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Automated ICT system health monitoring using Grafana

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Abstract

Futures Platform is a consultation company which provides foresights solutions and a tool to visualize all different possible solutions related to foresight.

As the technology evolve and ICT developments becomes more complex, there is been a need to understand the behaviour of the system architecture. This matter focuses more on the logging of what is happening on the background during the time applications are actively running, the process of logging includes several services components like CPU, usage, Network connections, Memory consumptions and so on.

In this project the focus has been to address the need of implementing monitoring system and also eradicating on time problems that may occurs after system faults. Several times these issues go un-noticed keep running on the background and they only emerged as visible errors on the user interface once reached certain thresholds. Project aimed to provide stable and reliable services without having noticed faults.

Ansible has been developed and design to achieve and aid configurations of most of the automation processes for different systems the idea of using ansible playbook in this implementation has been due to the advantages explained in this report but also the ability of Ansible to manage multiple server configurations in one configuration file.

The monitoring baseline of server's components to be logged/monitored were developed, the method of the installation was investigated and researched then finally during the project implementation Ansible scripts were developed to achieve the project's goal.

Keywords/tags (subjects)

Automated monitoring, Ansible, Telegraf, Grafana, Influx DB, System monitoring, APM

Miscellaneous (Confidential information)

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Acronyms

API	Application Programming Interface
APM	Application Performance Monitoring
DB	Database
CD	Continuous Delivery
CI	Continuous Integrations
CPU	Central Processing unit
CMS	Content Management System
DevOps	Development and Operations
HA	High Availability
ICT	Information Communications Technology
SPOF	Single Point of Failure
QA	Quality Assurance
UI	User Interface
UX	User Experience

1 Introduction

1.1 Background

This report has different purposes, main one is demonstrating how systems monitoring infrastructure can be installed and maintained using different advanced frameworks. How this technology can benefit organizations in early issue detections by understanding problematic components of the services before they become visible issues. Also, how it can benefit DevOps people to utilize the gathered metrics from the monitoring systems for the purposes of having better understand of the service architecture and how they operate in terms of resources usage.

This report can also serve as a tool for evaluating ICT projects or any projects in general. It explains some found fundamentals of how projects are evaluated and why in order to benefits organizations or target audiences.

Since technology is evolving rapidly and ICT systems are becoming even more complex. The development complexity of the systems can become challenging to track and monitor, this is where the major problem in DevOps is. These systems can have faults and issues where no one understand what is going on until the fault becomes visible one to the end user. By using proper monitoring tool DevOps professionals are able to monitor, log and predict any complex system architecture. By doing so they will be able to be alerted whenever they are a fault in the system, and they would have enough time to rectify it before it becomes visible to the end users. This is the major issue experienced in many organizations and in this project, implementation is to have better control of the system architecture no matter how complex they are.

The report has several advantages including the knowledge of how to install Grafana using Influx DB, how to read the metrics obtained from the tool in order to understand system health. How the metrics can help to predict the upcoming issues, faults or errors that may occur in the system. The document also explains how the project was successfully evaluated within the organization, meaning that what evaluation method was, participants involved and also based on the evaluation how the project fits the organization’s needs.

The report is suitable for audience who want to learn and understand installing and using Grafana as monitoring tool, how this tool can help in managing ICT system health and how it can help to correct small system faults before they become visible. More specifically, this report's audience are DevOps professionals, System Administrators, Developers and Technical Engineers/Support. But also, Project managers and ICT Management professionals can also benefit from the report.

1.2 Project Goal

The project's goal was to address the problem existing in the system architecture, where issues, errors and faults were not detected until they become visible ones on UI.

Many times, there has been undetected system faults, it could be any from using too many resources to low memory. These has caused problems to the end users of the system by where they report these faults when becoming visible ones, instead of being detected and rectified before they are noticed.

Using system monitoring tools such as Grafana helped in combat these problems on the architecture level of applications. Another goal which I based on the project's research was to expand share the knowledge how to install this tool using ansible playbook. Learning on how to install this tool has extended the current knowledge and based on the metrics gathered has made the application/system to be handled in an efficient way. Hopefully this project can help readers to gather some insights on this area and increase their application management systems.

A person benefited from this report would be able to share how the granularity of the information of this report has helped them to understand how to install the tool and also would be able to confirm that this method worked. As experienced many times, technical documentations can be difficult for beginners as they contained way too much technical details that a nontechnical person wouldn't easily understand. Basically, an individual reading this report should be able to say that the information was clear, easy to understand and the method used has worked on its purposes. It also helps to answer some technical questions in simplest way as possible. As this

report shows how to install Grafana using Influx DB as well as Telegraf and if the component of the report has worked then the goal of the project was reached.

2 Research Settings

2.1 Research summary

This project required a research in order to understand how to install the Grafana tool and its required components, mainly technical parts. There were different installation processes from different DevOps professionals, but the research was more focused on clearly documented instructions/process that even nontechnical person would be able to understand.

There are two ways or methods of how to perform a research which are qualitative and quantitate. These two methods are both effective on collecting data, but they use different approach in doing so, the nature of this project required discussions and dialogue from different end users and DevOps professionals. Thus, based on the descriptive data type needed in this project then the research approach that was used was qualitative.

In this project benchmarking and interviews were also used. Benchmarking is an effective way to compare two components, this can elaborate some attributes of one item compare to another one and find out which of them is beneficial over the other. This process can help in the decisions making against useful component, principles, best practices and so on.

2.2 Qualitative Research.

Qualitative Research is one of the scientific researches that look for answers to some questions (Hammarberg & Kirkman & Lacey 2016). This method uses procedure for collecting evidence which help to produce new findings and expand the knowledge of the topic. Qualitative research also seeks to understand and produce deeper knowledge of a given topic from different perspective of the focus group involved.

There are several common methods for conducting qualitative research, in this project it was more focused on the interviews and focus groups. This was to have broader view of the topic and gather good quality data as see in Table 1.

Table 1. Qualitative Methods used in the project

Method	Description
Interviews	This was a very good and appropriate method for this topic. It was more focus on understanding individuals understand and experiences of the topic and also their comments on how certain topic can be rectified. Rectification of the problem ways of solving rather than technically how.
Focus Groups	With focus groups, it was aimed internally to understand the behaviour of the of different departments when faults start to emerge. This helped to generate broad overview of the issues experienced by different people.

2.3 Research interview

Short interview was conducted to a group of eight people from different departments so as to expand the possibilities of collecting good data. One of the colleagues interviewed was Max Stucki Senior Foresight Analyst on 21 June 2020 who has expertise of the tool to be monitored and also the colleagues is handling clients who are end users of the tool. Mainly the focus of the interview was to understand and gather data about what we can do in order to improve our services availability and performances. Interviews are good way to gather direct insight from the audience, to collect good insights the interview would need to be conducted in

elaborations way (Indeed 2020). The type of interview used in this project was unstructured, meaning that we allowed discussions between the topic and also the topic of the changed according to the one discussed previously. The aim on this type of interview was to achieve a regular type of conversation rather than asking questions, this was to make audiences more comfortable and attentive to the subject. The questions used in this interview were completely less technical this was to allow nontechnical colleagues to understand the topic and give their input on the subject.

The interview provided some valuable insights on how these system faults are affecting the general usability of the tool and how installing Grafana would help to ensure service is available most of the time.

Table 2. Some of the unstructured questions asked to the interviewee

Research questions	Explanation
What we can do in order to achieve and ensure good services availability of the platform?	Initial respond of this question from several audience was that it would be good for tech team to understand what is happening on the platform, where problems are and how they can tackle them.
If we have system monitoring tool in place? Will it help?	It would help if the monitoring system if tech team is able to follow up with the system. To clarify this this section most of the interviewees meant that there should be a way for monitoring system to let tech team know of any ongoing issues. This means we are talking about alert notifications on practice.
Will it improve usability of our tool?	From the interview held, it was discussed that having monitoring tool will definitely improve the usability of

	the platform since end users will not see errors resulted from architecture failures.
Will it improve general way of handling errors/faults?	Definitely it will (Max Stucki 21 June 2020)
Will the team have a better control of the system?	Understanding the behaviour of the architecture is crucial, so indeed will have better control of the system architecture.

2.4 Data gathered from interview

Data received was analysed in forms of cards/post notes, each question and possible solutions was placed together. Which was then later used to find the best tool that could meet most of the solutions suggested by the interviewee. Such method of using cards (Problem solving with sticky notes) found to be successful in such that it visualizes the best approach towards possible solutions. This also allows several team members to see the problem from different perspective that facilitate in better understand of the core issue and how rectifying core problem can improve our services. Figure 1 illustrates solutions approach using sticky notes

Figure 1. Problem solving with sticky notes

2.5 Benchmarking

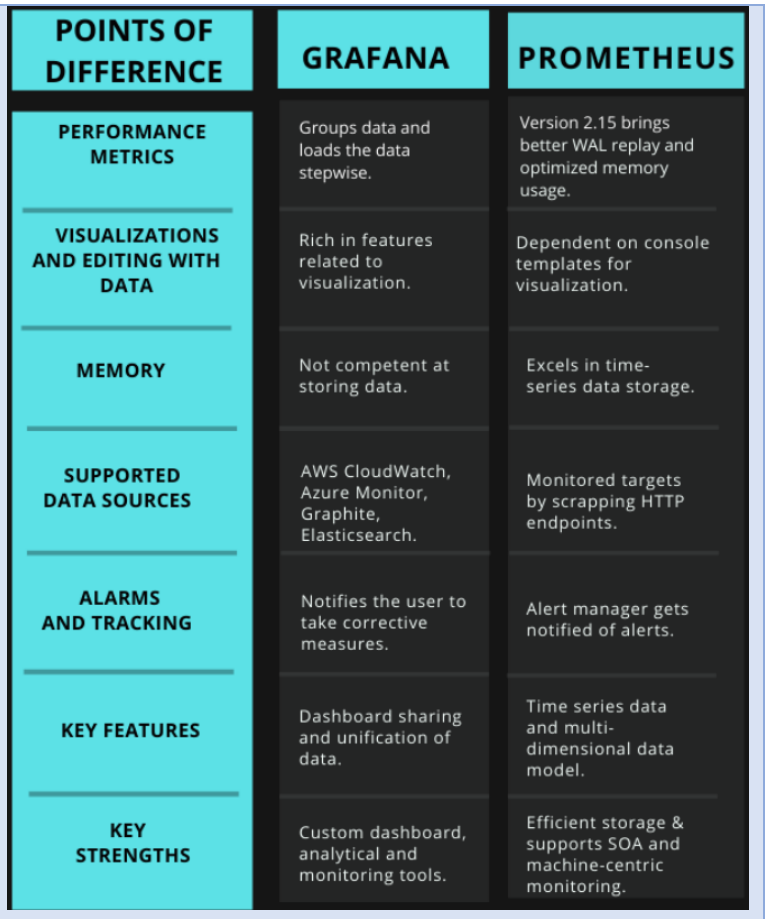
How benchmarking is applicable to this project is that there was a need to evaluate best practices and how other professionals have solved similar issues, also using which. methods.

Benchmarking can be defined as a process of comparing and learn from others on what is the best way, standard or practice based on your needs (Inspire One 2018). The main need for benchmarking was to locate best practices of system monitoring tools available that would fit organizational needs. The tool had to be from well-maintained/develop frameworks, ease of implementation and also easily readable obtained metrics. Simply any person should be able to read the metrics and identify any faults or inconsistencies.

Based on the nature of the project, there was a need to conduct three types of benchmarking in order to obtain good quality data that can be used to determine the project success.

Table 3. Benchmark types used in the project

Types of Benchmarking	Applicable reasons
Performance benchmarking	The main reason for implementing performance benchmarking was to gather as much data as possible related to the functionality of Grafana. In this section quantitative data was compared, meaning that data and metrics from these two tools were compared to determine the performances of each. As illustrated in Figure 2 below (Hoffman, 2020), during this project Grafana was compared with another tool Prometheus to understand which have better options and features that fits organization's needs. Each point of difference was compared in terms of data.

	 Figure 2. Benchmarking Grafana with Prometheus
Practice benchmarking	This method of benchmarking involved gathering and also comparing information about where between this tool there a gap or big differences is. In this section it is very important to determine the practicalities of both tools to observe and decide which of the tool would fit the organization needs.
Internal benchmarking	With internal benchmarking the tool was compared with server's own monitoring tool to determine the accuracy and readability of the data metrics. Also results from this tool were compared with several internal traffic monitoring tools.

2.6 Results summary

Based on the results obtained from the benchmarking process and data gathered from the technical comparison, the decisions were to install Grafana for monitoring purposes of the application. This way we would solve most of the problems experienced before and also understanding the application's behaviour even deeper. We would also be using this tool to visualize the data and keep logs of the hosts.

3 Effective automated monitoring

3.1 Automated monitoring

Monitoring is a process which is tracking the progress of an activity periodically and systematically by gathering and analysing data (M&E studies, 2015). Monitoring a system involves routinely gathering data which is measuring the progress of towards accomplishing the objectives of the programme. Basically, the metrics or data gathered should inform to what extent the system goals have been achieved.

Figure 3 shows the metrics of this project (from one of the API host) after it has been evaluated and completed. So, metrics like these are able to tell a lot of information about the system architecture and its behaviour.

Figure 3. General overview of the host metrics

Figure 4 shows the details of the metrics, components like services interruptions and CPU usage by the host which helps to predict any services interruptions which can occur in the near future.

Figure 4. Detailed overview of the metrics

Alerting was one of the critical needs for implementing automated monitoring tool, alerting the process of sending out notifications or alarming at the right time about a threat, danger, faults or problems (Onsolve, 2020). Normally, if the system goes down or become unavailable it is likely that the business will go down as well. In these situations, in the organizations there has to be an IT system or way of sending information when there are service interruptions.

From this project were able to set up a rule for sending notifications to DevOps team whenever there is an issue in the service architecture. This helps to mitigate any problem fast enough and reduce the potential of time consuming in finding the problem and avoid business interruptions.

Using this tool, it offers several options for sending out notifications, meaning that there are so many different ways of sending notifications. It was set so that in case a host or server is using resources (CPU usage, memory, network connectivity and so on) more than 80% it should notify DevOps team. Based on the internal discussion it was decided that we have to set a rule in the Grafana to send notifications via Microsoft teams' channel. In this channel DevOps are actively following up and they

do have channel notifications option turned on. This was believed to be easy way of notifying in case of urgent issues.

Figure 5 illustrates an example of an alert sent from Grafana to Microsoft team channel notifying about the CPU usage is high for news feed host. It can be seen that it took around nine minutes to rectify the problem and the new alert was sent out that everything is ok.

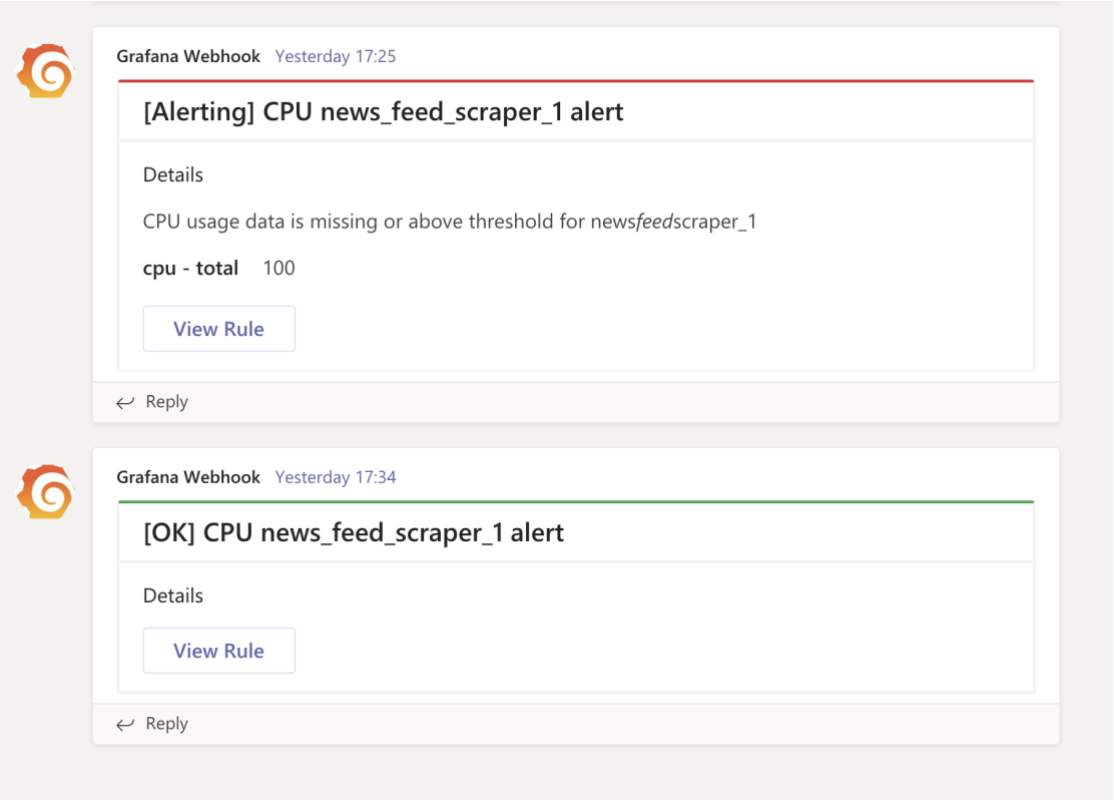


Figure 5. Microsoft Teams alerting

Another form of alerting decided was to send out emails to an outlook email distribution list, this means the same rule as discussed above was set but simply using different alerting channel which in this option was Microsoft outlook. This was again easy to notify since DevOps have their email notifications on and would actively ready these alert emails from Grafana.

