'payload={"channel": "#kapacitor_alerts3", "username": "HAL95", "text": "I have just picked up a fault in the AE35 uni
t.  It is going to go to 100% failure in 72 hours.", "icon_emoji": ":hal:"}\' https://hooks.slack.com/services/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'

      elif measurement > 90:

        command = 'curl -X POST --data-urlencode \'payload={"channel": "#kapacitor_alerts3", "username": "HAL90", "text": "I am putting myself to the fullest possible u
se, which is all I think that any conscious entity can ever hope to do.", "icon_emoji": ":hal:"}\' https://hooks.slack.com/services/T0WA5NWKG/B4WFP7ZB9/1KsSavLDURZoofh2
7M0PvcUX'

      elif measurement > 85:

        command = 'curl -X POST --data-urlencode \'payload={"channel": "#kapacitor_alerts3", "username": "HAL85", "text": "It can only be attributable to human error.",
 "icon_emoji": ":hal:"}\' https://hooks.slack.com/services/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'

      elif measurement > 80:

        command = 'curl -X POST --data-urlencode \'payload={"channel": "#kapacitor_alerts3", "username": "HAL80", "text": "Affirmative Dima, I read you.", "icon_emoji":
 ":hal:"}\' https://hooks.slack.com/services/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'

"slack_alerting_HAL.py" 99L, 7097C                                          1,1           Top
```

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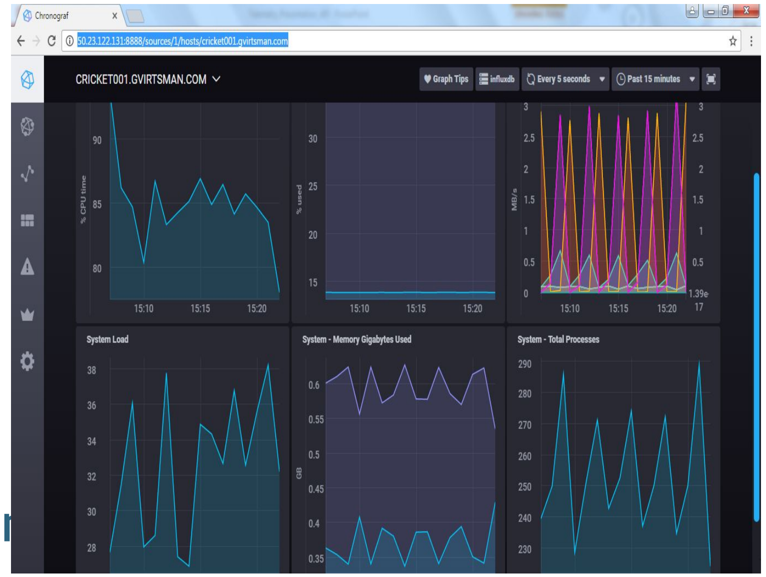
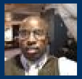
Target Audience & Usage

[Chronograf Host List]

[Cricket001]

- Remote Operators
  - Respond to alerts
  - Troubleshoot and recover from equipment failures
- Operations Manager
  - Monitor operator efficiency
  - Quantify lost opportunity
  - Preventative maintenance
  - Handle escalated operational issues
- Market scheduler
  - Profitability
  - Respond to grid operator's instructio





Project Objectives

- Create a reporting framework that has the ability to ingest billions of reads from tens of thousands of devices (noisy crickets)
- Easily scalable
- Fully Hosted in the Cloud (Zero Cap-Ex Platform)
- Use only open-source tools
- Each device (or cricket) will emit a basic output that can be transmitted over Radio Frequency or Wi-Fi or Cellular

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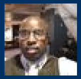

Data processing requirements

• Data Generation	(Python Crickets and Softlayer)
• Data Summarization	(Grafana)
• Graphing and Reporting	(Chronograf and D3.js)
• Retention policy	(InfluxDB, 365 Days)
• Resilient and Scalable	(InfluxDB, n-nodes)
• Event Subscription	(Slack instead of email)
• Alerts and Notifications	(Telegraf and Kapacitor)
• Predictive Maintenance	(K-Means and Neural Networks)

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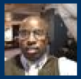
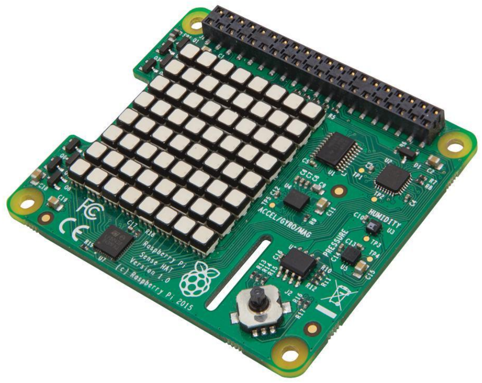


What is a cricket? Edge Computing!

- A Cricket is a device that can transmit data over Radio Frequency or Wi-Fi or Cellular
- A common example is the highly versatile Raspberry Pi ($30).
