IoT Data Analytics: Arsitektur dan Implementasi

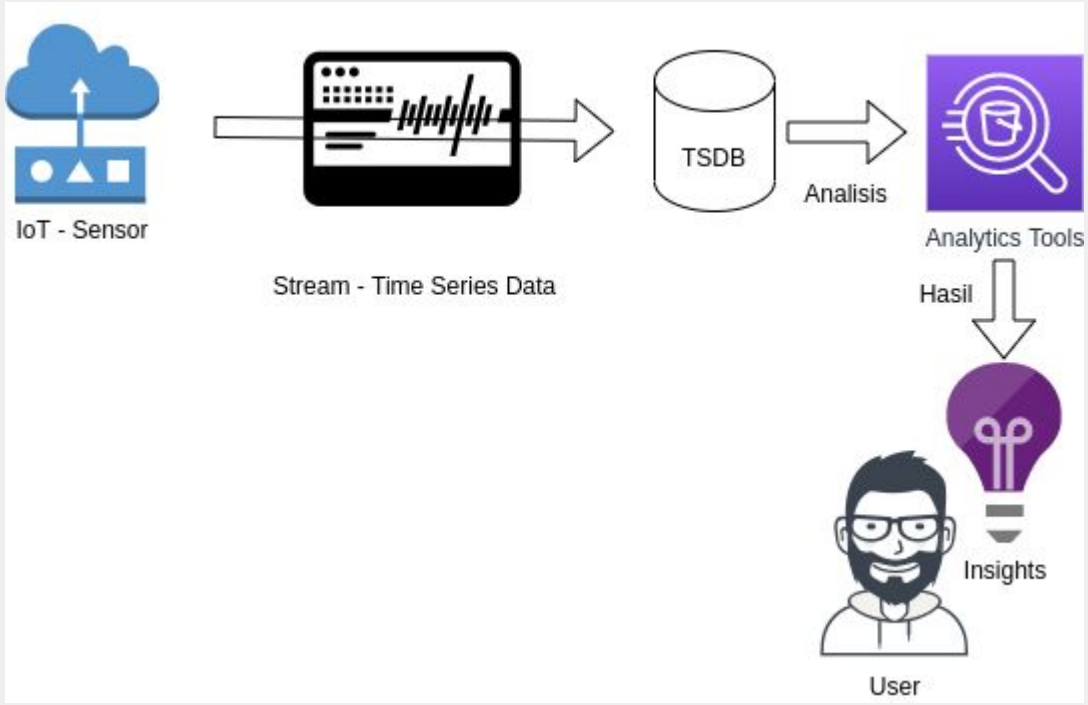
Dr. Bambang Purnomosidi D. P.
MTI - STMIK Akakom
Zimera Systems

Agenda

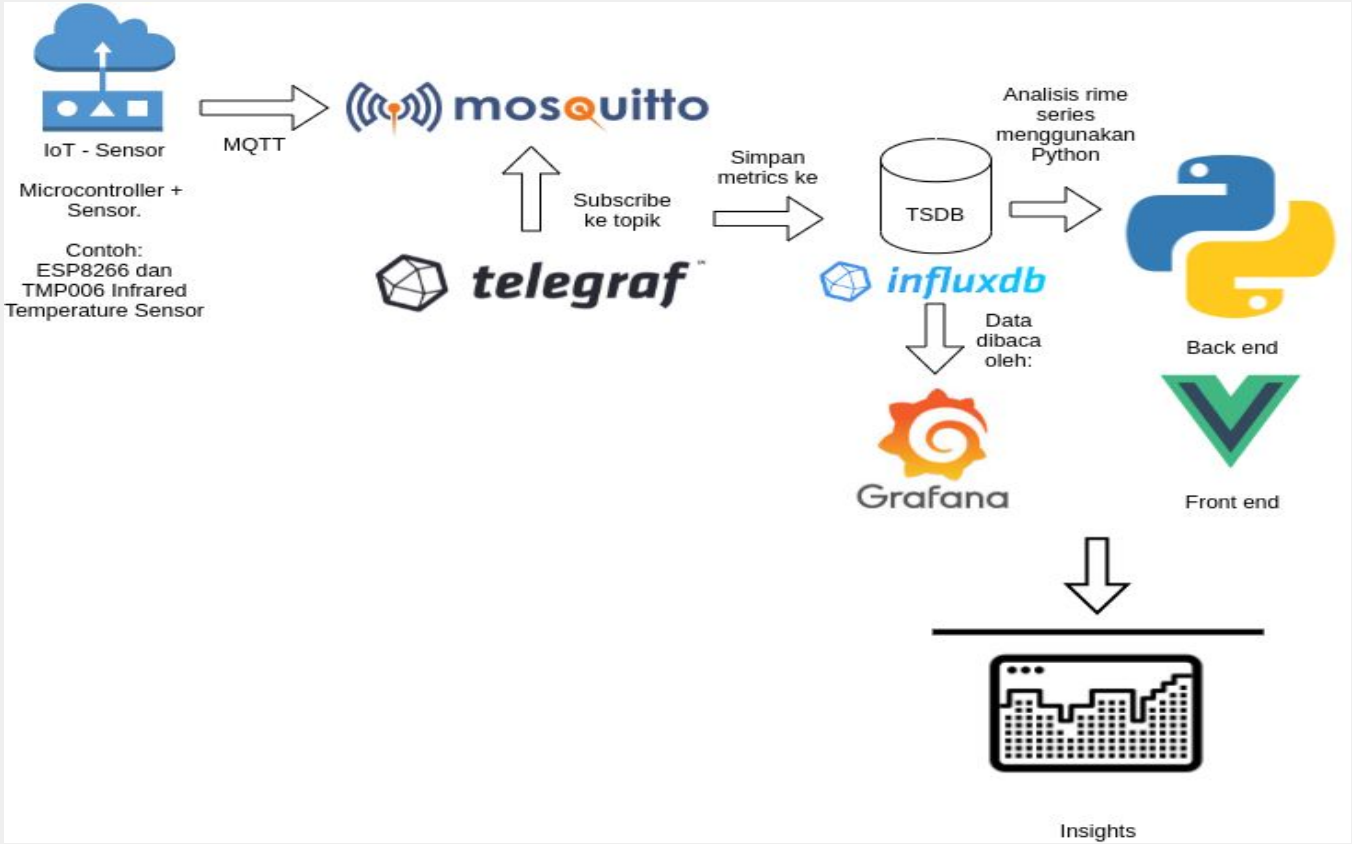
1. Pengertian IoT *Data Analytics*
2. Arsitektur IoT *Data Analytics*
3. *Use Cases* dari *IoT Data Analytics*
4. Data pada IoT dan *Time Series* Data
5. DBMS untuk *Time Series* Data di IoT
6. Demo

Pengertian IoT *Data Analytics*

Analisis dari data yang sangat besar yang berasal dari peranti terhubung (*connected devices*) - IoT (*Internet of Things*).