Figure 6 displays an example of an alert sent from Grafana to Microsoft outlook notifying about the CPU usage is high for news feed host.

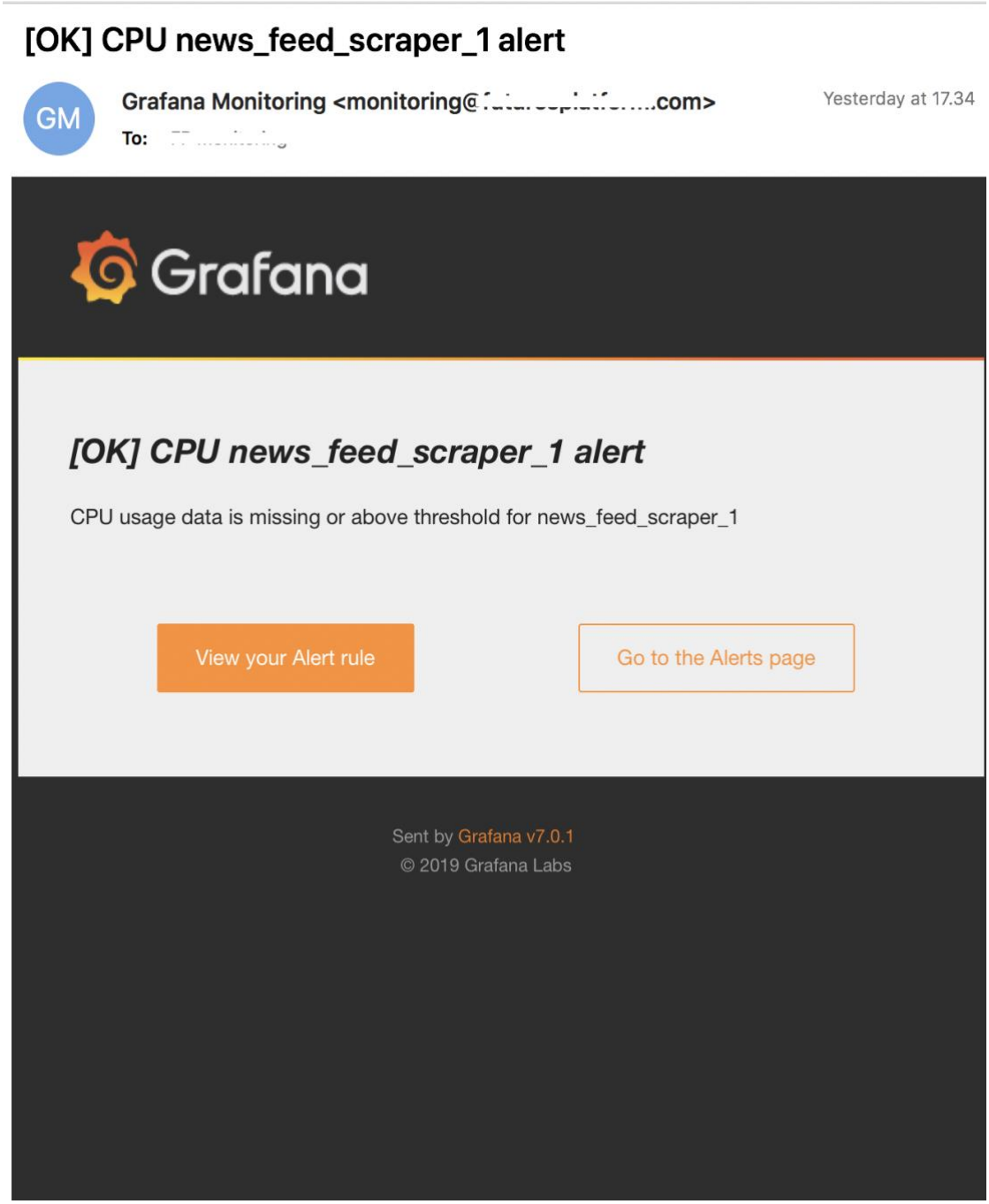


Figure 6. Email alerting

Application performance monitoring (APM) is a broad subject which involves the process of ensuring business applications and systems are performing as expected. In this project it was also one of the main factors to implementing this tool due to the ongoing experienced faults which were not noticed until they become visible on the

UI. Having good experienced how these problems occurs, they are mostly architecture level problems that happens on any system.

- Memory consumptions
- CPU usage.
- Disk space
- Network connectivity
- Load balancing
- Interruptions levels
- Kernel and so on.

Monitoring these resources was able to gather good insight (in the form of metrics) on how the servers are behaving and what they are doing. APM is something that needs to be kept running all the time, and DevOps actively following up with the alert sent out from Grafana. Each request and transactions in the application are measured by the tool, then administrators are able to quickly figure out the issues that has any negative impact on the application's performances.

Figure 7 illustrates services components monitored by Grafana

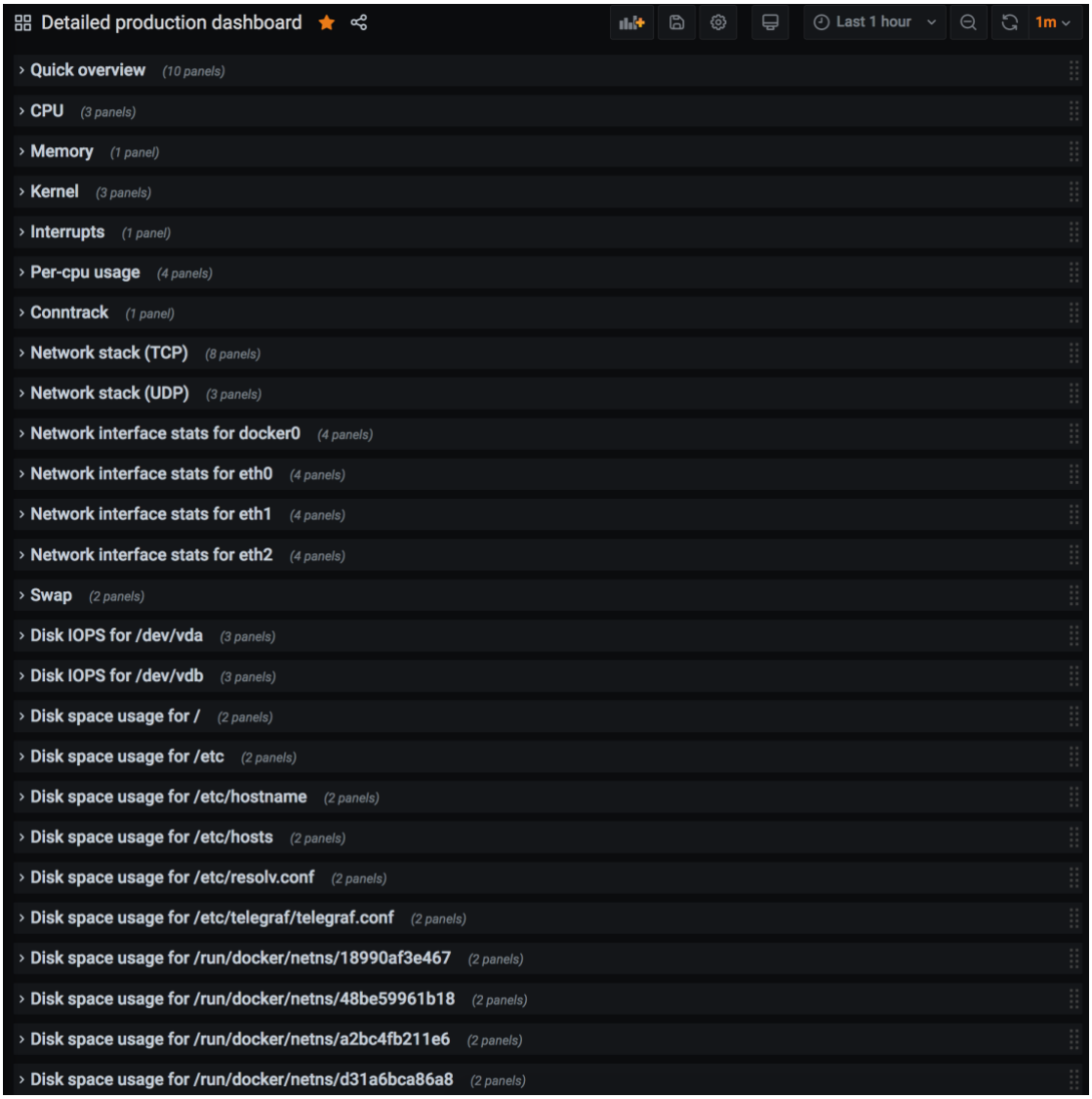


Figure 7. Monitored resources

In general, connected services are critical to monitor and in practice they must be tracked and logged.

Figure 8 (Pearlman, 2017) describes an example of API-led services connectivity which is becoming complex to monitor the architectural behaviour of the service.

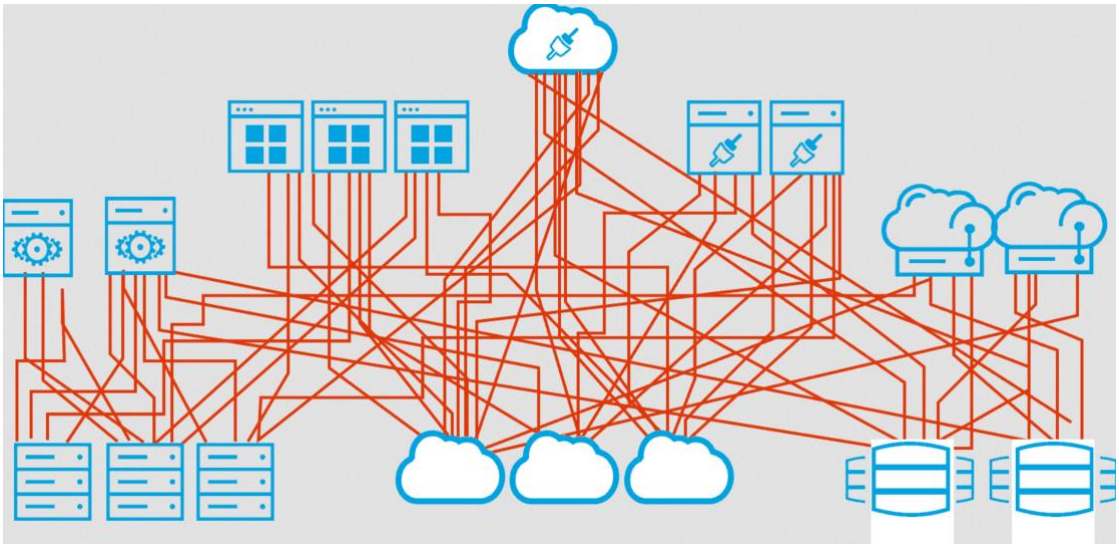


Figure 8. API-led service connectivity

Since information systems are becoming more complex, there is a need to understand the infrastructural behaviour in terms of how services are connected and how they affect one another. Thus, it is essential for any system to ensure reliability and stability of the services it provides this includes having the visibility of the overall system health and performances. There are several components of the system that can be real-time monitored, but this depends on the environments and how critical they are. In our needs we will monitor overall system health, so components like databases, API and containers.

Figure 9 (Smartbear, 2020) shows API monitoring.

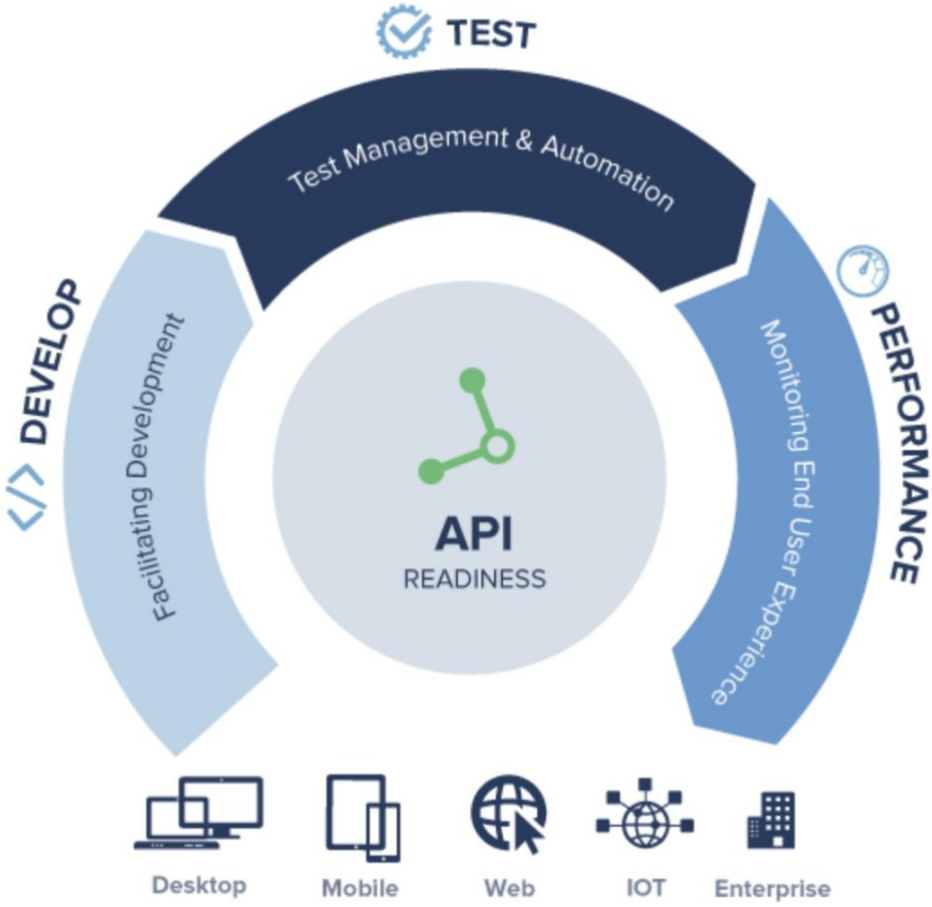


Figure 9. API monitoring

Effective real-time performance monitoring not only help to understand the metrics of the data but also reduce the time for development and operations people (DevOps) to trace and trouble shoot any root cause of the system failure. It gives the ability to catch any complications before it turns into a problem that it noticeable by end-users. This ensure that they provide and maintain high quality of the services and its availability, based on the metrics it also assists them to make good informed decisions about the future of the overall infrastructure of their system.

The time used to spend in order to find the root cause of the system failure has been reduce by the help of several monitoring aids. DevOps are no longer spending hours to trace a problem and fix it, but nowadays they are able to see and understand the metrics even before they turn into an issue which can then later on cause failure.

This also help to predict if there will be some faults or issues in the near future, which service component will be affected and to what extent.

3.2 Need for effective automated monitoring

Monitoring system health is an essential component of information system's architect operation. DevOps professionals need to understand the information outputted by the system in the form of feedback about its' activities, and those activities can be overall components that makes certain services in a system. This feedback needs to be monitored, assessed and applying any actions required.