- Raspberry Pi Sense HAT with Orientation, Pressure, Humidity, and Temperature Sensors ($30).
- In a peer-to-peer network, adding more "load" – or participants in the network – does not require any additional resources as each participant brings their own resources.



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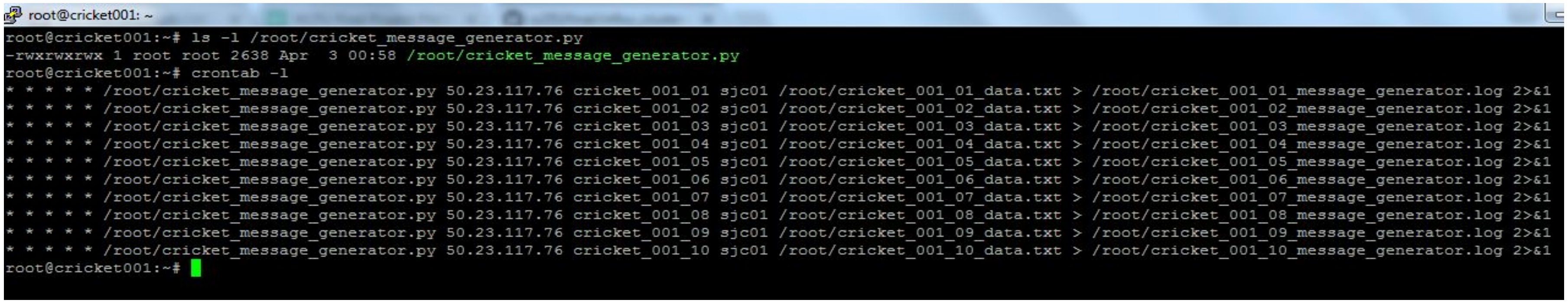
Did we buy 10,000 Raspberry Pi? No.

- We used Softlayer Cloud to simulate crickets across the globe.

Amsterdam 01	ams01	Dallas 13	dal13	San Jose 01	sjc01
Amsterdam 03	ams03	Frankfurt	fra02	San Jose 03	sjc03
Chennai	che01	Hong Kong	hkg02	Sao Paulo	sao01
Dallas 01	dal01	Houston	hou02	Seattle	sea01
Dallas 02	dal02	London	lon02	Seoul 01	seo01
Dallas 05	dal05	Melbourne	mel01	Singapore	sng01
Dallas 06	dal06	Milan	mil01	Sydney	syd01
Dallas 07	dal07	Montreal	mon01	Tokyo	tok02
Dallas 09	dal09	Oslo	osl01	Toronto	tor01
Dallas 10	dal10	Paris	par01	Washington, D.C. 01	wdc01
Dallas 12	dal12	Querétaro	mex01	Washington, D.C. 04	wdc04


root@cricket001: ~

```
root@cricket001:~# ls -l /root/cricket_message_generator.py
-rwxrwxrwx 1 root root 2638 Apr  3 00:58 /root/cricket_message_generator.py
root@cricket001:~# crontab -l
* * * * * /root/cricket_message_generator.py 50.23.117.76 cricket_001_01 sjc01 /root/cricket_001_01_data.txt > /root/cricket_001_01_message_generator.log 2>&1
* * * * * /root/cricket_message_generator.py 50.23.117.76 cricket_001_02 sjc01 /root/cricket_001_02_data.txt > /root/cricket_001_02_message_generator.log 2>&1