Arsitektur IoT *Data Analytics*



Use Cases dari IoT *Data Analytics*

- *Smart Metering - Smart Grids*: mengurangi konsumsi energi
- Olahraga: analisis video pergerakan pemain
- Kesehatan: deteksi pergerakan pada warga senior
- *Smart Parking*: sensor mendeteksi ketersediaan tempat parkir
- *Smart Building Monitoring*
- Sensor untuk pertanian: mendeteksi kondisi cuaca

Data pada IoT dan *Time Series Data*

- Sensor IoT akan mengeluarkan data dan data tersebut akan terurut secara kronologis.
- Data dengan jenis seperti itu disebut dengan *time series data*.
- Data tersebut kemudian direpresentasikan dengan cara yang berbeda-beda pada DBMS.
- InfluxDB menggunakan *line protocol* untuk pola format data:

<measurement>[,<tag_key>=<tag_value>[,<tag_key>=<tag_value>]]
<field_key>=<field_value>[,<field_key>=<field_value>] [<timestamp>]

myMeasurement,tag1=value1,tag2=value2 fieldKey="fieldValue"
1556813561098000000

DBMS untuk *Time Series* Data

☐ include secondary database models — 38 systems in ranking, October 2021

Rank Oct 2021	Rank Sep 2021	Rank Oct 2020	DBMS	Database Model	Score Oct 2021	Score Sep 2021	Score Oct 2020
1.	1.	1.	InfluxDB	Time Series, Multi-model	28.52	-0.98	+4.37
2.	2.	2.	Kdb+	Time Series, Multi-model	8.00	-0.13	+0.34
3.	3.	3.	Prometheus	Time Series	6.64	+0.21	+1.31
4.	4.	4.	Graphite	Time Series	5.50	+0.41	+1.14
5.	5.	↑ 6.	TimescaleDB	Time Series, Multi-model	3.96	+0.24	+1.05
6.	6.	↑ 7.	Apache Druid	Multi-model	3.44	+0.17	+1.06
7.	7.	↓ 5.	RRDtool	Time Series	2.28	-0.16	-0.91
8.	8.	8.	OpenTSDB	Time Series	1.86	0.00	-0.43
9.	9.	9.	Fauna	Multi-model	1.57	-0.16	-0.22
10.	10.	10.	GridDB	Time Series, Multi-model	1.30	-0.04	+0.46
11.	11.	↑ 12.	DolphinDB	Time Series	1.08	-0.01	+0.38
12.	12.	↑ 16.	Amazon Timestream	Time Series	0.88	+0.09	+0.45
13.	13.	↓ 11.	KairosDB	Time Series	0.75	-0.04	-0.02
14.	↑ 15.	↑ 21.	QuestDB	Time Series, Multi-model	0.71	+0.10	+0.45
15.	↓ 14.	↓ 13.	eXtremeDB	Multi-model	0.69	-0.03	+0.15
16.	16.	↑ 24.	VictoriaMetrics	Time Series	0.54	-0.05	+0.30
17.	17.	17.	IBM Db2 Event Store	Multi-model	0.48	+0.04	+0.08

18.	↑ 20.		TDengine	Time Series, Multi-model	0.36	+0.03	
19.	19.	↓ 15.	Alibaba Cloud TSDB	Time Series	0.33	-0.01	-0.12
20.	↓ 18.	↓ 19.	Axibase	Time Series	0.30	-0.06	-0.04
21.	↑ 22.	↑ 23.	M3DB	Time Series	0.24	0.00	-0.02
22.	↓ 21.	↓ 18.	Riak TS	Time Series	0.23	-0.03	-0.15
23.	23.	↓ 22.	Quasardb	Time Series	0.19	-0.04	-0.07
24.	24.		Apache IoTDB	Time Series	0.18	+0.01	
25.	↑ 26.	↑ 26.	Warp 10	Time Series	0.16	+0.02	-0.02
26.	↓ 25.	↓ 25.	Blueflood	Time Series	0.11	-0.05	-0.08
27.	27.	↑ 31.	Bangdb	Multi-model	0.09	-0.03	+0.07
28.			ArcadeDB	Multi-model	0.07		
29.	↓ 28.	↓ 14.	Heroic	Time Series	0.07	-0.02	-0.39
30.	↓ 29.	↓ 20.	Machbase	Time Series	0.05	-0.04	-0.25
31.	↓ 30.	↓ 27.	Hawkular Metrics	Time Series	0.04	-0.03	-0.06
32.	32.	↓ 30.	SiteWhere	Time Series	0.03	0.00	+0.02
33.	33.	↓ 32.	NSDb	Time Series	0.00	0.00	+0.00
34.	↑ 35.	↓ 32.	Hyprcubd	Time Series	0.00	±0.00	±0.00
34.	34.	↓ 28.	IRONdb	Time Series	0.00	0.00	-0.10
34.	↑ 35.	↓ 32.	Newts	Time Series	0.00	±0.00	±0.00
34.	↓ 31.	↓ 29.	SiriDB	Time Series	0.00	-0.04	-0.09
34.	↑ 35.	↓ 32.	Yanza	Time Series	0.00	±0.00	±0.00

Demo

Persiapan:

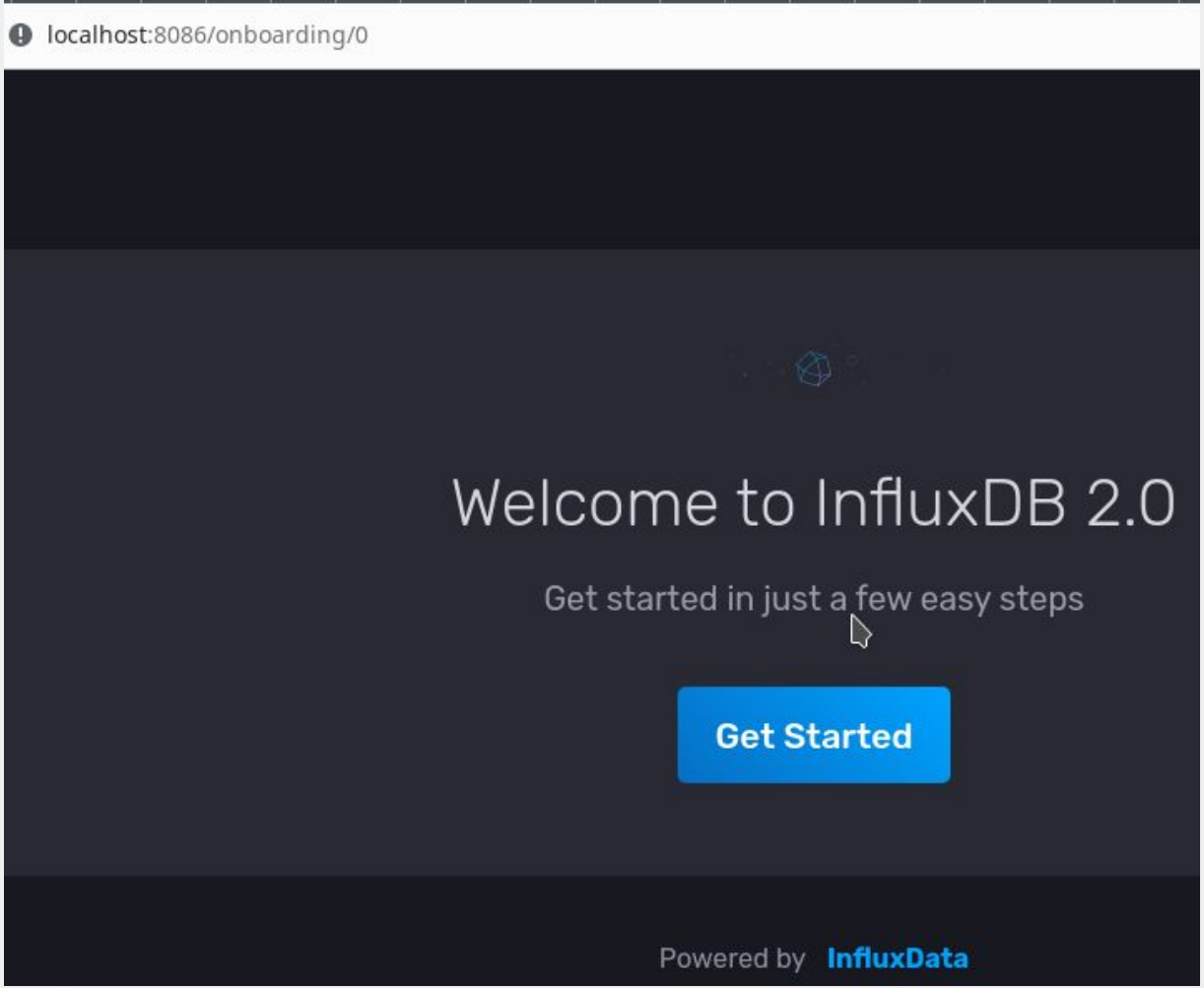
- NodeMCU + Sensor:
- MQTT Server: Eclipse Mosquitto (https://mosquitto.org/)
- InfluxDB dan Telegraf (https://portal.influxdata.com/downloads/)
- Grafana (https://grafana.com/)

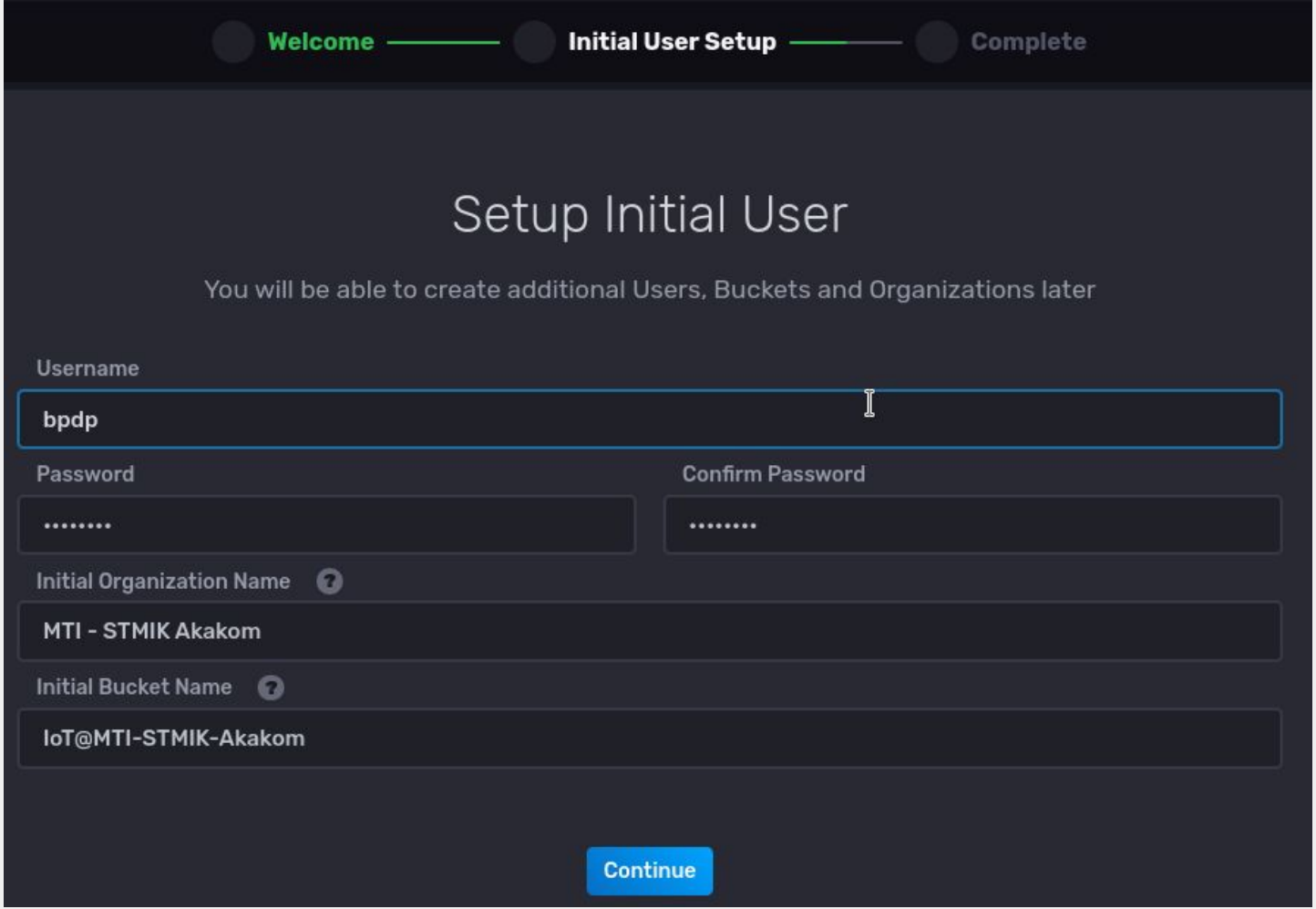
```
[0] bpdp@dellvuan ~/s/b/time-series → pwd
/home/bpdp/software/big-data-dev-tools/time-series
[0] bpdp@dellvuan ~/s/b/time-series → tree influxdb2-2.0.9-linux-amd64/
influxdb2-2.0.9-linux-amd64/
├── influx
├── influxd
├── LICENSE
└── README.md

0 directories, 4 files
[0] bpdp@dellvuan ~/s/b/time-series → tree telegraf-1.20.2/
telegraf-1.20.2/
├── telegraf
├── telegraf.conf
└── telegraf.conf.orig

0 directories, 3 files
[0] bpdp@dellvuan ~/s/b/time-series → tree grafana-8.2.2-oss -L 1
grafana-8.2.2-oss
├── bin
├── conf
├── data
├── LICENSE
├── NOTICE.md
├── plugins-bundled
├── public
├── README.md
├── scripts
└── VERSION

6 directories, 4 files
[0] bpdp@dellvuan ~/s/b/time-series →
```