One of the key feedbacks to be monitored and assessed could be for example below.

- To determine where the system meets the performance operational standards.
- To determine system faults and future predictions
- To be able to alert about the any faults
- Overall operations and resources usage of the system.
- To understand when the system is mostly utilized by the users, basically to determine active hours and such.

There are several service components that can be monitored in order to understand the architectural behaviour of an applications, this can be categorized as type of information track (Ellingwood, 2017). These value types that DevOps can monitor, and the information gathered can probably change some elements of the system architecture. Normally system operates on different architectural hierarchy, so it can be little bit challenging to decide what type of metrics are available on these different layers and how the metrics can aid in the system stability. Below is some of the components that can be monitored, it depends on the services and its architecture.

Host based metrics:

For development team this was very important components, to be able to understand and measure the metrics of all components that makes ours services. These includes several API, CMS tool etc. These metrics which obtained from host based were like CPU usage, memory, disk space please see Figure 10.

Figure 10. Host based metrics, elastic search

Software or application metrics:

Here we wanted to understand the application as one component in terms of functionality. This mainly depends on what kind services it is, the integrations (API) and other services dependencies, how all of these elements function together. Errors, failures, performances and resources usage were some of the component metrics that were captured and measured as seen in Figure 11.

Figure 11. Application metrics

Network metrics:

In most applications monitoring network connectivity in the infrastructure can be worth monitoring, this is because how important connectivity is and if it happens that there is a network issue then that means the whole services will be down. So, understanding network metrics is very important, and this should be checked its correctness and overall functionality in order to deliver necessary performances.

Connectivity, errors, packet loss and even bandwidth can be some of the components to be measured, see Figure 12.

Figure 12. Network metrics in the application.

3.2.1 Early issues detection

This is one of the critical components to be considered in the development of system health monitoring. Early issue detection or early problem detection can be defined as a process of alerting system developers about an event that may take an

unexpected behaviour and lead to system failures. Normally early issue detection will require some actions in order to prevent unwanted problems.

Anomality detections can reduce time and efforts by locating any threating issue in the system functionality and applying applicable fixes.

Figure 13 illustrates service interrupts which occurs every now and then, it displays the intensity and time which lead to determine when is the next interruption will occur.

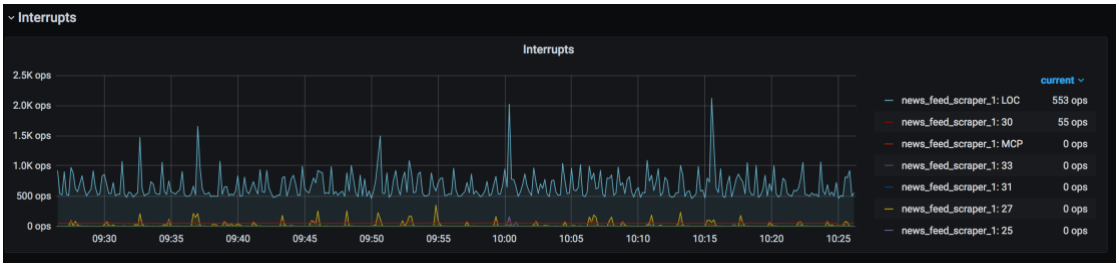


Figure 13. Services interrupts peaks.

3.2.2 Service availability

Information systems are becoming more complex as new technologies emerge and develop, this makes challenging in ensuring services are available whenever they are needed. If it happens that a system lost its availability, then in the business world this can lead to a bigger problem when it comes to transactions or any other services. Service availability has a key requirement which is to provide and deploy highly available systems that has low intensity of interruptions even in the events of failure. Using system health monitoring tool can aid services availability, as mentioned in this report detecting and rectifying issues before they become visible on the UI.

The aim of this project in terms of services was also to make sure that the organization provides highly available system that is available to the end user 99% of the time. Based on this reason it was aimed to take increasingly sophisticated measures together with the software development life cycle to ensure that HA is reached by designing the system that will have no single point of failure (SPOF).

Using automated monitoring system like Grafana will enable detections of failures for both stateless and stateful components in the services architecture, meaning that DevOps professionals will be able to achieve load balance between nodes or hosts that build the services (APIs). Monitoring these hosts will understand and predicts any upcoming services interruptions and thus we have achieved the goal of services available.

Below image demonstrate services availability in one of the hosts in the architecture, it shows that it has been using the resources efficiently and no interruptions.

Figure 14 shows an example of stable monitored services.

Figure 14. Stable service host.

3.2.3 Performances or APM

The needs of monitoring the performance of the applications or APM was clearly discussed and that it to have an ability in detecting and diagnosing complex application performance issues to maintain and provide good services (Suresh,

2020). With APM using Grafana it was about ensuring that system is performing as expected all the time using proper tracking, visualizing metrics, alerting from end-point failures and also reporting performances issues. Also, the end goal in the performances monitoring was to make sure that services were supplied uninterrupted to the end users and its quality needs to be good.

APM is becoming inevitable components of the services and in DevOps teams, it has become a duty to solve the needs by providing stable services infrastructure and environments that support the applications.

APM solutions can help to combat the challenges faced in the production environment's architecture example in this project's application user can run a query to retrieve data from elastic search and if this query takes too long to return results it means that there is an issue which can be hard to identify. In this project it was set that if a query takes more than defined timeframe to return results then Grafana must alert DevOps professionals about it. What will follow is to look at the metrics of the elastic search and identify why it is taking too long to respond or basically pointing out the problem which could be anywhere from high resources usage or endpoint failure.

This was one of the problems faced before implementing this tool, with the help of the tool these types of issues and many are tracked, monitored and fixed withing short period of time.

Below are some components of APM, where monitored application traffics are essential in identifying problems in the UI.

In Figure 15 (dnstuff, 2020) illustrates general ways or methods of measuring application performances.

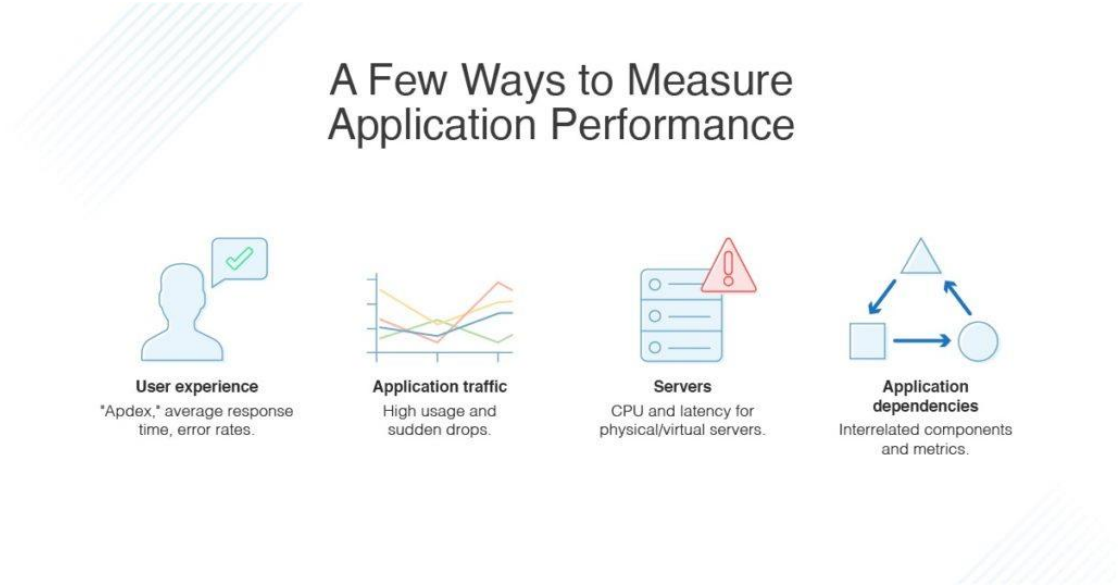


Figure 15. APM measures

With Figure 16, we can see the overall behaviour of all services components that are integrated in the application architecture. We can easily pinpoint which host is problematic and with detailed data we can find out what problems are.

Figure 16. Monitored host's overview

3.2.4 Predictions

Predicting the behaviour of the application was also essential in the project, using the metrics obtained from monitoring tool DevOps are able to tell when the peak of issue will go high and reach failure state. A good example if host is using too much memory to execute the services and it has taken x amount of time to reach 70% of the memory usage, based on the timeframes it means that DevOps will know how long it will take to reach 100%. During this time a person will understand how much time left or how much time they have to identify the issue and fix it before memory usage is 100% which is a total failure.

With this tool and the data gathered a person will be able to tell a lot of information about the behaviour of the application. They will see how the patterns and metrics ae affected over time, how they change and also when certain issues are recurring and why.

3.3 General system requirements

In order to install Grafana, the tool requires that a person need to have Python 2.7 or above ad also Ansible 2.8 or above, these are the main tools for the installation process.

These two configurations tools are very important in the installation process, of course user can select their own. If we take ansible as an example it has a lot of advantages which explains which we decided to adopt it.

- It is agentless, meaning that it does not have any dependencies in order to install it.
- Ansible can be installed on the machine even before starting the project.
- Ansible offers secure communication protocol (SSH), so this offers secure channel.
- Ansible playbook is easy to use and modify accordingly.
- You have the ability to encrypt and decrypt secrets of the playbook.

We need to have Python library in order to store and use data in a time series database (Influx DB). But also, ansible modules are written in Python including core

ones which makes Ansible work. So, by default Ansible will automatically try to find Python configurations.

3.4 Framework

Framework is defined as a crucial supporting component of building up and object (Rouse 2020). For this project there are three essentials tools needed to make Grafana perform as expected. Ansible playbook was used as the main configurations management tool for the automation purposes, ansible was built to and designed to support configuration management on different systems.
Apart from Ansible there were frameworks which goes parallel with Grafana and they are explained in the sub-chapter of this section

3.4.1 Influx DB

According to Influx Data (Influx Data 2020), Influx DB is an open-source time series database that is written is statistical programming language, which is designed for fast compiling, efficient data collection as well as highly availability data storage. This database also offers high quality real-time data visualizations which helps DevOps to evaluate the metrics progress with time and makes the management and handling data series efficiently.

- It offers high data performances
- Easy to write and manage queries for retrieving data
- Ability to compact data reduce data storage
- Offers down sampling feature

Figure 17 (Nigam 2018) illustrates example of HTTP API send to Influx DB which is then sent to Grafana.

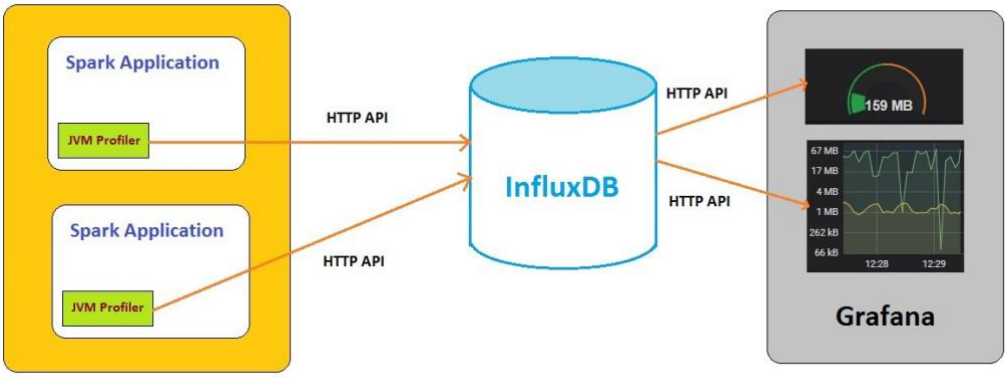


Figure 17. Influx DB API connections

Figure 18 (Nigam 2018) we can see how Influx DB hardware sizing needs.

Load	Field writes per second	Moderate queries per second	Unique series
Low	< 5 thousand	< 5	< 100 thousand
Moderate	< 250 thousand	< 25	< 1 million
High	> 250 thousand	> 25	> 1 million
Probably infeasible	> 750 thousand	> 100	> 10 million

Figure 18. Influx DB hardware sizing

3.4.2 Grafana

Grafana is a defined as an open-source data visualizations and analytic application (Grafana Labs 2020). Due to the advanced features of tool, it allows DevOps to create and query highly visualize dashboards and also explore the metrics. This tool converts time series data from the databases passed to Influx DB into graphs and visuals where user can select data and time frame to be displayed. It depends on the organization's needs but there are many possible ways to visualize time series data using Grafana. For this project the aim of Grafana was to let users read and understand the metrics delivered from Influx DB. They should be easily interpretable

and insightful. Also, these metrics and dashboards can be re-used for different purposes and use cases, since values are variables.

The project aimed to explore the metrics and create logs of the monitored servers, it was also required to split the data into several different views with the ability to compare them alongside using separate dashboards.

Another good feature of Grafana where this project wanted to achieve is the option of sending out alert notifications whenever they are faults which have reached defined thresh hold in the tool. Of course, alerting rules are per needs and as explained on previous chapters for this project was decided that to send notification to Outlook email and Microsoft teams' channel.

Figure 19 shows the main front page of Grafana installed on this project.

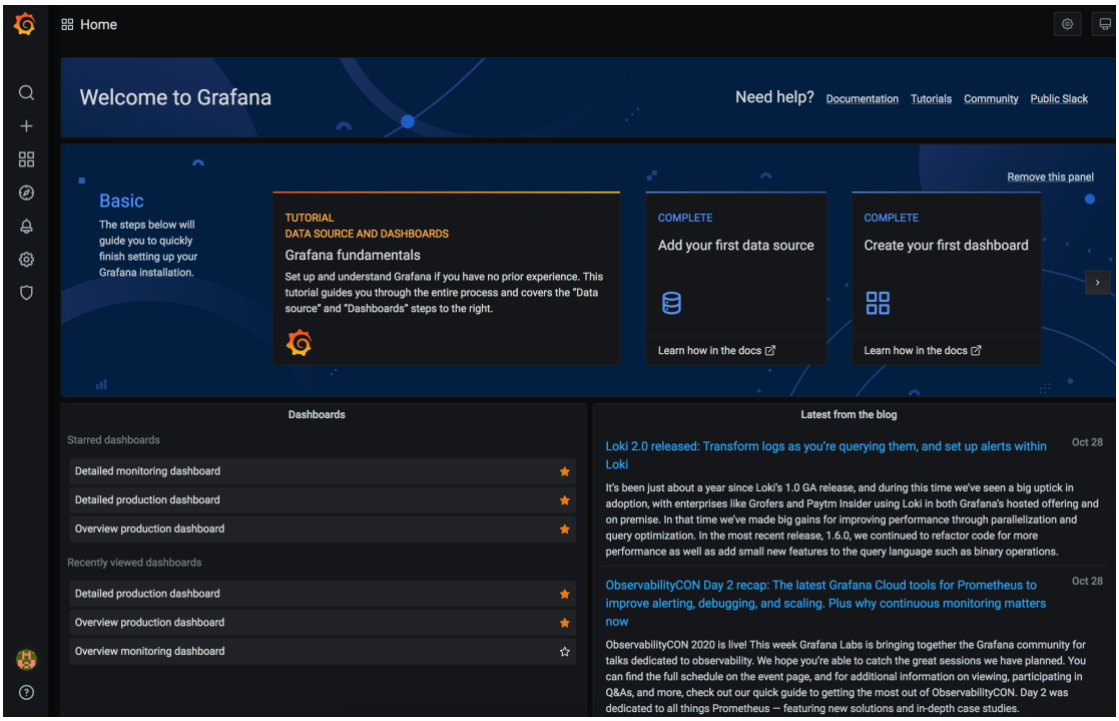


Figure 19. Grafana main dashboard.

Figure 20 illustrates metrics from Drupal API, which is monitored using Grafana and as we can see we do have stable metrics.