* * * * * /root/cricket_message_generator.py 50.23.117.76 cricket_001_03 sjc01 /root/cricket_001_03_data.txt > /root/cricket_001_03_message_generator.log 2>&1
* * * * * /root/cricket_message_generator.py 50.23.117.76 cricket_001_04 sjc01 /root/cricket_001_04_data.txt > /root/cricket_001_04_message_generator.log 2>&1
* * * * * /root/cricket_message_generator.py 50.23.117.76 cricket_001_05 sjc01 /root/cricket_001_05_data.txt > /root/cricket_001_05_message_generator.log 2>&1
* * * * * /root/cricket_message_generator.py 50.23.117.76 cricket_001_06 sjc01 /root/cricket_001_06_data.txt > /root/cricket_001_06_message_generator.log 2>&1
* * * * * /root/cricket_message_generator.py 50.23.117.76 cricket_001_07 sjc01 /root/cricket_001_07_data.txt > /root/cricket_001_07_message_generator.log 2>&1
* * * * * /root/cricket_message_generator.py 50.23.117.76 cricket_001_08 sjc01 /root/cricket_001_08_data.txt > /root/cricket_001_08_message_generator.log 2>&1
* * * * * /root/cricket_message_generator.py 50.23.117.76 cricket_001_09 sjc01 /root/cricket_001_09_data.txt > /root/cricket_001_09_message_generator.log 2>&1
* * * * * /root/cricket_message_generator.py 50.23.117.76 cricket_001_10 sjc01 /root/cricket_001_10_data.txt > /root/cricket_001_10_message_generator.log 2>&1
root@cricket001:~#
```

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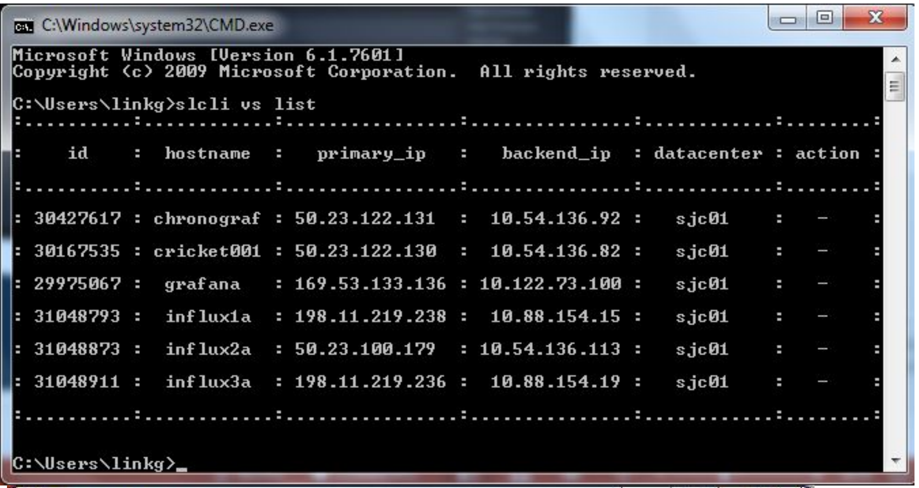
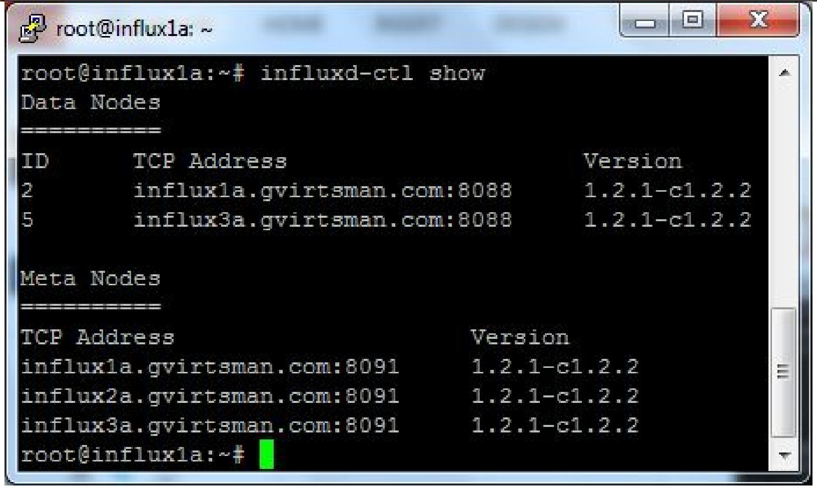
Architecture Overview



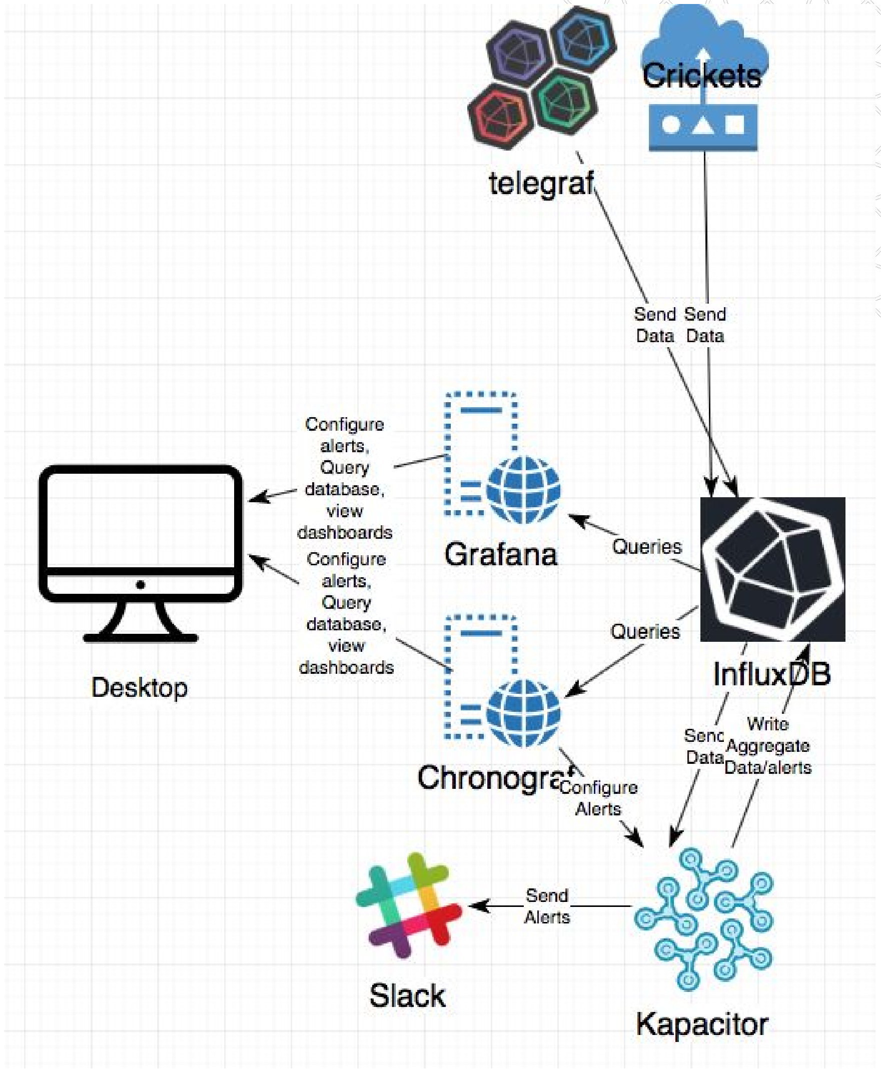
C:\Windows\system32\CMD.exe

```
Microsoft Windows [Version 6.1.7601]
Copyright (c) 2009 Microsoft Corporation.  All rights reserved.