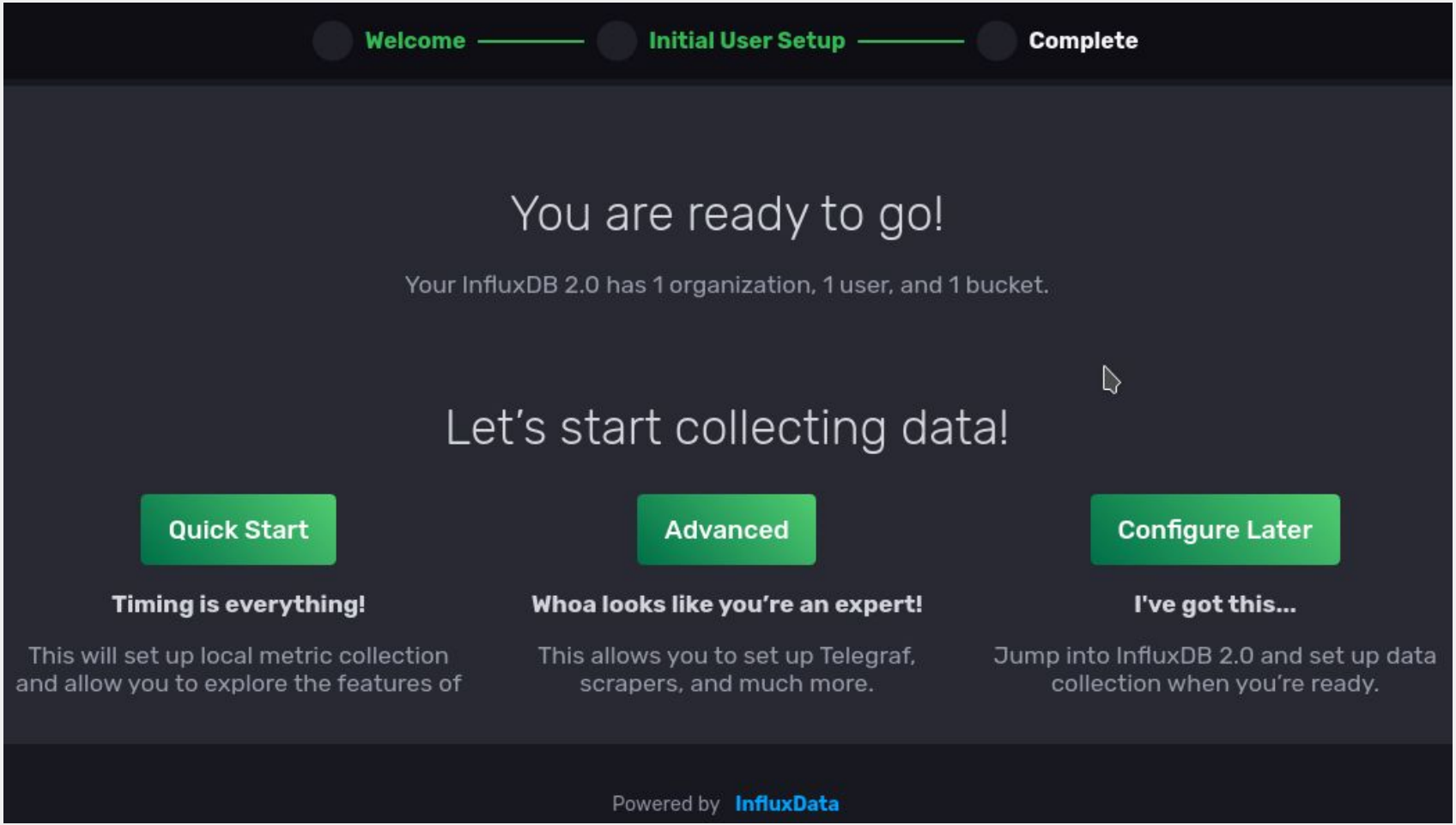
```
[0] bpdp@dellvuan ~/e/f/time-series (master) → cat influxdb
set -x PATH /home/bpdp/software/big-data-dev-tools/time-series/influxdb/ $PATH
[0] bpdp@dellvuan ~/e/f/time-series (master) → cat telegraf
set -x PATH /home/bpdp/software/big-data-dev-tools/time-series/telegraf $PATH
set -x TELEGRAF_CONFIG_PATH /home/bpdp/software/big-data-dev-tools/time-series/telegraf/telegraf.conf
# untuk konfigurasi:
# $TELEGRAF_CONFIG_PATH, /home/bpdp/.telegraf/telegraf.conf, or /etc/telegraf/telegraf.conf
[0] bpdp@dellvuan ~/e/f/time-series (master) → cat grafana-oss
set -x PATH /home/bpdp/software/big-data-dev-tools/time-series/grafana-oss/bin $PATH
[0] bpdp@dellvuan ~/e/f/time-series (master) →
```