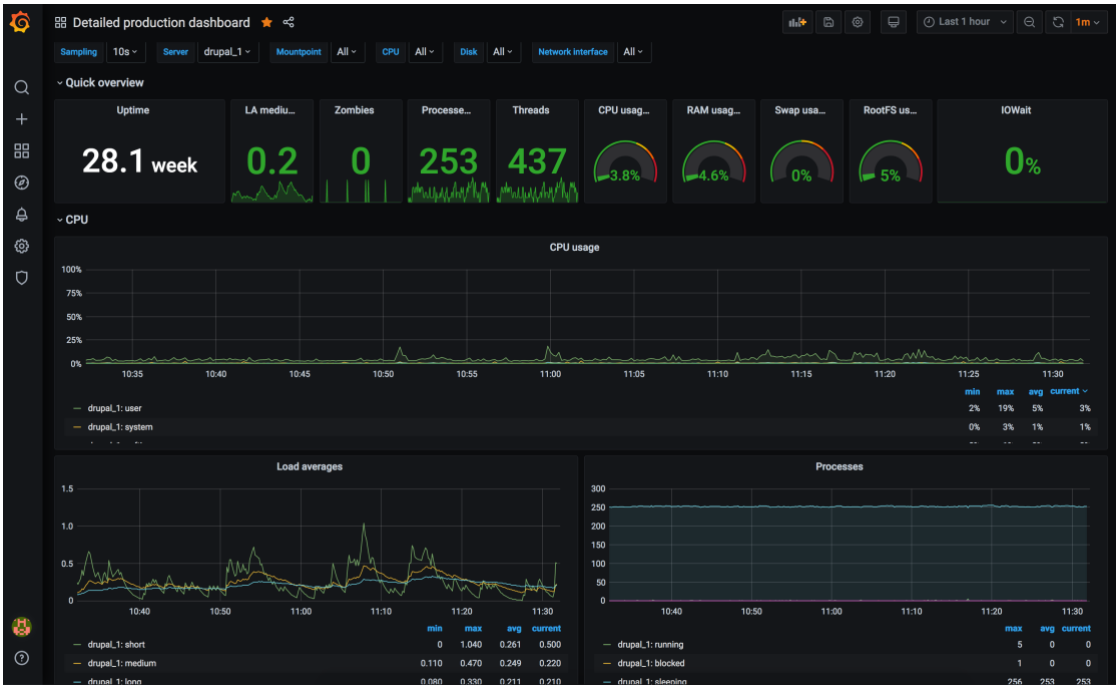


Figure 20. Detailed Grafana dashboard

3.4.3 Telegraf

Telegraf is plugin-driver server needed in Influx DB installation for collecting and also reporting data (Influx Data 2020). Telegraf offers the ability to connect to different data sources to collect and send data to the destination defined. The need of collecting various application and services data metrics for various purposes has made this project to select Telegraf due it its lightweight nature. Telegraf itself contains over 200 plugins (Berman 2019) which aid in the data gathering and writing process which then data is easily shipped to other services like Grafana or data storage.

Figure 21 (Influx Data) demonstrates the architecture

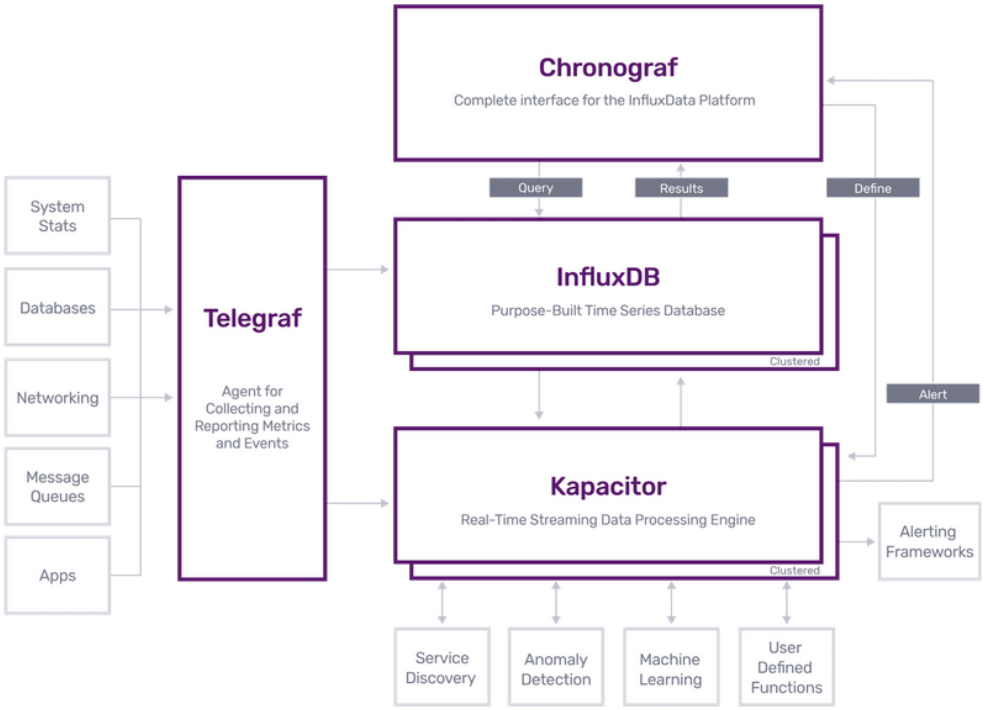


Figure 21. Telegraf architecture

4 Installation process

The installation process was long, it took time since the framework were new to this project and also it took time to find out the proper ways of how to install this tool plus errors and fix. After gathering knowledge, it easy to follow up and also coming up with my own process and which component to implement first then followed by another.

4.1 Ansible

Ansible is rapidly rising an open-source ICT automation tool which is used for several IT related tasks such as configurations, application deployment (CI/CD), services orchestration and so on (Red Hat 2020). With this IT can automate many complex tasks in order to simplify these complex tasks and make them more manageable with saving time. This also allows developers to focus on other task while ansible

automate some of them thus it frees up a lot of time and also it lifts up the efficiency. There are few advantages of why we have chosen this tool for implementing automated monitoring system such as:

- It is an open-source tool; thus, no costs are involved. It is free for anyone and any organization.
- With this tool it only needs some basic understand of the ansible playbook, thus no special skills are needed. So, there is no need to invest of much time neither resources for learning ansible.
- Ansible is a powerful tool, it can manage very complex tasks and automate them. In our project we have manage to automate many of the tasks such data integrations, alerting, hosts configurations and so on.
- Ansible is an independent tool, there was no need to install any extra software or services in order to run it.
- We had more time to focus on other developments and let ansible run on the background.

Figure 22 (Keecheeril 2016) illustrates Ansible architecture and how it is working.

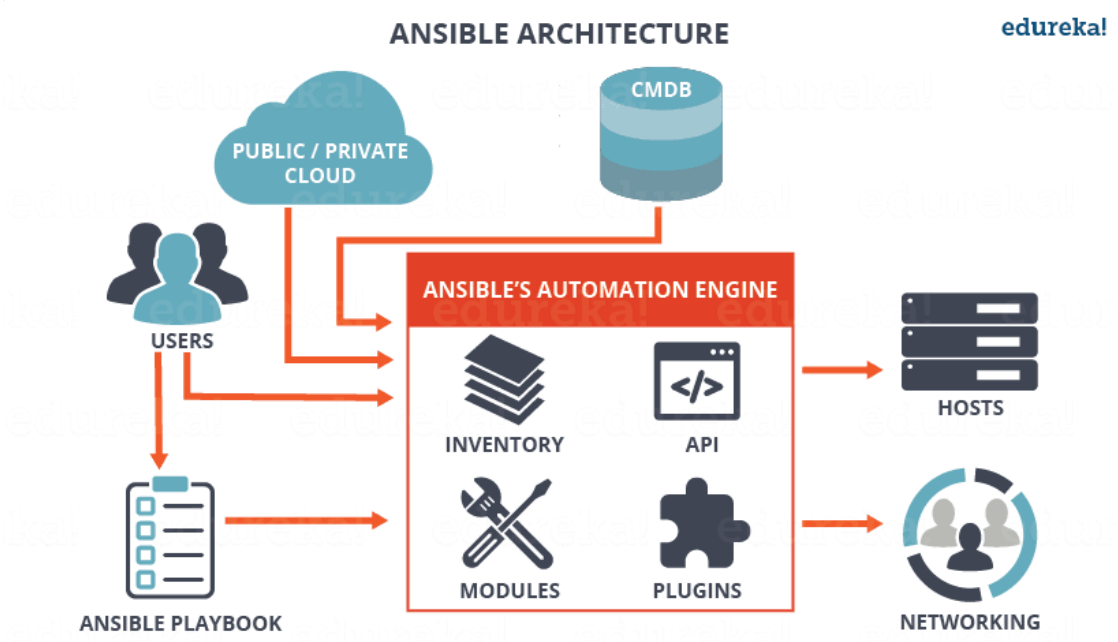


Figure 22. Ansible automation tool architecture

Figure 23 describes the project was set up using Ansible playbook.

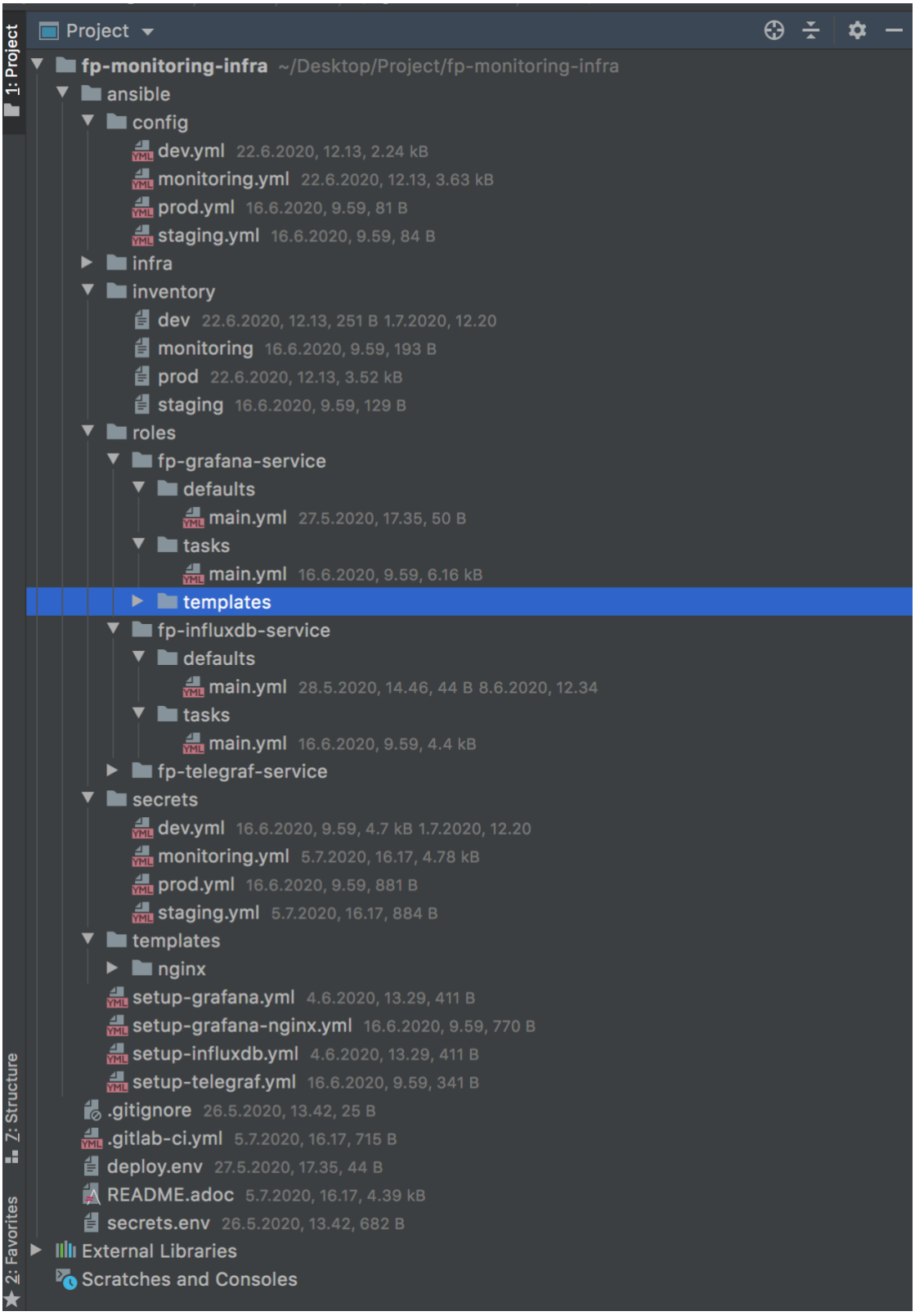


Figure 23. Project set up with Ansible

4.1.1 Maintaining multiple systems servers

Ansible was used to maintain multiple servers due to its ability to manage grouped servers or manage common configurations between servers which results in server management automation. Using this tool's playbook which had re-usable tasks, it was able to ease set up monitoring configurations of several servers and manage to send data quickly. All servers related configurations are expressed in the playbook code and are executed across any specified hosts to access the data.

With maintaining multiple servers in the project, it was able to make any changes very fast from adding/removing/editing new hosts in the hosts' file. The tool only concerns about the servers IP address and credentials which were stores in the next chapter.

4.1.2 Vaults ids for storing secrets

Ansible vault can be used to encrypt any file or variables from inside the playbook. In this project we will use ansible built-in-vault module for encrypting credentials in the project repository, these credentials should never be pushed un-encrypted this is because they cannot be removed from Git repository. We need to add Git commit hook that will check the secret files.

New encrypted file can be created by using ansible vault command, whereby secrets is the file name.

ansible-vault create secrets.yml

After that you will be prompted for a password and the ansible vault command should launch the default system file editor (Phpstorm used in this project).

Executing Ansible playbook with encrypted files requires passing the vault password for the secret files and there are two ways to achieve this.

1. Using interactive mode and asking for password every time, you need to use below command when running ansible. This means user will be prompted to add password whenever they need to execute playbook with encrypted files.
   –ask-vault-pass

2. Storing the vault password locally on your machine outside project repository by running below ansible command.
   --vault-id=project_name@<path_to_local_vault_file>

In this project we have selected second option which is to store vaults locally since there will be no need of asking for password every time we work with secrets and also for storing multiple vaults. This way you can enter the passwords for each host as string on a single line in the above created file.

There are many resources explaining how to use ansible commands with example, those are not listed in this report, but they are available from Ansible official website (https://docs.ansible.com/ansible/latest/index.html).

4.2 Set up GitLab project

Depends on the organizations and how they handle projects, some individuals might choose to work with the project locally until some point they create remote project and push what they have been working on. For this case remote project was first created on Git, this was based on organizational policies and best practices. This means that correct project details were added and including users of this project. Users can be defined per needs, but this project choose to add the whole technical teams so that everyone is aware of what is going on, what has been done and what is expected to be completed.

Based on own experiences, it is easier to give access to the whole technical team for several needs such as:

Project status review – This is how projects are followed up, supervisor and colleagues can simply login to Git and see the project details together with the progress. This creates transparency in the team and good communications, and of course in case project is delayed for one reason or another then it is easier for any team member to review the project and help.

Code review – Sharing the project with the team makes it easier to do code review with the responsible person. Thus, since they already have access to the project, they won't have a need to request it.

Figure 24 shows an example of how new project was added in GitLab, due to the sensitivity of the project and Git accounts it was decided to include this example from general Git level.