C:\Users\linkg>slcli vs list
:..........:...........:...............:..............:............:........:
:    id    : hostname  :   primary_ip   :  backend_ip  : datacenter : action :
:..........:...........:...............:..............:............:........:
: 30427617 : chronograf : 50.23.122.131  :  10.54.136.92 :   sjc01    :   -    :
: 30167535 : cricket001 : 50.23.122.130  :  10.54.136.82 :   sjc01    :   -    :
: 29975067 :  grafana   : 169.53.133.136 : 10.122.73.100 :   sjc01    :   -    :
: 31048793 :  influx1a  : 198.11.219.238 :  10.88.154.15 :   sjc01    :   -    :
: 31048873 :  influx2a  : 50.23.100.179  : 10.54.136.113 :   sjc01    :   -    :
: 31048911 :  influx3a  : 198.11.219.236 :  10.88.154.19 :   sjc01    :   -    :
:..........:...........:...............:..............:............:........:

C:\Users\linkg>_
```

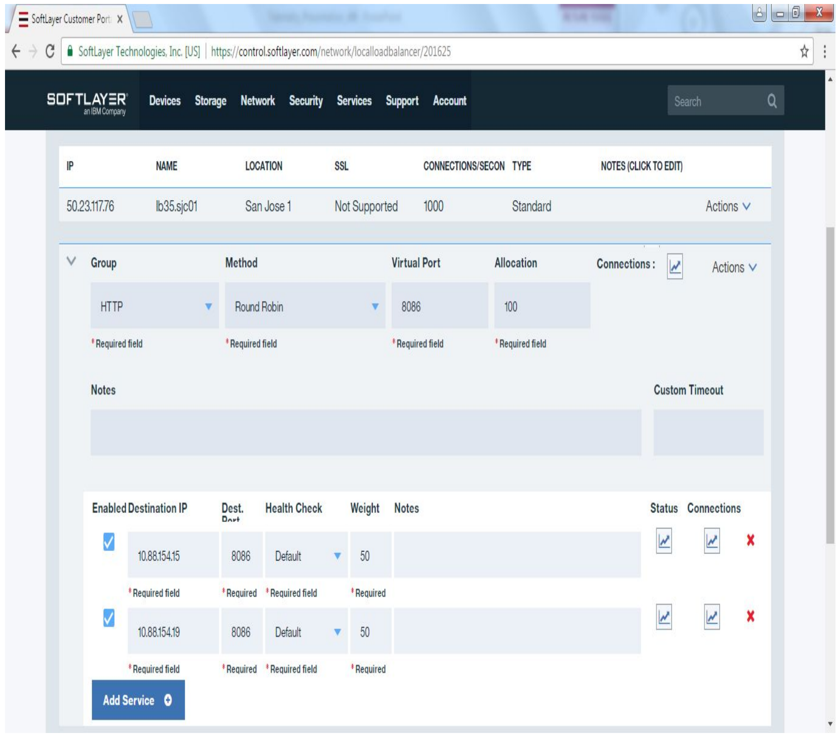


root@influx1a: ~

```
root@influx1a:~# influxd-ctl show
Data Nodes
==========
ID      TCP Address                     Version
2       influx1a.gvirtsman.com:8088     1.2.1-c1.2.2
5       influx3a.gvirtsman.com:8088     1.2.1-c1.2.2

Meta Nodes
==========
TCP Address                     Version
influx1a.gvirtsman.com:8091     1.2.1-c1.2.2
influx2a.gvirtsman.com:8091     1.2.1-c1.2.2
influx3a.gvirtsman.com:8091     1.2.1-c1.2.2
root@influx1a:~#
```



Technology Stack



SoftLayer Customer Port

SoftLayer Technologies, Inc. [US] | https://control.softlayer.com/network/localloadbalancer/201625