Menyiapkan InfluxDB

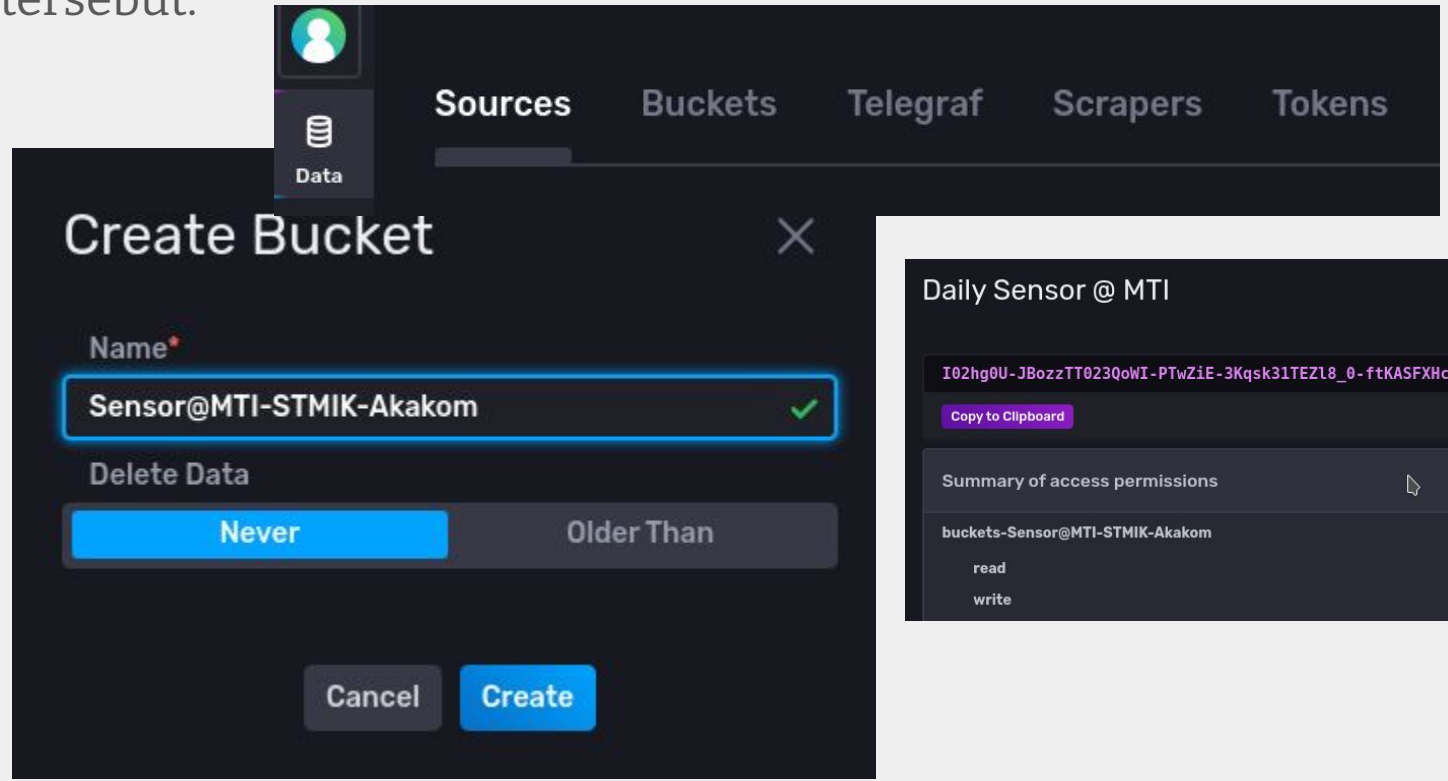
```
[0] bpdp@dellvuan ~/e/f/time-series (master) → source ~/env/fish/time-series/influxdb
[0] bpdp@dellvuan ~/e/f/time-series (master) → influxd
INFO[0000]log.go:104 gosnowflake.(*defaultLogger).Infof reset OCSP cache file. /home/bpdp/.cache/snowflake/ocsp_response_cache.json
INFO[0000]log.go:104 gosnowflake.(*defaultLogger).Infof reading OCSP Response cache file. /home/bpdp/.cache/snowflake/ocsp_response_cach
e.json
2021-10-28T02:30:37.483142Z     info    Welcome to InfluxDB     {"log_id": "0XTBbAel000", "version": "2.0.9", "commit": "d1233b7951", "b
uild_date": "2021-10-01T21:09:53Z"}
2021-10-28T02:30:37.660513Z     info    Resources opened        {"log_id": "0XTBbAel000", "service": "bolt", "path": "/home/bpdp/.influx
dbv2/influxd.bolt"}
2021-10-28T02:30:37.764270Z     info    Checking InfluxDB metadata for prior version.   {"log_id": "0XTBbAel000", "bolt_path": "/home/bp
dp/.influxdbv2/influxd.bolt"}
2021-10-28T02:30:37.795384Z     info    Using data dir  {"log_id": "0XTBbAel000", "service": "storage-engine", "service": "store", "path
": "/home/bpdp/.influxdbv2/engine/data"}
2021-10-28T02:30:37.795529Z     info    Compaction settings     {"log_id": "0XTBbAel000", "service": "storage-engine", "service": "store
", "max_concurrent_compactions": 4, "throughput_bytes_per_second": 50331648, "throughput_bytes_per_second_burst": 50331648}
2021-10-28T02:30:37.795575Z     info    Open store (start)      {"log_id": "0XTBbAel000", "service": "storage-engine", "service": "store
", "op_name": "tsdb_open", "op_event": "start"}
```

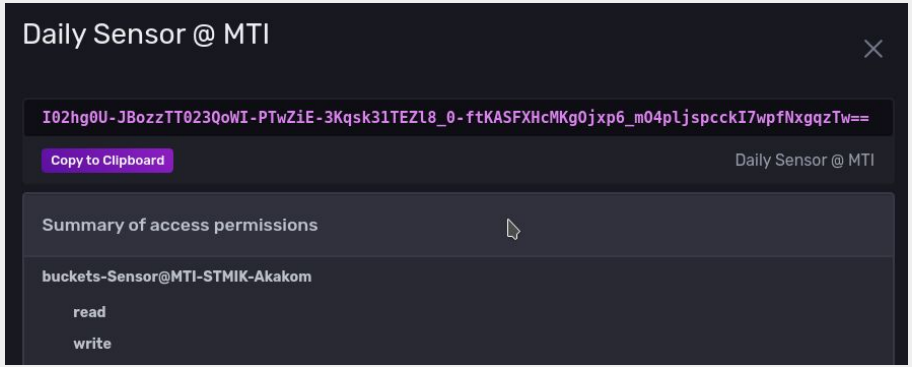

localhost:8086/onboarding/0
Welcome to InfluxDB 2.0
Get started in just a few easy steps
Get Started
Powered by InfluxData


Welcome
Initial User Setup
Complete
Setup Initial User
You will be able to create additional Users, Buckets and Organizations later
Username
bpdp
Password
Confirm Password
Initial Organization Name
MTI - STMIK Akakom
Initial Bucket Name
IoT@MTI-STMIK-Akakom
Continue



Setelah itu buat **Bucket** (tempat menyimpan data) dan **token** untuk Bucket tersebut.