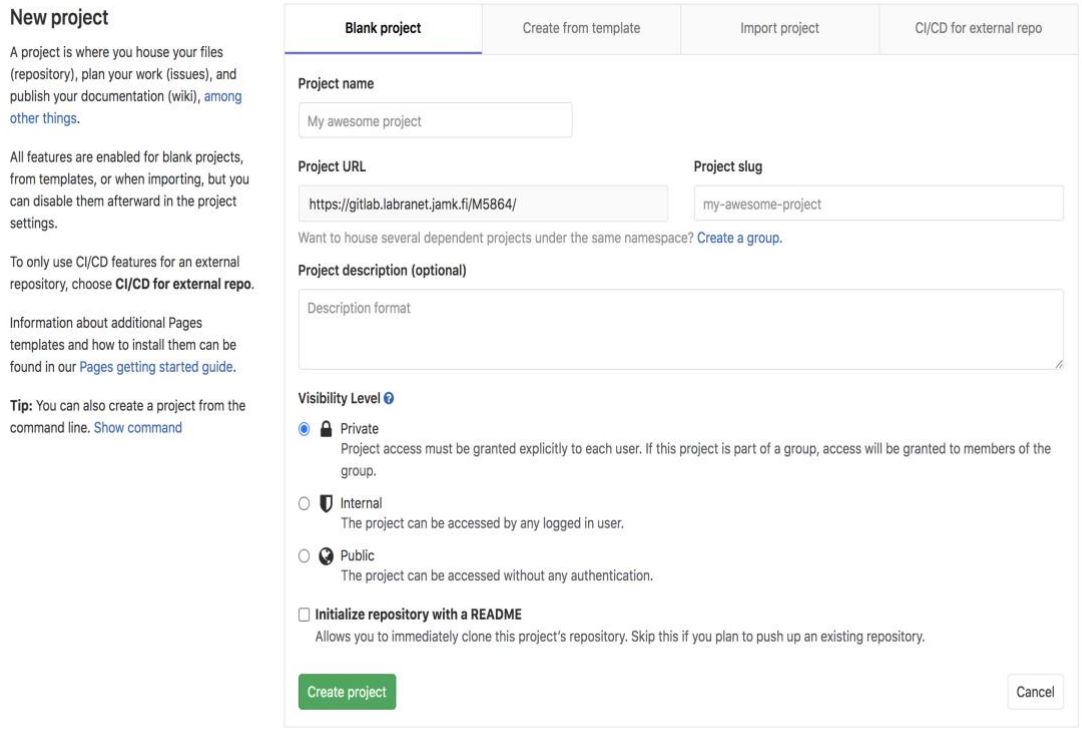


Figure 24. Basic project set up on Gitlab

4.2.1 Clone above created project locally

This one of the straightforward steps, on the local machine set up a folder of any name, preferably name that user can easily understand. Navigate into the folder using terminal in Mac or cmd on windows and simply clone the project created on Git by using below commands.

cd foldercreatedabove

git clone https://github.com/project/repository.git

These are different ways to do it, one might implement the project first locally and then push changes to Git, but for this project we first created project reposit. Other individual might rename the project locally but for this project name consistency was

important thus everything was exactly from remote to locally. As mention previously, this part has more than one implementation method, thus user needs to select what fits for their own needs.

Upon completing cloning process, then folder structure was created. This was based on the framework described above and also environments to be monitored. As see from Figure 24 the project structure and inside the folder project specific data as added in the Ansible playbook.

4.2.2 Project specific settings

In the ansible playbook configurations folder, there several configurations were made. These are mainly project specific settings, which act as basic settings for the whole project.

It can be seen from the Figure 25 on ansible>config>monitoring.yml.

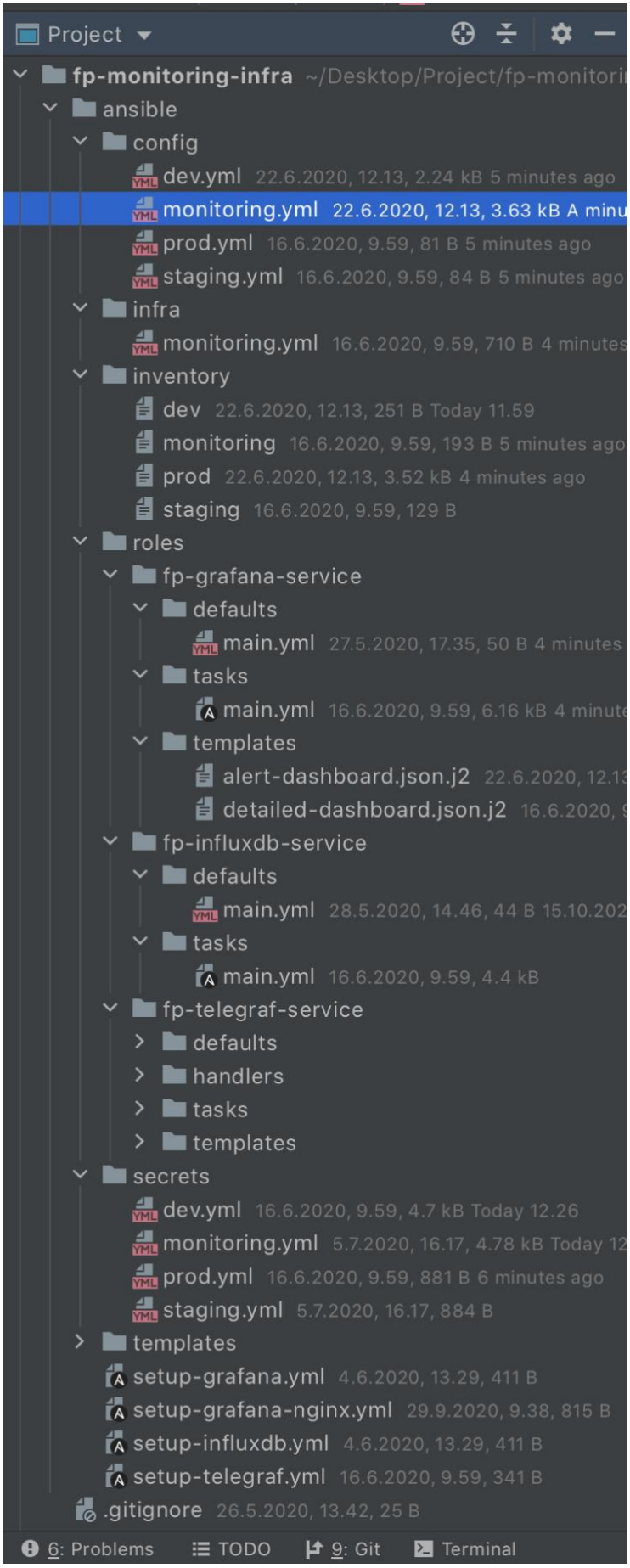


Figure 25. Project specific settings

Configurations for Grafana domain URL and path, this is where domain needs to be defined as well as Grafana path for accessing the tool. URL is where the toll will be hosted.

```
grafana:
  domain: 'yourdomain.com'
  path: 'grafana'
```

Configurations for sending out email notifications, this was needed in the alerting process of this tool. SMTP email server needs to be defined.

```
smtp:
  host: 'in-v3.mymail.com'
  port: 587
  sender:
    name: 'Grafana Monitoring'
    address: 'monitoring@yourdomain.com'
```

Microsoft teams' notifications settings as well as email notification specific settings were added, in this section these needs to be defined so that Grafana knows where to send the notifications. The frequency for sending out alert is two hours.

```
notification:
  channels:
    email_channel:
      name: email-channel
      type: email
      uid: notifier1
      orgId: 1
      isDefault: false
      sendReminder: true
      frequency: 2h
      disablResolveMessage: false
      settings:
        singleEmail: false
        addresses: 'monitoring@yourdomain.com'
    teams_channel:
      name: teams-channel
      type: teams
      uid: notifier2
      orgId: 1
      isDefault: false
      sendReminder: true
      frequency: 2h
      disablResolveMessage: false
      # url is kept in secrets
```

After that in the basic configurations default Grafana dashboards were defined, this is for visualizing the metrics that will be obtained. These dashboard settings are by default and they can be found from Grafana source, but they can also be modified per needs.

```
dashboards:
  grafana:
    - template: 'detailed-dashboard.json.j2'
      uid: '000000651'
      name: "Detailed staging dashboard"
      datasource: '{{ influx.databases.staging.name }}'
    - template: 'detailed-dashboard.json.j2'
      uid: '000000652'
      name: "Detailed monitoring dashboard"
      datasource: '{{ influx.databases.monitoring.name }}'
    - template: 'detailed-dashboard.json.j2'
      uid: '000000653'
      name: "Detailed production dashboard"
      datasource: '{{ influx.databases.prod.name }}'
    - template: 'alert-dashboard.json.j2'
      uid: '000000654'
      name: "Overview production dashboard"
      datasource: '{{ influx.databases.prod.name }}'
      hosts: '{{ grafana_influx_prod_hosts.query_results |
map(attribute="value") | list }}'
      extra_mountpoints:
        mongo_1:
          - /mongo-data
      alerts:
        cpu:
          threshold: 50
          notifiers:
            - uid: '{{
grafana.notification.channels.email_channel.uid }}'
            - uid: '{{
grafana.notification.channels.teams_channel.uid }}'
        memory:
          threshold: 80
          notifiers:
            - uid: '{{
grafana.notification.channels.email_channel.uid }}'
            - uid: '{{
grafana.notification.channels.teams_channel.uid }}'
        disk:
          threshold: 80
          notifiers:
            - uid: '{{
grafana.notification.channels.email_channel.uid }}'
            - uid: '{{
grafana.notification.channels.teams_channel.uid }}'
    - template: 'alert-dashboard.json.j2'
      uid: '000000655'
      name: "Overview monitoring dashboard"
      datasource: '{{ influx.databases.monitoring.name }}'
      hosts: '{{ grafana_influx_monitoring_hosts.query_results |
map(attribute="value") | list }}'
      extra_mountpoints:
```

```
        influx_1:
          - /var/fp
      alerts:
        cpu:
          threshold: 50
          notifiers:
            - uid: '{{
grafana.notification.channels.email_channel.uid }}'
            - uid: '{{
grafana.notification.channels.teams_channel.uid }}'
        memory:
          threshold: 80
          notifiers:
            - uid: '{{
grafana.notification.channels.email_channel.uid }}'
            - uid: '{{
grafana.notification.channels.teams_channel.uid }}'
        disk:
          threshold: 80
          notifiers:
            - uid: '{{
grafana.notification.channels.email_channel.uid }}'
            - uid: '{{
grafana.notification.channels.teams_channel.uid }}'
```

Influx DB settings, in this section host databases had to be defined and those were based on the development process in place. Which is three environments development for initial development, staging for performing QA of development environment and finally production where it is a production environment. We have given access Influx DB to several databases.

```
influx:
  host: '10.4.12.44'
  port: 8086
  url: 'http://10.4.12.44:8086'
  databases:
    monitoring:
      name: 'influxdb-fp-monitoring'
      database: 'fp_monitoring_db'
    prod:
      name: 'influxdb-fp-prod'
      database: 'fp_prod_db'
    staging:
      name: 'influxdb-fp-staging'
      database: 'fp_staging_db'
```

Also, in the prod.yml file as seen from Figure 22, Telegraf settings had to be done. Those were for collecting and reporting the metrics from production database. Rest of the files were used for development and staging environment.

```
telegraf:
  influx:
    url: 'http://10.4.12.44:8086'
    database: 'fp_prod_db'
```

Figure 22 shows infra folder where settings related to the whole project infrastructure were made. Basically, components like Grafana servers and Influx DB servers of the project, and these servers are the database defined from previous section.

```
grafana_servers:
  upcloud_hosts:
    - title: "[Monitoring] Grafana host"
      hostname: hostname.com

  upcloud_plan: "1xCPU-2GB"
  upcloud_storage_devices:
    - { size: 30, os: Ubuntu 18.04 }
  upcloud_firewall_rules: "{{ firewall.webserver_rules }} + {{
firewall.gitlab_ci_rules }}"
  upcloud_user: "devops"
  upcloud_ssh_keys: "{{ ssh_keys.devops }}"
  upcloud_zone: de-fra1

influx_servers:
  upcloud_hosts:
    - title: "[Monitoring] Influx host"
      hostname: hostname.com

  upcloud_plan: "2xCPU-4GB"
  upcloud_storage_devices:
    - { size: 30, os: Ubuntu 18.04 }
  upcloud_user: "devops"
  upcloud_ssh_keys: "{{ ssh_keys.devops }}"
  upcloud_zone: de-fra1
```

It is the inventory folder where we define all the hosts that are going to be monitored, for this project all servers were defined and monitored. In this folder we can list either individual hosts or custom defined groups of hosts. This means that user can define group of devices running using similar roles e.g. content API

These are the inventory settings for Grafana ADD

```
[all:vars]
ansible_user=devops

[grafana_server]
94.237.98.70      short_name=grafana_1
nginx_domain_name=monitoring.yourdomain.com

[influx_server]
94.237.98.57      short_name=influx_1
```

.

Below is an example of the production inventory where all hosts to be monitored were connected to Influx DB. For this project we managed to add multiple devices.

Hence, data has been changed for security reasons.

```
[all:vars]
ansible_user=devops
ansible_ssh_common_args='-o StrictHostKeyChecking=no'

[target_servers]
94.234.85.98     short_name=lb_private_1          uc_hostname=lb-
private.fp-prod.prod.fi            uc_uuid=98377-c74a-47dc-23dsa-
e802d666e789
94.457.8.236      short_name=lb_public_1
uc_hostname=me.yourdomain.com                 uc_uuid=23423khkj-d68f-
490a-a8ae-2389hd77hd

94.466.09.652     short_name=host_1               uc_hostname=fp-
prod-host1.yourdomain.dev                uc_uuid=kjshdkd273-6aad-
46ca-86df-sldkj238983
94.876.38.93      short_name=host_2               uc_hostname=fp-
prod-host2.yourdomain.dev                uc_uuid=sdsad3-f879dsd4756-
8efb-adasd23e

94.988.93.491     short_name=rabbit_mq_1          uc_hostname=fp-
prod-rabbitmq.yourdomain.dev             uc_uuid=sdwew322432-ddf3-
471f-98fd-2342342d223dwd23

94.763.93.322     short_name=my_api_postgres_1  uc_hostname=radar-
api-postgres.fp-prod.yourdomain.fi    uc_uuid=ndhdh737373-d951-4d3d-
8319-7363hhdy26bd
94.098.987.994     short_name=my_api_1           uc_hostname=radar-
api.fp-prod.yourdomain.fi             uc_uuid=nhdh78377-3feb-4e1e-
93ff-983hhd7636h3

94.724.99.507       short_name=minio_1
uc_hostname=minio.fp-prod.yourdomain.fi                 uc_uuid=nksd-
6fbf-43a9-jdhd7-jdjdj837ndn73
94.876.27.541     short_name=my_ai_minio_1       uc_hostname=myai-
minio.fp-prod.yourdomain.fi          uc_uuid=00aa79e9-44f9-4941-a4d1-
582e8cb69a7b
94.237.31.138     short_name=my_ai_en_1          uc_hostname=myai-
en.fp-prod.yourdomain.fi             uc_uuid=00acebde-6a66-4f37-a7be-
f29e929acced
94.237.83.115     short_name=my_ai_fi_1          uc_hostname=myai-
fi.fp-prod.yourdomain.fi             uc_uuid=nasdkdakjansd-99ab-44fb-
8de1-3355fe072e9b

94.283.84.509      short_name=media_api_1
uc_hostname=media-api1.fp-prod.yourdomain.fi
uc_uuid=892398jh-c831-495f-ae9e-57a86d468bf5
94.237.31.128     short_name=media_api_2           uc_hostname=media-
api2.fp-prod.yourdomain.fi            uc_uuid=00a8abe9-ac5e-4ff3-
94e4-98387237783hjjh2

94.237.26.224     short_name=elastic_2020_1        uc_hostname=fp-
prod-es2020.yourdomain.dev               uc_uuid=9829737nwdjkd-f4a0-
4ebb-8b09-6f9ffb76f599
```

```
94.237.86.174      short_name=elastic_updater_1
uc_hostname=elastic-updater.fp-prod.yourdomain.fi
uc_uuid=001b0ad8-63cf-4aa0-ab93-22192f20cc2f

94.237.93.248      short_name=news_mine_postgres_1  uc_hostname=news-
mine-postgres.fp-prod.yourdomain.fi    uc_uuid=008df7a7-2107-4f96-
b441-715ef0c33e27
94.237.93.247      short_name=news_mine_api_1       uc_hostname=news-
mine-api.fp-prod.yourdomain.fi         uc_uuid=039383-50e6-48ba-9283-
af917eedb9e5
94.237.89.189      short_name=news_mine_scraper_1   uc_hostname=news-
mine-scraper.fp-prod.yourdomain.fi     uc_uuid=938383jj-d449-4a93-
a5dd-6c5d9fda6f57

94.937.91.44       short_name=mongo_1               uc_hostname=fp-
prod-mongo.yourdomain.dev                uc_uuid=0095506e-bd32-43b6-
b166-e552f740b5bd
94.2152.8.237       short_name=postgres_1
uc_hostname=postgres.fp-prod.yourdomain.fi
uc_uuid=0039ff88-0c7d-48f1-b2b7-932832882332j
94.9387.85.198      short_name=mysql_1
uc_hostname=mysql.fp-prod.yourdomain.fi
uc_uuid=00a12efa-6946-4e33-9409-jkasjkds878937893e
94.2938.89.191      short_name=redis_1
uc_hostname=redis.fp-prod.yourdomain.fi
uc_uuid=dkd838833-4ac3-jdjhd-8e6c-cee9b0dfe2bb

94.237.85.156      short_name=drupal_1
uc_hostname=drupal.fp-prod.yourdomain.fi
uc_uuid=00115169-de8f-446e-b943-lkjlkdk378937893
```

4.3 Initial setup of Influx DB

In this section of configurations, Influx DB services must be set up first this is because Grafana uses Influx DB set up for fetching the hosts data for setting up the dashboards. Initially Influx was configured for the testing environments which were development where initial developments are done and second development2 which is mainly for migrating developments done on the first environment and the doing proper QA. So, at the beginning it was configured to have two databases and production database was added later after evaluations process.