SOFTLAYER an IBM Company | Devices | Storage | Network | Security | Services | Support | Account | Search

IP	NAME	LOCATION	SSL	CONNECTIONS/SECON	TYPE	NOTES (CLICK TO EDIT)
50.23.117.76	lb35.sjc01	San Jose 1	Not Supported	1000	Standard	Actions

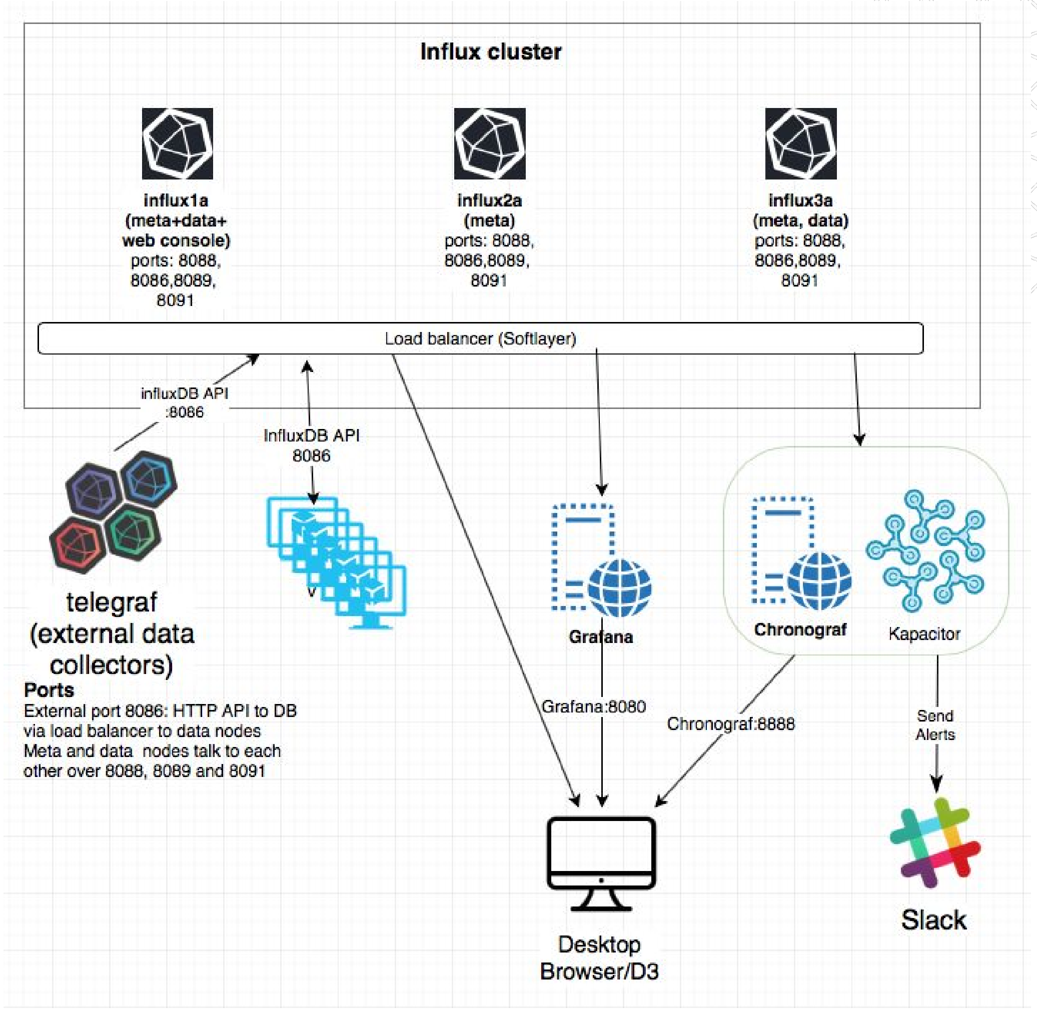
Group	Method	Virtual Port	Allocation	Connections :
HTTP	Round Robin	8086	100	
*Required field	*Required field	*Required field	*Required field	

Notes

Custom Timeout

Enabled	Destination IP	Dest. Port	Health Check	Weight	Notes	Status	Connections
✓	10.88.154.15	8086	Default	50			
	*Required field	*Required	*Required field	*Required			
✓	10.88.154.19	8086	Default	50			
	*Required field	*Required	*Required field	*Required			

Add Service


Influx cluster
influx1a (meta+data+ web console) ports: 8088, 8086,8089, 8091
influx2a (meta) ports: 8088, 8086,8089, 8091
influx3a (meta, data) ports: 8088, 8086,8089, 8091
Load balancer (Softlayer)
influxDB API :8086
InfluxDB API 8086
telegraf (external data collectors)
Grafana
Chronograf
Kapacitor
Grafana:8080
Chronograf:8888
Send Alerts
Slack
Desktop Browser/D3

Ports
External port 8086: HTTP API to DB via load balancer to data nodes
Meta and data nodes talk to each other over 8088, 8089 and 8091

A Load Balancer is a great way to control data flow to InfluxDB as long as the crickets can store data and recover independently

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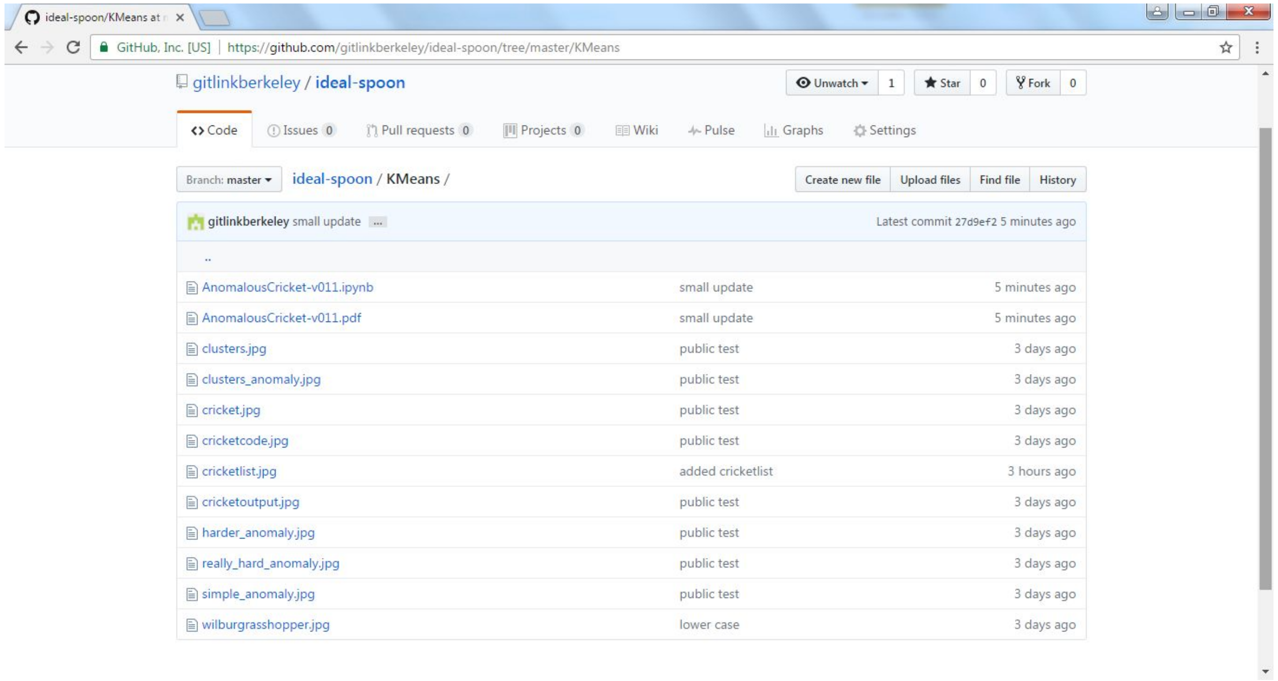
Predictive Maintenance using K-Means


ideal-spoon/KMeans at

GitHub, Inc. [US] | https://github.com/gitlinkberkeley/ideal-spoon/tree/master/KMeans