MQTT Broker / Server: Eclipse Mosquitto

```
[0] bpdp@dellvuan ~/s/b/time-series → sudo mosquitto
[sudo] password for bpdp:
1635389072: mosquitto version 2.0.11 starting
1635389072: Using default config.
1635389072: Starting in local only mode. Connections will only be possible from clients running on this machine.
1635389072: Create a configuration file which defines a listener to allow remote access.
1635389072: For more details see https://mosquitto.org/documentation/authentication-methods/
1635389072: Opening ipv4 listen socket on port 1883.
1635389072: Opening ipv6 listen socket on port 1883.
1635389072: mosquitto version 2.0.11 running
```

IOT - Sensor

```
2021-10-28 09:48:08.194773592 +0700 WIB m=+9.060277848
2021-10-28 09:48:09.194020166 +0700 WIB m=+10.059524414
2021-10-28 09:48:10.194239782 +0700 WIB m=+11.059744035
2021-10-28 09:48:11.194390216 +0700 WIB m=+12.059894476
2021-10-28 09:48:12.194602499 +0700 WIB m=+13.060106752
2021-10-28 09:48:13.194770943 +0700 WIB m=+14.060275147
2021-10-28 09:48:14.193982254 +0700 WIB m=+15.059486502
2021-10-28 09:48:15.194197922 +0700 WIB m=+16.059702168
2021-10-28 09:48:16.194363173 +0700 WIB m=+17.059867427
2021-10-28 09:48:17.194565212 +0700 WIB m=+18.060069455
2021-10-28 09:48:18.194739233 +0700 WIB m=+19.060243475
2021-10-28 09:48:19.194868991 +0700 WIB m=+20.060373236
2021-10-28 09:48:20.194037858 +0700 WIB m=+21.059542101
2021-10-28 09:48:21.194254075 +0700 WIB m=+22.059758331
2021-10-28 09:48:22.194507486 +0700 WIB m=+23.060011743
```

Telegraf: subscribe ke topik di MQTT Broker / Server

Konfigurasi:

```
[agent]
  ## Default data collection interval for all inputs
  interval = "1s"
  round_interval = true

  metric_batch_size = 1000

  metric_buffer_limit = 10000

  collection_jitter = "0s"

  flush_interval = "1s"
  flush_jitter = "0s"

[[inputs.mqtt_consumer]]
  servers = ["tcp://localhost:1883"]

  topics = [
    "sensors/#",
  ]
  data_format = "influx"

[[outputs.influxdb_v2]]
  urls = ["http://127.0.0.1:8086"]

  token = "$INFLUX_TOKEN"

  organization = "MTI - STMIK Akakom"

  bucket = "Sensor@MTI-STMIK-Akakom"
```

Menjalankan **telegraf**

```
[0] bpdp@dellvuan ~/s/b/t/telegraf-1.20.2 → set -x INFLUX_TOKEN I02hg0U-JBozzTT023QoWI-PTwZiE-3Kqsk31TEZl8_0-ftKASFXHcMKgOjxp6_mO4pljspc
ckI7wpfNxgqzTw==
[0] bpdp@dellvuan ~/s/b/t/telegraf-1.20.2 → telegraf
2021-10-28T02:52:37Z I! Starting Telegraf 1.20.2
2021-10-28T02:52:37Z I! Using config file: /home/bpdp/software/big-data-dev-tools/time-series/telegraf/telegraf.conf
2021-10-28T02:52:37Z I! Loaded inputs: mqtt_consumer
2021-10-28T02:52:37Z I! Loaded aggregators:
2021-10-28T02:52:37Z I! Loaded processors:
2021-10-28T02:52:37Z I! Loaded outputs: influxdb_v2
2021-10-28T02:52:37Z I! Tags enabled: host=dellvuan
2021-10-28T02:52:37Z I! [agent] Config: Interval:1s, Quiet:false, Hostname:"dellvuan", Flush Interval:1s
2021-10-28T02:52:37Z I! [inputs.mqtt_consumer] Connected [tcp://localhost:1883]
```

```
[0] bpdp@dellvuan ~/s/b/time-series → sudo mosquitto
[sudo] password for bpdp:
1635389072: mosquitto version 2.0.11 starting
1635389072: Using default config.
1635389072: Starting in local only mode. Connections will only be possible from clients running on this machine.
1635389072: Create a configuration file which defines a listener to allow remote access.
1635389072: For more details see https://mosquitto.org/documentation/authentication-methods/
1635389072: Opening ipv4 listen socket on port 1883.
1635389072: Opening ipv6 listen socket on port 1883.
1635389072: mosquitto version 2.0.11 running
1635389279: New connection from ::1:48240 on port 1883.
1635389279: New client connected from ::1:48240 as pub (p2, c1, k30, u'mqtt').
1635389557: New connection from ::1:48242 on port 1883.
1635389557: New client connected from ::1:48242 as Telegraf-Consumer-Durb3 (p2, c1, k60).
```