For each database added it had its own user for writing metrics and also one read-only user used for Grafana.

Below are the Ansible commands used more can be found from several online resource example from (https://docs.influxdata.com/influxdb/v1.7/introduction/installation/).

```
ansible-playbook -i ansible/inventory/monitoring \
```

```
  --vault-id=fp-monitoring@<path_to_local_vault_file> \
  --extra-vars=@ansible/config/monitoring.yml  \
  --extra-vars=@ansible/secrets/monitoring.yml \
  --tags=setup \
    ansible/setup-influxdb.yml
```

Configuration (databases)

```
ansible-playbook -i ansible/inventory/monitoring \
  --vault-id=fp-monitoring@<path_to_local_vault_file> \
  --extra-vars=@ansible/config/monitoring.yml  \
  --extra-vars=@ansible/secrets/monitoring.yml \
  --tags=config \
    ansible/setup-influxdb.yml
```

There are several services components were also configured such Influx data volume which the amount the data collected.

Docker networks settings were also implemented where image of influx dB: 1.8.0-alpine was used. More information of these docker image versions for Influx can be found from (https://hub.docker.com/_/influxdb). Also starting docker service contains settings were added, as well as creating Influx databases and database rights were added.

Please refer to the below piece of code for the Influx DB implementations, hence data values were modified.

```
- name: "Install required pip packages for influx"
  pip:
    state: 'present'
    name: ['influxdb==5.3.0']
  tags:
    - setup

- name: "Make sure that directories exist"
  file:
    path: "{{ item }}"
    state: directory
    recurse: yes
  with_items:
    - '/var/fp/influxdb_data'
  tags:
    - setup

- name: "Create influx data volume"
  docker_volume:
    state: present
    name: "influxdb_data"
    driver_options:
      type: none
      device: '/var/fp/influxdb_data'
      o: bind
```

```
  tags:
    - setup

- name: "Create docker networks"
  docker_network:
    state: present
    name: "{{ item }}"
  loop:
    - monitoring_network
  tags:
    - setup

- name: "Start Influxdb service container"
  docker_container:
    state: started
    restart_policy: unless-stopped
    name: influxdb
    image: "{{ influxdb_docker_image }}"
    pull: no
    recreate: no
    ports:
      - 8086:8086
    env:
      NFLUXDB_HTTP_AUTH_ENABLED: 'true'
      INFLUXDB_ADMIN_USER: '{{ secrets.influx.admin.username }}'
      INFLUXDB_ADMIN_PASSWORD: '{{ secrets.influx.admin.password }}'
    log_driver: 'json-file'
    log_options:
      max-size: '200m'
      max-file: '5'
    volumes:
      - influxdb_data:/var/lib/influxdb
    networks:
      - { 'name': 'monitoring_network' }
  tags:
    - setup

- name: "Create influx databases"
  influxdb_database:
    hostname: 'localhost'
    port: 8086
    username: '{{ secrets.influx.admin.username }}'
    password: '{{ secrets.influx.admin.password }}'
    database_name: '{{ item.value.database }}'
    ssl: no
    validate_certs: no
  loop: '{{ lookup("dict", influx.databases) }}'
  loop_control:
    label: "{{ item.key }}"
  tags:
    - setup
    - config

- name: "setup influx retention policy"
  influxdb_retention_policy:
    hostname: 'localhost'
    port: 8086
    username: '{{ secrets.influx.admin.username }}'
    password: '{{ secrets.influx.admin.password }}'
    database_name: '{{ item.value.database }}'
    policy_name: default_retention_policy
    duration: 4w
    replication: 1
```

```
  loop: '{{ lookup("dict", influx.databases) }}'
  loop_control:
    label: "{{ item.key }}"
  tags:
    - setup
    - config

- name: "Create read-only user for grafana"
  influxdb_user:
    hostname: "localhost"
    port: 8086
    login_username: '{{ secrets.influx.admin.username }}'
    login_password: '{{ secrets.influx.admin.password }}'
    user_name: '{{ secrets.influx.grafana_user.username }}'
    user_password: '{{ secrets.influx.grafana_user.username }}'
    grants:
      - database: '{{ influx.databases.monitoring.database }}'
        privilege: 'READ'
      - database: '{{ influx.databases.prod.database }}'
        privilege: 'READ'
      - database: '{{ influx.databases.staging.database }}'
        privilege: 'READ'
  tags:
    - setup
    - config

- name: "Create write-only user for telegraf monitoring hosts"
  influxdb_user:
    hostname: "localhost"
    port: 8086
    login_username: '{{ secrets.influx.admin.username }}'
    login_password: '{{ secrets.influx.admin.password }}'
    user_name: '{{
secrets.influx.databases.monitoring.telegraf_user.username }}'
    user_password: '{{
secrets.influx.databases.monitoring.telegraf_user.password }}'
    grants:
      - database: '{{ influx.databases.monitoring.database }}'
        privilege: 'WRITE'
  tags:
    - setup
    - config

- name: "Create write-only user for telegraf prod hosts"
  influxdb_user:
    hostname: "localhost"
    port: 8086
    login_username: '{{ secrets.influx.admin.username }}'
    login_password: '{{ secrets.influx.admin.password }}'
    user_name: '{{
secrets.influx.databases.prod.telegraf_user.username }}'
    user_password: '{{
secrets.influx.databases.prod.telegraf_user.password }}'
    grants:
      - database: '{{ influx.databases.prod.database }}'
        privilege: 'WRITE'
  tags:
    - setup
    - config

- name: "Create write-only user for telegraf staging hosts"
  influxdb_user:
    hostname: "localhost"
```

```
    port: 8086
    login_username: '{{ secrets.influx.admin.username }}'
    login_password: '{{ secrets.influx.admin.password }}'
    user_name: '{{
secrets.influx.databases.staging.telegraf_user.username }}'
    user_password: '{{
secrets.influx.databases.staging.telegraf_user.password }}'
    grants:
      - database: '{{ influx.databases.staging.database }}'
        privilege: 'WRITE'
  tags:
    - setup
    - config
```

4.4 Initial setup of Grafana

Grafana services set up was added after completing Influx changes above. The setup with done for the first two development environments explained on Chapter 4.3.

```
ansible-playbook -i ansible/inventory/monitoring \
  --vault-id=fp-monitoring@<path_to_local_vault_file> \
  --extra-vars=@ansible/config/monitoring.yml  \
  --extra-vars=@ansible/secrets/monitoring.yml \
  --tags=setup \
    ansible/setup-grafana.yml
```

Docker networks settings were also implemented where docker image of Grafana/grafana:7.0.1-ubuntu was used. More information of these docker image versions for Grafana can be found from (https://hub.docker.com/r/grafana/grafana/). Also starting docker service containers settings were added, as well as creating Influx databases and database rights were added. As explained on previous chapter same settings were added on Grafana as well.

Please refer to the below piece of code for the Grafana implementations, hence sensitive data values were modified.

```
# It's needed as we will get some hosts from influx to template the
dashboard
- name: "Install required pip packages for influx"
  pip:
    state: 'present'
    name: ['influxdb==5.3.0']
  tags:
    - setup

- name: "Make sure that directories exist"
```

```
  file:
    path: "{{ item }}"
    state: directory
    recurse: yes
  with_items:
    - '/var/fp/grafana_data'
  tags:
    - setup

- name: "Create grafana data volume"
  docker_volume:
    state: present
    name: "grafana_data"
    driver_options:
      type: none
      device: '/var/fp/grafana_data'
      o: bind
  tags:
    - setup

- name: "Create docker networks"
  docker_network:
    state: present
    name: "{{ item }}"
  loop:
    - monitoring_network
  tags:
    - setup

- name: "Start Grafana service container"
  docker_container:
    state: started
    restart_policy: unless-stopped
    name: grafana
    image: "{{ grafana_docker_image }}"
    pull: no
    recreate: no
    ports:
      - 3000:3000
    env:
      GF_SERVER_PROTOCOL: "http"
      GF_SERVER_DOMAIN: "{{ grafana.domain }}"
      GF_SERVER_ENFORCE_DOMAIN: "false"
      GF_SERVER_ROOT_URL: "%(protocol)s://%(domain)s/{{ grafana.path
}}"
      GF_SECURITY_ADMIN_PASSWORD: "{{ secrets.grafana.admin.password
}}"
      GF_SMTP_ENABLED: "true"
      GF_SMTP_HOST: '{{ grafana.smtp.host }}:{{ grafana.smtp.port }}'
      GF_SMTP_USER: '{{ secrets.grafana.smtp.username }}'
      GF_SMTP_PASSWORD: '{{ secrets.grafana.smtp.password }}'
      GF_SMTP_FROM_NAME: '{{ grafana.smtp.sender.name }}'
      GF_SMTP_FROM_ADDRESS: '{{ grafana.smtp.sender.address }}'
      GF_SMTP_SKIP_VERIFY: 'false'
      GF_SMTP_WELCOME_EMAIL_ON_SIGNUP: 'false'
      GF_USERS_ALLOW_SIGN_UP: "false"
      GF_USERS_ALLOW_ORG_CREATE: "false"
      GF_SERVER_ENABLE_GZIP: "true"
      GF_INSTALL_PLUGINS: "grafana-clock-panel,grafana-simple-json-
datasource,petrslavotinek-carpetplot-panel,savantly-heatmap-
panel,vonage-status-panel,neocat-cal-heatmap-panel,natel-discrete-
panel,flant-statusmap-panel,grafana-image-renderer"
    log_driver: 'json-file'
```

```
    log_options:
      max-size: '200m'
      max-file: '5'
    volumes:
      - grafana_data:/var/lib/grafana
    networks:
      - { 'name': 'monitoring_network' }
  tags:
    - setup

- name: Pause play until a URL is reachable from this host
  uri:
    url: "http://localhost:3000"
    follow_redirects: none
    method: GET
    user: "admin"
    password: "{{ secrets.grafana.admin.password }}"
    force_basic_auth: yes
  register: _result
  until: _result.status == 200
  retries: 12 # 1 minute
  delay: 5 # Every 5 seconds
  tags:
    - setup

- name: "Create influxdb datasources for monitoring hosts"
  grafana_datasource:
    name: " {{ item.value.name }}"
    grafana_url: "http://localhost:3030"
    grafana_user: "admin"
    grafana_password: "{{ secrets.grafana.admin.password }}"
    org_id: "1"
    ds_type: "influxdb"
    ds_url: "{{ influx.url }}"
    database: "{{ item.value.database }}"
    user: '{{ secrets.influx.grafana_user.username }}'
    password: '{{ secrets.influx.grafana_user.password }}'
    time_interval: ">10s"
  loop: '{{ lookup("dict", influx.databases) }}'
  loop_control:
    label: "{{ item.key }}"
  tags:
    - setup
    - config

- name: "Get notifications channels"
  uri:
    url: "http://localhost:3030/api/alert-notifications"
    user: "admin"
    password: "{{ secrets.grafana.admin.password }}"
    force_basic_auth: true
    method: GET
  register: grafana_notification_channels
  tags:
    - setup
    - config

- set_fact:
    grafana_notification_channels_ids: "{{
grafana_notification_channels.json | map(attribute='uid') | list }}"
  tags:
    - setup
    - config
```

```
- name: "Setup notification channels"
  uri:
    url: "http://localhost:3030/api/alert-notifications{{
(item.value.uid in grafana_notification_channels_ids) |
ternary('/uid/' + item.value.uid, '') }}"
    user: "admin"
    password: "{{ secrets.grafana.admin.password }}"
    force_basic_auth: true
    method: "{{ (item.value.uid in grafana_notification_channels_ids)
| ternary('PUT', 'POST') }}"
    body_format: json
    body: "{{ item.value | to_json }}"
  loop: '{{ lookup("dict", grafana.notification.channels |
combine(secrets.grafana.notification.channels, recursive=True)) }}'
  tags:
    - setup
    - config

- name: "Get the hosts from influx monitoring db"
  influxdb_query:
    hostname: "{{ influx.host }}"
    port: "{{ influx.port }}"
    login_username: '{{ secrets.influx.grafana_user.username }}'
    login_password: '{{ secrets.influx.grafana_user.password }}'
    database_name: "{{ influx.databases.monitoring.database }}"
    query: 'SHOW TAG VALUES FROM system WITH KEY=host'
  register: grafana_influx_monitoring_hosts
  tags:
    - setup
    - config
    - dashboards

- name: "Get the hosts from dev2 influx db"
  influxdb_query:
    hostname: "{{ influx.host }}"
    port: "{{ influx.port }}"
    login_username: '{{ secrets.influx.grafana_user.username }}'
    login_password: '{{ secrets.influx.grafana_user.password }}'
    database_name: "{{ influx.databases.staging.database }}"
    query: 'SHOW TAG VALUES FROM system WITH KEY=host'
  register: grafana_influx_staging_hosts
  tags:
    - setup
    - config
    - dashboards

- name: "Get the hosts from prod influx db"
  influxdb_query:
    hostname: "{{ influx.host }}"
    port: "{{ influx.port }}"
    login_username: '{{ secrets.influx.grafana_user.username }}'
    login_password: '{{ secrets.influx.grafana_user.password }}'
    database_name: "{{ influx.databases.prod.database }}"
    query: 'SHOW TAG VALUES FROM system WITH KEY=host'
  register: grafana_influx_prod_hosts
  tags:
    - setup
    - config
    - dashboards

- name: "Setup dashboards"
  uri:
```

```
    url: "http://localhost:3030/api/dashboards/db"
    user: "admin"
    password: "{{ secrets.grafana.admin.password }}"
    force_basic_auth: true
    method: POST
    body_format: json
    body: '{
            "dashboard": {{ lookup("template", item.template) }},
            "folderId": 0,
            "overwrite": true
          }'
  loop: '{{ dashboards.grafana }}'
  tags:
    - setup
    - config
    - dashboards
```

4.5 Initial setup of Telegraf

Since Telegraf will be used for collection a d reporting metrics, so it was set up to listen all the hosts that were kept in ansible/inventory/prod file under target_servers group and use Influx DB as an output. With this way ssh connectivity must be established with the name@<target_host> for Telegraf services to function.

Docker networks settings were also implemented where image of telegraf: 1.14.3-alpine was used. More information of these docker image versions for telegraf can be found from (https://hub.docker.com/_/telegraf). Also starting docker service contains settings were added.

```
telegraf_docker_image: 'telegraf:1.14.3-alpine'

telegraf_influx_db:
  url: ''
  name: ''
  username: ''
  password: ''
```

Ansible script used for configurations:

```
ansible-playbook -i ansible/inventory/prod \
  --vault-id=fp-prod@<path_to_local_vault_file> \
  --extra-vars=@ansible/config/prod.yml  \
  --extra-vars=@ansible/secrets/prod.yml \
  --tags=setup \
    ansible/setup-telegraf.yml
```

Configurations for continuous deployment of Telegraf services were also implemented, these were to make sure the services are going to be up.

```
- name: "Reload telegraf service"
  command: "docker exec telegraf pkill -1 telegraf"
  listen:
    - reload_telegraf
  tags:
    - config
```

More detailed information about the Telegraf tasks settings can be found in Appendix 1 as well as Telegraf template settings can be found on Appendix 2, this data is very detailed and very long. Please refer to Git for further details (https://github.com/influxdata/telegraf)

4.6 Configuring dashboards on Grafana

Depends on the needs, there are several ways to define the dashboards on Grafana and this is a topic which should be planned well before hand. For this project it was decided to have two types of dashboard

1. Detailed dashboard – This needs to be s separate dashboard for each host which contains all the monitored metrics related to this hosts. Whenever there is a new server it should be added for in the detailed dashboard.
   Figure 26 shows the detailed dashboard type from one of the servers.