gitlinkberkeley / ideal-spoon

Unwatch 1 | Star 0 | Fork 0

Code | Issues 0 | Pull requests 0 | Projects 0 | Wiki | Pulse | Graphs | Settings

Branch: master | ideal-spoon / KMeans / | Create new file | Upload files | Find file | History

gitlinkberkeley small update ... Latest commit 27d9ef2 5 minutes ago

..

AnomalousCricket-v011.ipynb	small update	5 minutes ago
AnomalousCricket-v011.pdf	small update	5 minutes ago
clusters.jpg	public test	3 days ago
clusters_anomaly.jpg	public test	3 days ago
cricket.jpg	public test	3 days ago
cricketcode.jpg	public test	3 days ago
cricketlist.jpg	added cricketlist	3 hours ago
cricketoutput.jpg	public test	3 days ago
harder_anomaly.jpg	public test	3 days ago
really_hard_anomaly.jpg	public test	3 days ago
simple_anomaly.jpg	public test	3 days ago
wilburgrasshopper.jpg	lower case	3 days ago

NBViewer

If we had more time…

- Realistic Data Construction (not randomized)
- Spark Streaming K-Means in concert with live Projected Waveforms (D3)
- Intelligent Crickets: Ex-ante Alerts followed by Self-Repair at the Edge
- Analyze Clusters of Devices and their combined Waveforms
- Bake-off Old School K-Means vs. New School Neural Networks

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InfluxDB: time series database

TICK Stack

InfluxDB

- Open source
- TICK stack (Telegraf, Influxdb, Chronograf, Kapacitor)
- Horizontally scalable (paid for product).
- 3 Meta nodes, 2+ data nodes.
- ~250,000 inserts/sec, ~25 queries/sec on a single node.
- Retention policy + # replicated copies.