Menjalankan **grafana-server**

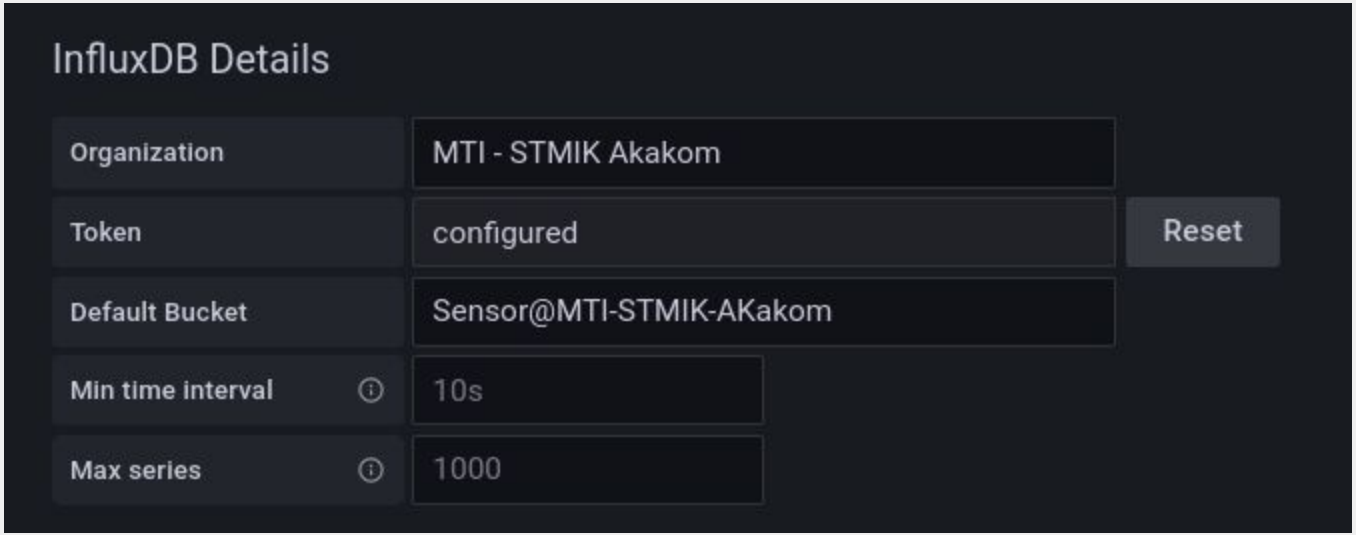
```
[0] bpdp@dellvuan ~/s/b/t/grafana-oss → source ~/env/fish/time-series/grafana-oss
[0] bpdp@dellvuan ~/s/b/t/grafana-oss → grafana-server
WARN[10-28|09:57:09] falling back to legacy setting of 'min_interval_seconds'; please use the configuration option in the `unified
ing` section if Grafana 8 alerts are enabled. logger=settings
WARN[10-28|09:57:09] falling back to legacy setting of 'min_interval_seconds'; please use the configuration option in the `unified
ing` section if Grafana 8 alerts are enabled. logger=settings
INFO[10-28|09:57:09] Config loaded from                       logger=settings file=/home/bpdp/software/big-data-dev-tools/time-ser
afana-oss/conf/defaults.ini
INFO[10-28|09:57:09] Path Home                                logger=settings path=/home/bpdp/software/big-data-dev-tools/time-ser
afana-oss
INFO[10-28|09:57:09] Path Data                                logger=settings path=/home/bpdp/software/big-data-dev-tools/time-ser
afana-oss/data
INFO[10-28|09:57:09] Path Logs                                logger=settings path=/home/bpdp/software/big-data-dev-tools/time-ser
afana-oss/data/log
INFO[10-28|09:57:09] Path Plugins                             logger=settings path=/home/bpdp/software/big-data-dev-tools/time-ser
afana-oss/data/plugins
INFO[10-28|09:57:09] Path Provisioning                        logger=settings path=/home/bpdp/software/big-data-dev-tools/time-ser
afana-oss/conf/provisioning
INFO[10-28|09:57:09] App mode production                      logger=settings
INFO[10-28|09:57:09] Connecting to DB                         logger=sqlstore dbtype=sqlite3
INFO[10-28|09:57:09] Starting DB migrations                   logger=migrator
INFO[10-28|09:57:09] migrations completed                     logger=migrator performed=0 skipped=346 duration=519.503µs
INFO[10-28|09:57:09] Starting plugin search                   logger=plugins
INFO[10-28|09:57:09] Registering plugin                       logger=plugins id=input
INFO[10-28|09:57:09] Live Push Gateway initialization         logger=live.push_http
INFO[10-28|09:57:09] HTTP Server Listen                       logger=http.server address=[::]:3000 protocol=http subUrl= socket=
```

Konfigurasi Grafana:

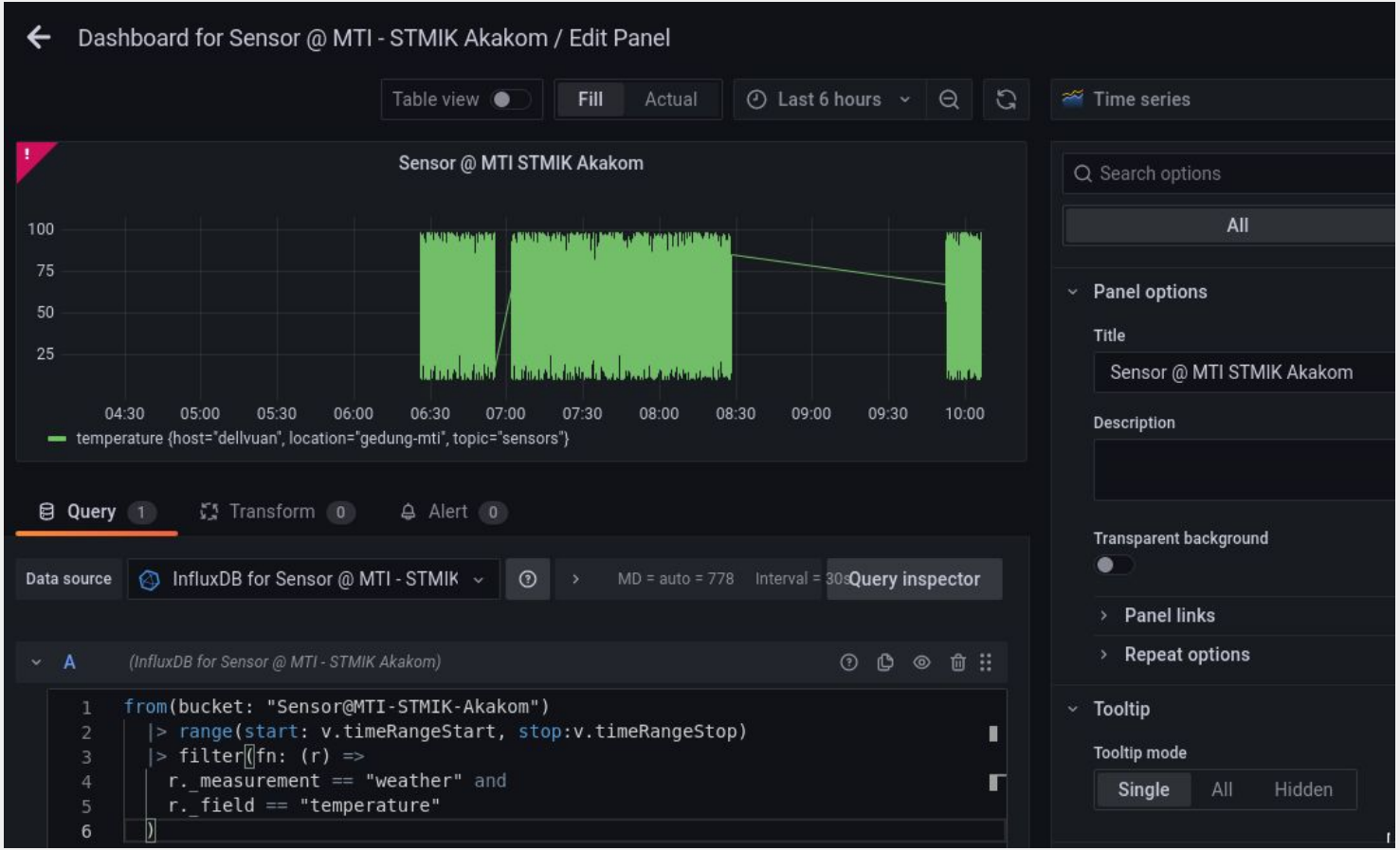
- Data Sources
- Dashboard

Data Sources:

1. **Configuration** - **Data sources**
2. Pilih **InfluxDB**
3. Pilih **Flux** untuk query language
4. Pada **HTTP**, isikan **URL** http://localhost:8086 (server InfluxDB),


InfluxDB Details
Organization
MTI - STMIK Akakom
Token
configured
Reset
Default Bucket
Sensor@MTI-STMIK-AKakom
Min time interval
10s
Max series
1000

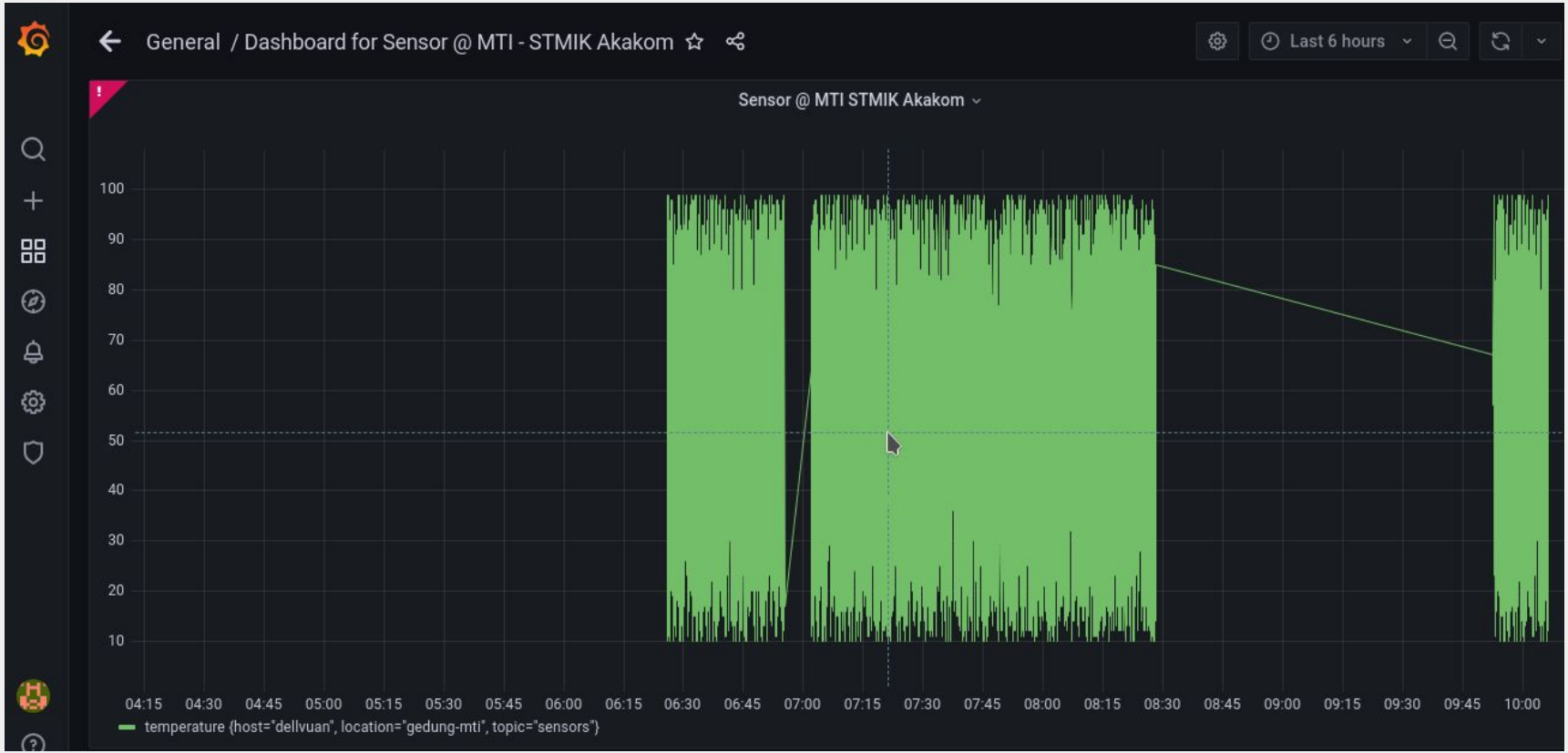
Konfigurasi *Dashboard*



Query:

(InfluxDB for Sensor @ MTI - STMIK Akakom)

```
from(bucket: "Sensor@MTI-STMIK-Akakom")
  |> range(start: v.timeRangeStart, stop:v.timeRangeStop)
  |> filter(fn: (r) =>
    r._measurement == "weather" and
    r._field == "temperature"
  )
```


General / Dashboard for Sensor @ MTI - STMIK Akakom
Last 6 hours
Sensor @ MTI STMIK Akakom
100
90
80
70
60
50
40
30
20
10
04:15
04:30
04:45
05:00
05:15
05:30
05:45
06:00
06:15
06:30
06:45
07:00
07:15
07:30
07:45
08:00
08:15
08:30
08:45
09:00
09:15
09:30
09:45
10:00
temperature {host="dellvuan", location="gedung-mti", topic="sensors"}

MAGISTER TEKNOLOGI INFORMASI
STMIK AKAKOM YOGYAKARTA

Terima Kasih!