Figure 26. Detailed host dashboard

2. An overview dashboard – This is type of dashboard contains metrics from all monitored servers. This is where you can see an overall health of all servers added to the services as seen from Figure 27. For overview dashboard it must be set up every time whenever new server is added.

Figure 27. An overview dashboard type.

Below scripts was used for defining these dashboards.

```
ansible-playbook -i ansible/inventory/monitoring \
  --vault-id=fp-monitoring@<path_to_local_vault_file> \
  --extra-vars=@ansible/config/monitoring.yml  \
  --extra-vars=@ansible/secrets/monitoring.yml \
  --tags=dashboards \
    ansible/setup-grafana.yml
```

Figure 28 shows the settings for detailed dashboard.

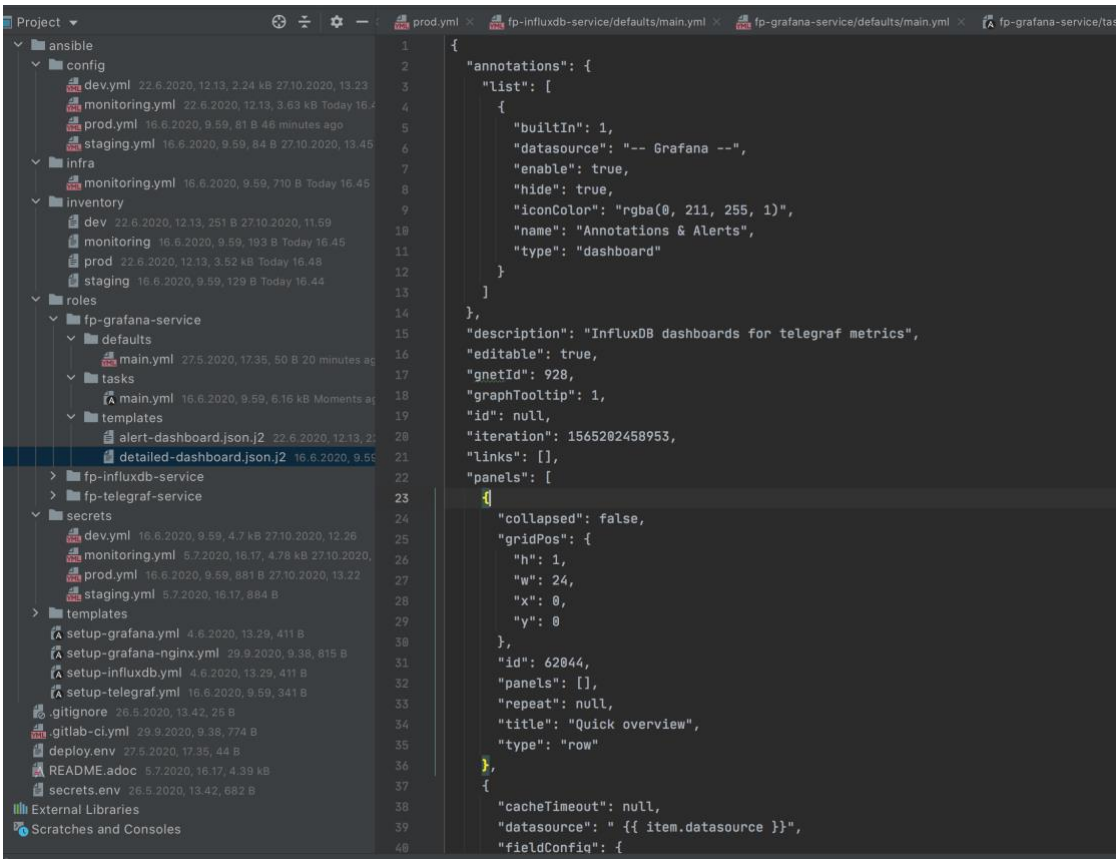


Figure 28. Settings for detailed dashboard.

4.7 Settings for alerting rules

As alerting needs explained in in Chapter 3.1, the settings were defined based on the alerting channels which were Microsoft Teams and Outlook.

Refer to the below scripts to observer what has been implemented on the alerting rules set up and from which dashboards with the threshold of 50% and 80% resources usage.

```
grafana:
  domain: 'monitoring.yourdomain.com'
  path: 'grafana'

  smtp:
    host: 'in-v3.mymail.com'
    port: 562
```

```
    sender:
      name: 'Grafana Monitoring'
      address: 'monitoring@yourdomain.com'

  notification:
    channels:
      email_channel:
        name: email-channel
        type: email
        uid: notifier1
        orgId: 1
        isDefault: false
        sendReminder: true
        frequency: 2h
        disablResolveMessage: false
        settings:
          singleEmail: false
          addresses:
'monitoring@yourdomain.com;email.myemail@yourdomain.com'
      teams_channel:
        name: teams-channel
        type: teams
        uid: notifier2
        orgId: 1
        isDefault: false
        sendReminder: true
        frequency: 2h
        disablResolveMessage: false
        # url is kept in secrets

dashboards:
  grafana:
    - template: 'detailed-dashboard.json.j2'
      uid: '000000651'
      name: "Detailed staging dashboard"
      datasource: '{{ influx.databases.staging.name }}'
    - template: 'detailed-dashboard.json.j2'
      uid: '000000652'
      name: "Detailed monitoring dashboard"
      datasource: '{{ influx.databases.monitoring.name }}'
    - template: 'detailed-dashboard.json.j2'
      uid: '000000653'
      name: "Detailed production dashboard"
      datasource: '{{ influx.databases.prod.name }}'
    - template: 'alert-dashboard.json.j2'
      uid: '000000654'
      name: "Overview production dashboard"
      datasource: '{{ influx.databases.prod.name }}'
      hosts: '{{ grafana_influx_prod_hosts.query_results |
map(attribute="value") | list }}'
      extra_mountpoints:
        mongo_1:
          - /mongo-data
      alerts:
        cpu:
          threshold: 50
          notifiers:
            - uid: '{{
grafana.notification.channels.email_channel.uid }}'
            - uid: '{{
grafana.notification.channels.teams_channel.uid }}'
        memory:
          threshold: 80
```

```
          notifiers:
            - uid: '{{
grafana.notification.channels.email_channel.uid }}'
            - uid: '{{
grafana.notification.channels.teams_channel.uid }}'
        disk:
          threshold: 80
          notifiers:
            - uid: '{{
grafana.notification.channels.email_channel.uid }}'
            - uid: '{{
grafana.notification.channels.teams_channel.uid }}'
    - template: 'alert-dashboard.json.j2'
      uid: '000000655'
      name: "Overview monitoring dashboard"
      datasource: '{{ influx.databases.monitoring.name }}'
      hosts: '{{ grafana_influx_monitoring_hosts.query_results |
map(attribute="value") | list }}'
      extra_mountpoints:
        influx_1:
          - /var/fp
      alerts:
        cpu:
          threshold: 50
          notifiers:
            - uid: '{{
grafana.notification.channels.email_channel.uid }}'
            - uid: '{{
grafana.notification.channels.teams_channel.uid }}'
        memory:
          threshold: 80
          notifiers:
            - uid: '{{
grafana.notification.channels.email_channel.uid }}'
            - uid: '{{
grafana.notification.channels.teams_channel.uid }}'
        disk:
          threshold: 80
          notifiers:
            - uid: '{{
grafana.notification.channels.email_channel.uid }}'
            - uid: '{{
grafana.notification.channels.teams_channel.uid }}'


influx:
  host: '10.4.76.54
  port: 8086
  url: 'http://10.4.45.44:9904
  databases:
    monitoring:
      name: 'influxdb-fp-monitoring'
      database: 'fp_monitoring_db'
    prod:
      name: 'influxdb-fp-prod'
      database: 'fp_prod_db'
    staging:
      name: 'influxdb-fp-staging'
      database: 'fp_staging_db'
```

5 Testing phase (QA)

5.1 Quality Assurance

Quality assurance refers to the systematic process of testing services or product meets certain requirements (Tiempo Development 2019), meaning that QA has to make sure the organization deliver the best product or services as possible. Upon completion of the project, for this completion phase it was completed on development stage the team compose internal testing cases (this is organization's level). This is the environment for implementing or conducting the first stage of QA, which was done in few steps.

Initial requirements and needs were clearly reviewed, they were aligned together with the metrics components of the tool, meaning there were comparisons of the project requirements together with Grafana. Grafana installed on development environment was presented to the team, all monitored hosts/servers were examined and evaluated based on the metrics produced by the tool, meaning that it was discussed if all servers and its elements are monitored and tracked well and in case of issues can the system send out alert notifications. The team went through each server's monitoring needs and what is produced by Grafana, several tests were conducted to ensure that the tool work as expected. Several notifications were sent out from Grafana to confirm that this system is stable and the ability to send out notifications is also stable.

The tool was tested on the UI, this was selecting different dashboards and previewing many data metrics, changes were made on the dashboards and observe how they reflect on the UI.

Other test conducted were from an internal testing case which was compose upon installing the tool, unfortunately this is a matter of internal communications and it is also confidential so it will not be covered on this report however any one can create their own testing cases based on their needs.

Overall, the team followed general procedures on conducting QA process with just minor modifications in it. Refer to Figure 29 (Mikhailau 2019) to understand the general processes of quality assurance.

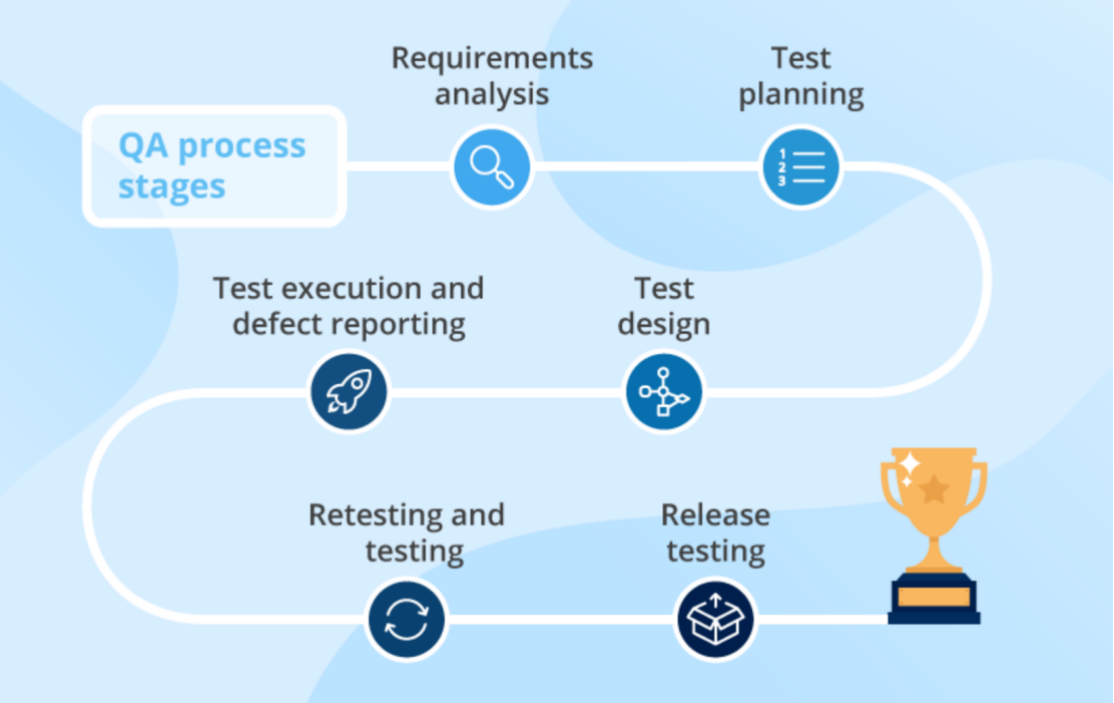


Figure 29. QA general processes

5.2 Testing methodologies

There are various ways of testing software, this topic is also based on the organization requirements and policies. For this project it was decided to test the tool so that to make sure it can successfully operate in multiple environments, it can also monitor multiple hosts efficiently and also its ability to send out alert notifications to teams' channel and outlook.

Next, we go into details of the testing methodology conducted where the goal was to utilize these methodologies in the tool installation process.

Unit testing:

This is one of the first level of testing, it was simply the process of making sure that these individual components (Telegraf, Influx DB and Grafana) that makes the whole automated monitoring system works as they should. Documented testing cases were conducted on the development environment, this process was automated to expand the testing coverage. Issues identified were fixed and unit test was conducted again to verify that it has passed.

Integration testing:

On this section it was tested to make sure the integration of the above components is working fine, meaning that databases are connect and the metrics are sent over to Influx DB to be visualized in Grafana. In this methodology all the components were tested as group to see the integration behaviour and ensuring the whole segment of the tool is working as expected. This type of test involved selecting different databases and observe the metrics to see if they match source DB and if they are correct ones.

Performance testing:

This is basically non-functionally type of testing which involves testing the tool's behaviour under different situations. The main goal if this testing method was to examine how Grafana is stable in terms of loading it with large amounts to data from different time frames. Testing data was loaded data on the tool to find out if the system will still able to accept it and also visualize them correct in time series. Upon this test it was agreed that the tool was stable.

Compatibility testing:

This simple testing method was done to understand if the tool is compatible with different data sources and environments. This was mainly an internal knowledge since there are several sources of data to be monitored and visualize. It was also needed to understand how this tool is compatible with different operating systems which hosts the data sources.

System testing:

In this testing methodology, the whole components of the tool were tested as one package. Meaning that the functionality of the tool needed to be tested against the specific requirements of the project.

Usability testing:

Usability testing involved measuring how the tool is easy to user, this is to verify that end-user perspective of utilizing the tool. The main goal is to determine if a person with less technical background can login to Grafana and easily select what dashboard type to observe the metrics. Also, if the metrics can let this individual know about the stability of the hosts.

5.3 QA Results

The results of QA process were clearly identified, this was based on the needs of the tool and also testing phase of the tools. Based on the needs it was confirmed that this tool meets organizations monitoring needs and it will be valuable in terms of future perspective.

For the short descriptions of the testing results refer to Table 2.

Table 4. Testing results

Testing method	Comments
Unit testing	It has passed unit testing
Integration testing	It has passed integration testing; data was sent across the tool for monitoring.
Performance testing	It has passed performance testing
Compatibility testing	It has passed compatibility testing
System testing	It has passed system testing, but a person needs to be careful not to save dashboard on the UI. Saving them will affect the default dashboards created previously
Usability	It needs to be used with someone with good technical understand IT. It will be difficult for nontechnical person to have broader understand of the metrics and even using the tool.

6 Evaluation of the project

6.1 Evaluation at Futures Platform

Evaluation is described as a process of genuinely analysing a program (e.g. project, research, or publication) by Thomson & Hoffman (2003). The process involves several phases and steps in order to collect and examine the data about program's actions, aspects and the outcome of it. Figure 30 (Castle 2018) describes the process.

Figure 30. Evaluation process.

Project evaluation is defined as process evaluation; however, it mainly involves the assessment of an ongoing, as well as a completed project or research in an organization. The main focus on this is to determine the level of achievement, impact (can be profitability) and perhaps sustainability of the project in a company.

In many organizations this process has been adapted for several reasons. One main purpose from the organization's point of view is to determine how successful a certain program is; areas of improvement reshape the goals. Also, when evaluation results are shared among the organization, it helps the company to advance several processes based on what was done effectively and what was not.

At Futures Platform, we use project evaluation for several purposes, which are mainly focused not only on business benefits but also on employees' wellbeing and their personal development plans. The following items lists ADD

1. We use project evaluation in order for the company to learn and better use what has been successful during the project. The lesson to be learned is based on what went wrong or what did not fit in the project. This aspect could answer questions like what happened and why we were successful and what is to do next.
2. Another point why we value project evaluation is that everyone involved will have a say in the project; this could be colleagues from marketing teams which we work very closely with or the UX team. This way we get each person's perspective/feedback, which leads to improvements of the project and communication.
3. Project evaluation keeps management up to date, which is kind of project status. This is essential if we are looking for resources or just better utilizing of the current resources.
4. We also conduct project evaluation to acquire some kind of validity and realism of the project, things like are we going to the right way and so on, which also provides a guide for the future plans
5. Also, one of the reasons is to identify which project member needs guidance or training to deepen their skills and better performances.

Depending on the organization's needs, size, and best practices, project evaluation can vary from one company to another; nevertheless, the principle might remain the same.