- Quorum: Write: one copy, Read: choice per sessions. (biased towards heavy writes, light reads, AP)
- SQL like syntax
- Column store, compression, LSM tree (two component – memory + disk, defer index updates)

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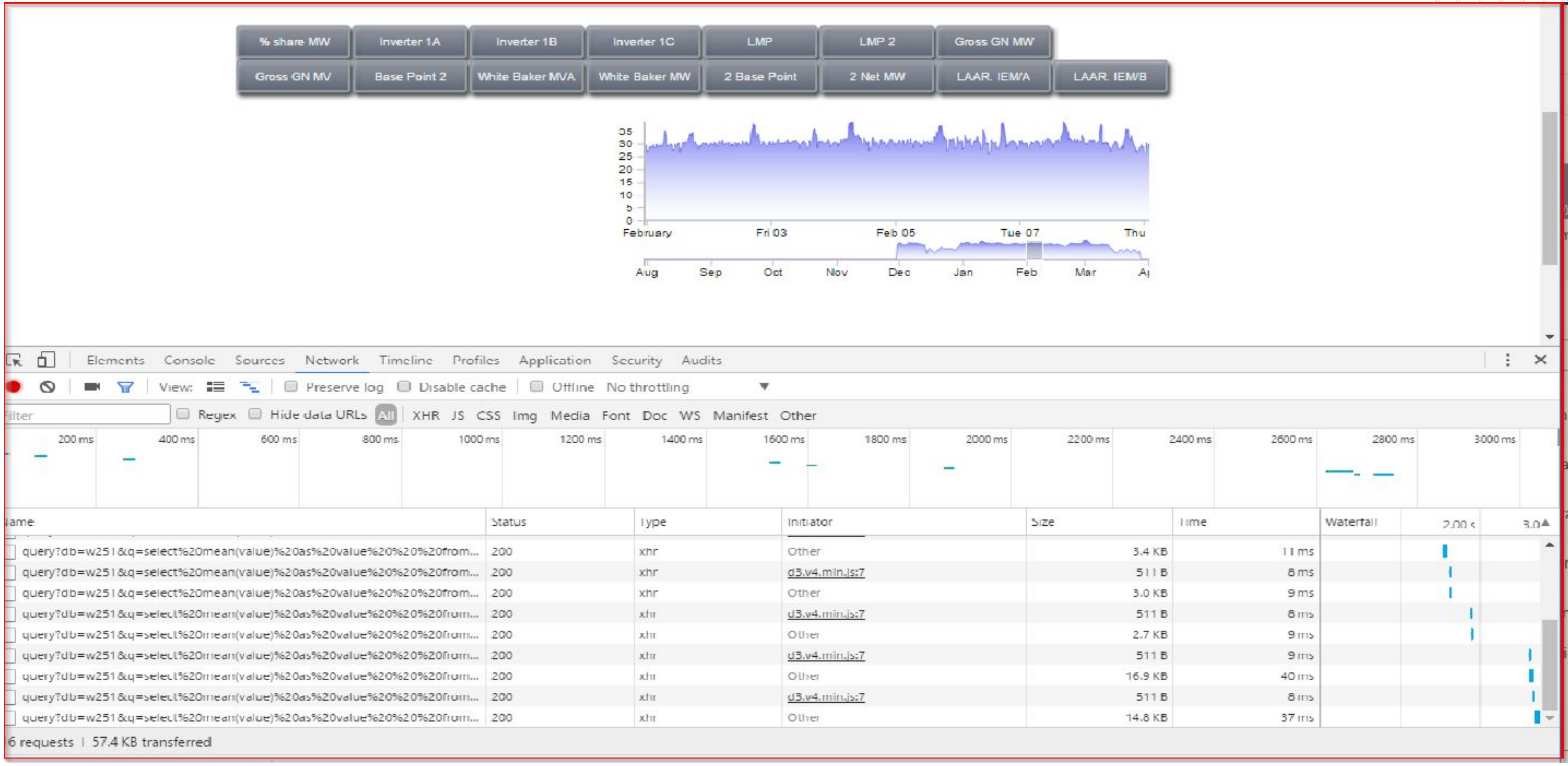
InfluxDB Query Performance

D3.js



ame	Status	Type	Initiator	Size	Time	Waterfall
query?db=w251&q=select%20mean(value)%20as%20value%20%20from...	200	xhr	Other	3.4 KB	11 ms	
query?db=w251&q=select%20mean(value)%20as%20value%20%20from...	200	xhr	d3.v4.min.js:7	511 B	8 ms	
query?db=w251&q=select%20mean(value)%20as%20value%20%20from...	200	xhr	Other	3.0 KB	9 ms	
query?db=w251&q=select%20mean(value)%20as%20value%20%20from...	200	xhr	d3.v4.min.js:7	511 B	8 ms	
query?db=w251&q=select%20mean(value)%20as%20value%20%20from...	200	xhr	Other	2.7 KB	9 ms	
query?db=w251&q=select%20mean(value)%20as%20value%20%20from...	200	xhr	d3.v4.min.js:7	511 B	9 ms	
query?db=w251&q=select%20mean(value)%20as%20value%20%20from...	200	xhr	Other	16.9 KB	40 ms	
query?db=w251&q=select%20mean(value)%20as%20value%20%20from...	200	xhr	d3.v4.min.js:7	511 B	8 ms	
query?db=w251&q=select%20mean(value)%20as%20value%20%20from...	200	xhr	Other	14.8 KB	37 ms	

6 requests | 57.4 KB transferred

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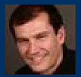
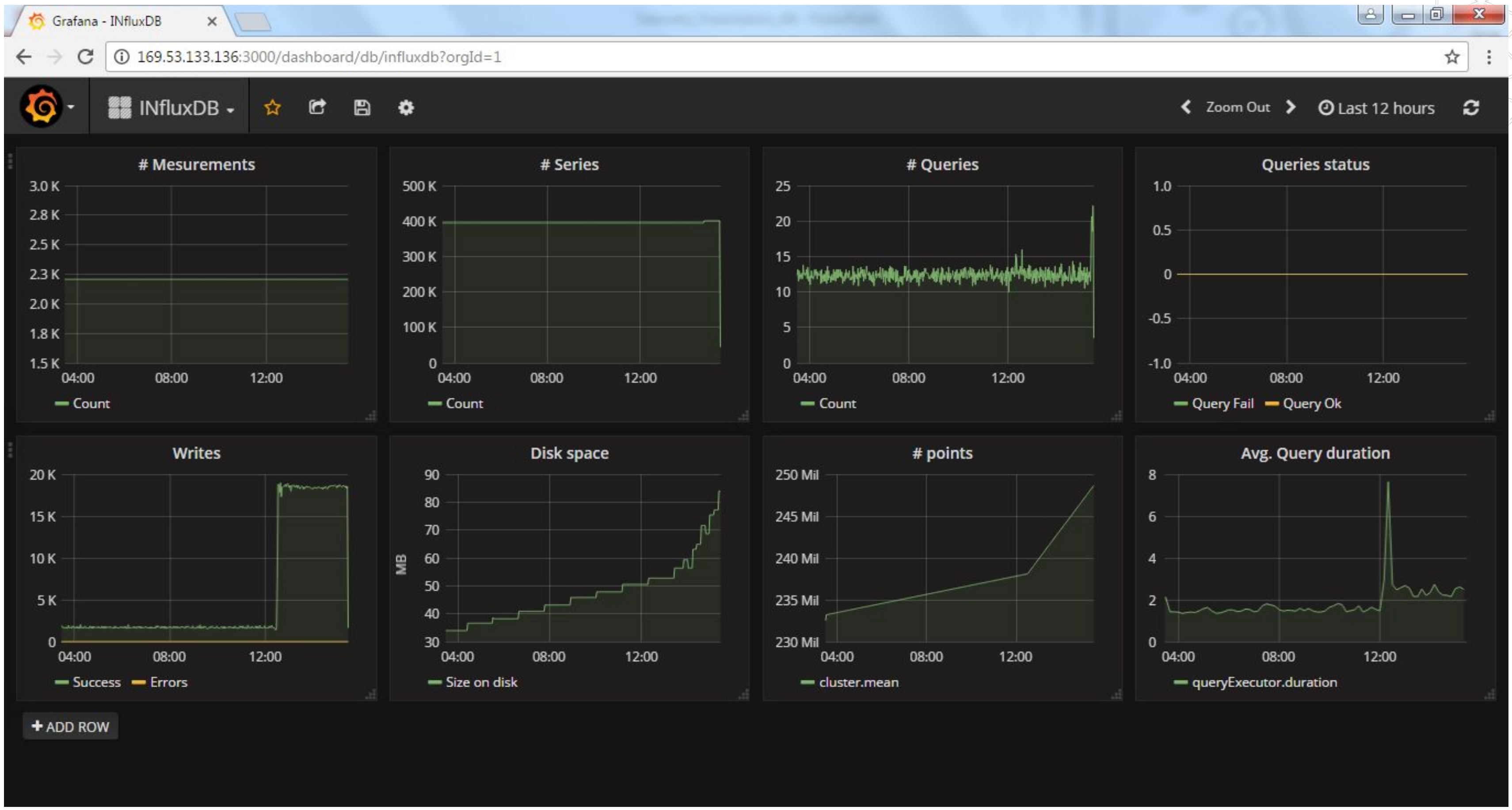


Grafana Dashboard

[Grafana Dashboard]



Questions?

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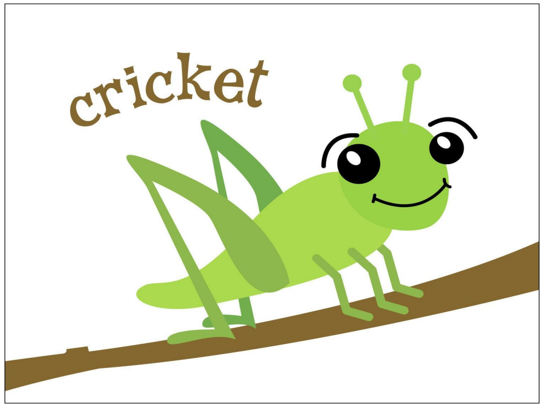
Roy Gvirtsman

Geoffrey Link

Zhongqiao Jin

Happiness Munedzimwe

[Github Repository]



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