6.2 Need for evaluation from different parties

The project had to be evaluated in order to obtain detailed information of it, the information needed was not only technical (this was mainly for development people) but also how did the project went, was it successful and how it can benefit the company.

From the company's point of view, they wanted to understand how this tool can benefits our development process, what can we get out of it and for long terms future plans how it can solve service disruptions.

Overall, the project evaluations were needed so as to understand the outcome presented and also to align the needs of technology with the project results. These were mainly reflecting how services architectural problems can be avoided and solved by using effective monitoring.

This evaluation method was conducted in two phases, the first one was to access the needs of the departments (Technical department), which were clearly presented. The second one was to oversee, or we can also call it process evaluation by examining how the project would actually solve issues identified. The second process also measured how the individuals in teams were satisfied with the results, and how they reflect on the solutions with the issues existed.

6.3 What was evaluated

Overall performances of the tool had to be analysed and evaluated, and these points as explained in this report were based on the needs. Evaluation focused more on the Grafana operational level to determine for example if Grafana is doing the tasks was it designed to, is it reliable and working with minimum errors and also usability of the tool. Basically, Grafana was compared against the initial monitoring needs and requirements presented at the initial stage of the project (we can call this requirements specifications).

User experiences was also evaluated in terms of how easy to read and understand the metrics, navigations within the Grafana looking for metrics and also if there are any issues experienced on user level. These were also key to understand since at the project needs it was required that monitoring system should be able to give insights or being utilised by nontechnical persons.

Important part of the evaluation was how Grafana sends the alerting notification if there are faults identified, and these alerting frequencies reliable or not.

In conclusions it was found out that the tool meet almost all of the needs and it meets the services requirements plus no costs involved.

6.4 Evaluation method

The evaluation method used was formative, formative evaluation method is mainly used to evaluate a project or research from different project phases (early stage, while it is still ongoing and even upon project completion) i.e., feedback is provided from both parties, improvements are suggested, and lessons are noted. This method fitted the company since we wanted everyone involved to have a chance to give feedback or express their voice while the project is going on. Their suggestions were very useful during and after the project was conducted.

There are several benefits of using formative evaluation method, those include below ones.

- This method allowed us to clarify the need of the project and align them with some technological expectations.
- It allowed us to have better understanding of the project's process change, meaning that what works what, what don't and why.
- There was always a change to improve any service components along the way.
- We are able to acquire successful feedback from project parties.
- Ability to have clear future goals.

The evaluation took place in three phases; this is because of the nature of the topic and these phases below have fitted our evaluation needs.

- Planning the evaluation process, this was the initial phase where it was planned how the evaluation should occur: what tools were going to be used, prioritizations, and informing the audiences about the schedule.
- The second phases were actual evaluation implementations, which means the audience were concentrated on evaluating and aligning their needs to the research results.
- The last phase was conclusion, meaning that it was decided on what the long-term impacts of the company's operations were based on.

6.5 Evaluation results

Results from the evaluation phase of the project, it was decided by team members that Grafana is the tool needed to address the ongoing problems and needs. Decisions of the evaluation were based on the personnel involved in the evaluation process, each gave an opinion about Grafana and how this tool will improve the services.

7 Production deployment

7.1 Deployment process

After everything was confirmed to be working as expected, it was planned to deploy the changes to production so that production environment will be monitored. Since all production hosts were already listed somewhere together with their credentials it was a matter of adding these hosts and point Grafana to monitor production environment instead of developments one.

As seen from Figure 31, there was a list of these host, so by adding production inventory file and add proper access rights and definitions Grafana was able to access production database and start to collect data.

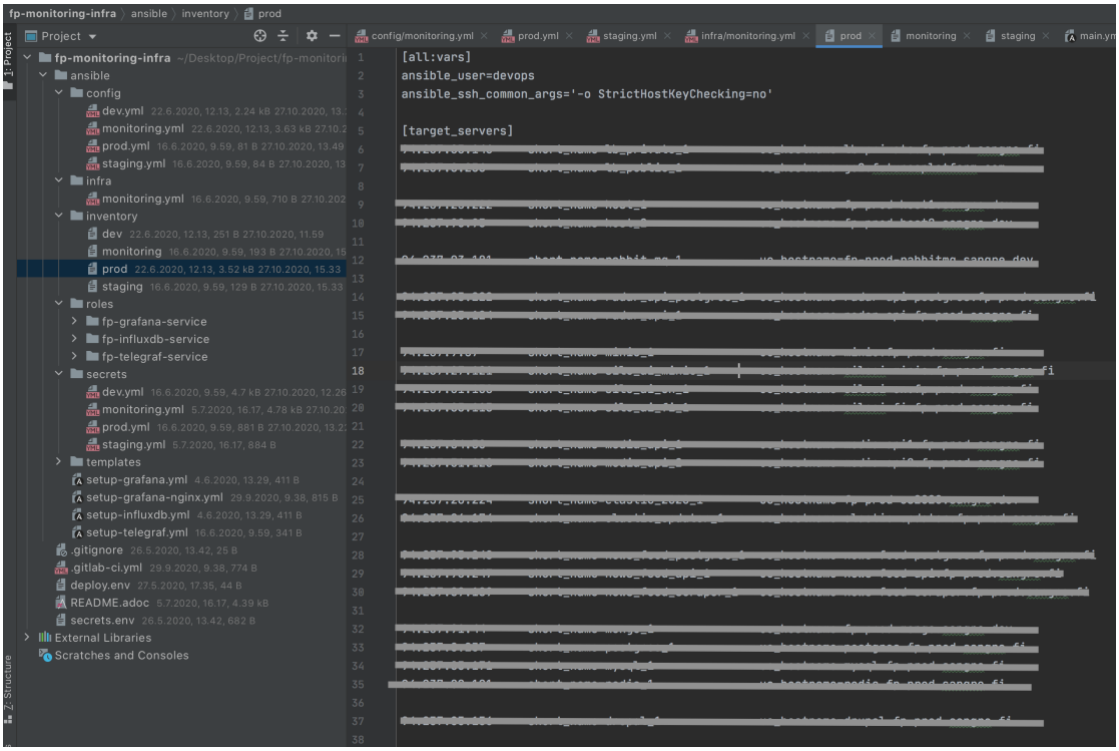


Figure 31. Production environment hosts

7.2 Project timeframe

This project had a timeline, this was an essential part of the project to ensure that it has transparency, well planned and also several team members involved will be constantly aligned and informed about the project. This project consisted of several tasks with each of them had its own due date, this assisted in the productivity for the project and engagement.

Each step was broken down into smaller pieces those includes researching of the tool, benchmarking, installation process details gathering, implementation of the project in the test environments, evaluations from team members and production deployment. Since the project tasks were completely new there were many learning curves on the way, what worked and what didn't along the process. The project technical implementation took a month and half to complete, this means that few hours a day were invested to the project technical implementation. Some delays were caused on finding solutions for elements or processes that didn't work or had difficulties in their implementation.

Figure 32 shows the project completion on Git.

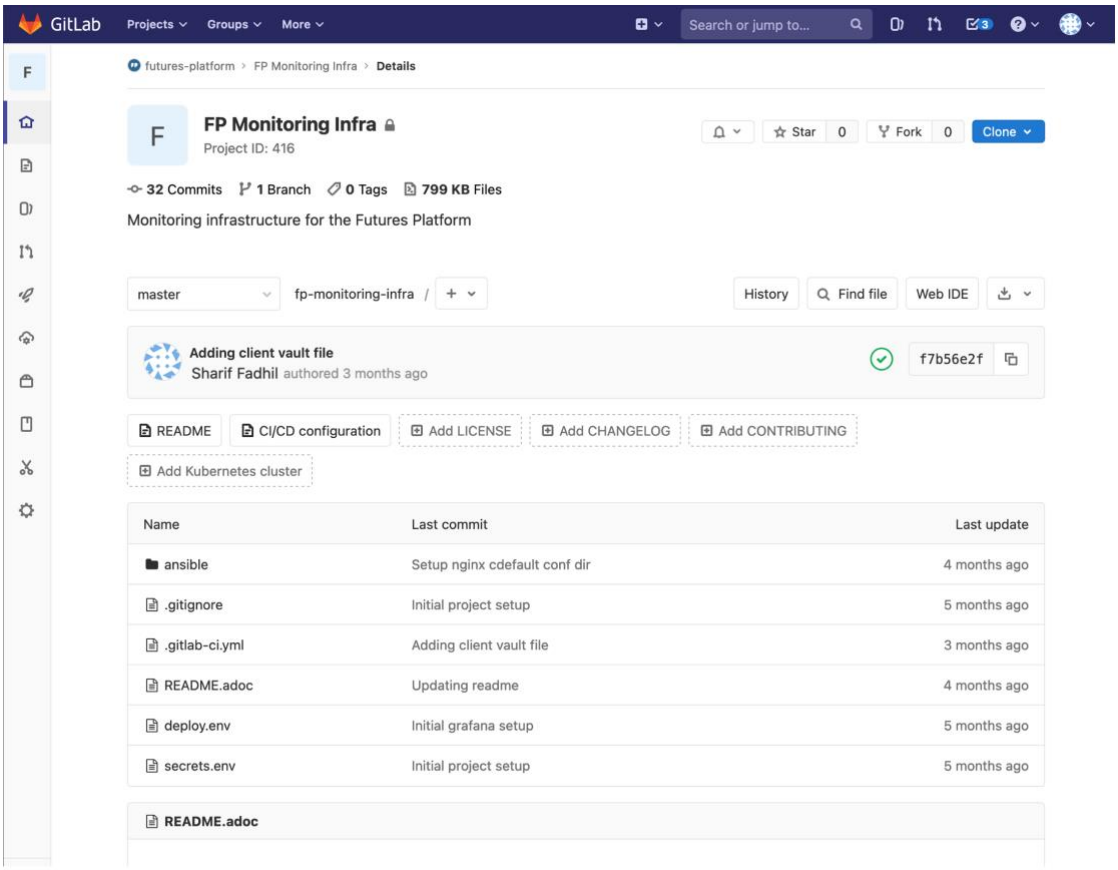


Figure 32. Project end results on Git

8 Discussion

8.1 Project conclusion.

The project came to a successful result, automated system monitoring tools was established, and DevOps team started to collect useful data and visualize it. Having monitoring tool in place ensured that at any time no faults and errors would go unnoticed by end users.

The tool sends instant alert notifications to Microsoft teams and Outlook, which notifies the team for first respond to the process of fixing the faults. This has reduced the time invested in the investigations of the faults where the tool inform exactly which host is problematic and what is the problem. And also, the team is instantly notified of the problem rather than waiting for someone to report it.. Overall alerting

part of the implementation has been successful, and the DevOps teams was satisfied of the alerting results.

The project scope was to monitor complex system architecture and that was achieved. Discussing about the Ansible, it is a very well-maintained tool with very good documentations and step by step instructions on how to work with the playbook. This means that Ansible can still be viable tool for several automation needs in the present and near future.

8.2 Fitted our needs

Upon concluding the project and discussions we had together with colleagues it was concluded that the tool Grafana has fitted our needs or even most of the needs. This tool was able to meet our system observability needs and also improving system performances.

The tool was able to visualize all the details related to data monitoring gathered from different data sources and also real-time tracking with alerting. Since the tool is an open-source platform, it does not cost anything but still it gave a lot of features, excellent documentation and most importantly it was easy to read visual representations of the most important data. With this tool, it means that it was able to minimize even cut some of the internal costs related to system performances monitoring.

8.3 Maintenance

As part of development life cycle, Grafana and its components should be maintained. This means that maintaining monitoring process should be an endless process, new hosts should be added to the configurations so that they can be monitored. Old and unused ones should be removed from the configurations, so that the code remains clean and updated with the changes. Depending on the organizations and their practices but for this project the whole process was clearly documented so that any

professional will understand where to start whenever they need to work with the Ansible playbook. Maintenance plan should be defined among the DevOps professionals on how they will maintain the tool and the services.

The maintenance fundamentals are same as the general system development lifecycle. All the steps and methods will not be covered in this report if a reader is interested to find out more there are sources explaining in detail how to achieve this e.g. from (https://www.smartsheet.com/system-development-life-cycle-guide).

Figure 33 (smartsheet 2020) illustrates briefly on system development life cycle where the maintenance of this will follow same methods with slight modifications based on Organizational needs.

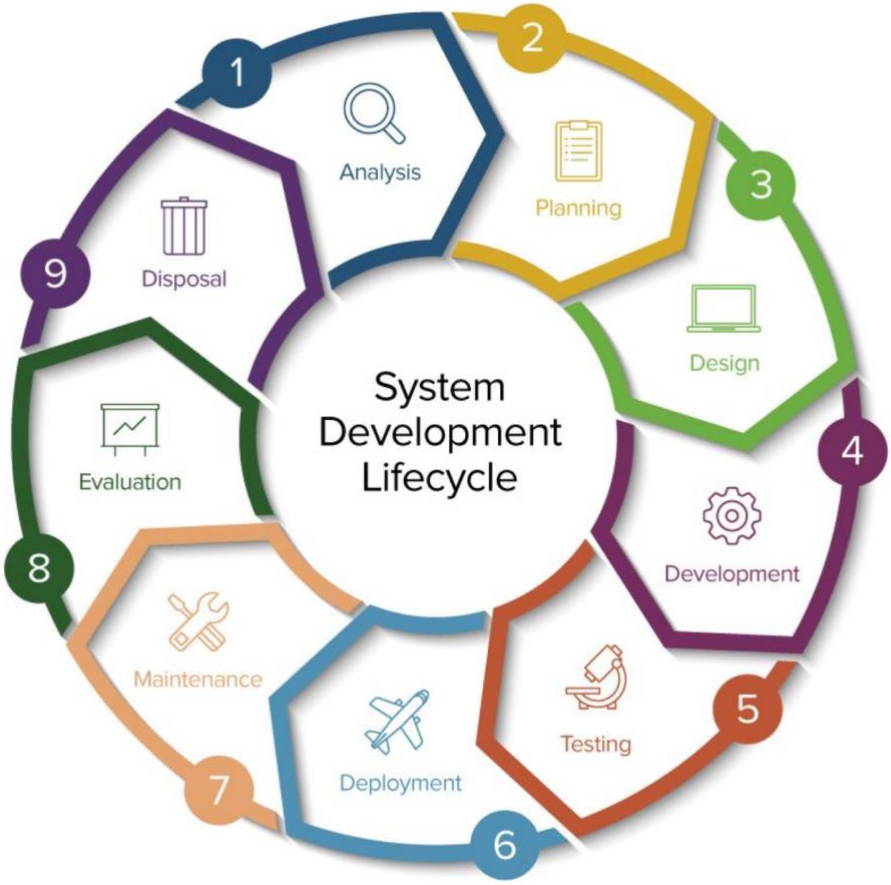


Figure 33. System development lifecycle

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Appendices

Appendix 1. Telegraf services settings on the tasks folder

Here are the settings for Telegraf services.

```
- name: "Make sure that directories exist"
  file:
    path: "{{ item }}"
    state: directory
    recurse: yes
  with_items:
    - '/etc/fp/telegraf'
  tags:
    - setup

- name: "Template tefegraf configuration file"
  template:
    src: "telegraf.conf.j2"
    dest: "/etc/fp/telegraf/telegraf.conf"
    backup: yes
    mode: 0644
  notify: reload_telegraf
  tags:
    - setup
    - config

- name: "Start Telegraf service container"
  docker_container:
    state: started
    restart_policy: unless-stopped
    name: telegraf
    image: "{{ telegraf_docker_image }}"
    pull: no
    recreate: no
    env:
      HOST_ETC:  '/hostfs/etc'
      HOST_PROC: '/hostfs/proc'
      HOST_SYS:  '/hostfs/sys'
      HOST_VAR:  '/hostfs/var'
      HOST_RUN:  '/hostfs/run'
      HOST_MOUNT_PREFIX: '/hostfs'
    log_driver: 'json-file'
    log_options:
      max-size: '200m'
      max-file: '5'
    network_mode: host
    volumes:
      - /:/hostfs:ro
      - /etc:/hostfs/etc:ro
      - /proc:/hostfs/proc:ro
      - /sys:/hostfs/sys:ro
      - /var:/hostfs/var:ro
      - /run:/hostfs/run:ro
      - /etc/fp/telegraf/telegraf.conf:/etc/telegraf/telegraf.conf:ro
  tags:
    - setup
```