Report Date: 05/06/2022
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Summary

At the last meeting, This paper's topic was decided to adapt distributed computing to a smart farm system using Long Range Wide Area Network(LoRaWAN). After considering whether to apply distributed computing to a LoRa gateway or containers for the application, it was decided to apply containers for the application. Then, Prof. Smith suggested using Wabash Heartland Innovation Network(WHIN)'s crop monitoring system based on LoRaWAN. However, WHIN recently changed LoRaWAN to Long Term Evolution(LTE) network. So it was decided that the farm data would come from a directly built LoRaWAN, not from WHIN. This required building these networks directly on different farms. Since it is difficult to implement this directly at various farms, real-time weather data is received from the API server of ThingsBoard, an Internet of Things(IoT) platform [1]. Finally, the topic of this paper was fixed with "Network performance evaluation of clustered server-based LoRaWAN IoT for smart farm platform".

What IIEEE completed this week:

- The first meeting with Prof. Smith and Jack from WHIN
  - Prof. Smith offered an idea about this project. How about making a service that will show factors about crops dead related to weather data.
  - He said that a short paper is needed about a detailed subject with system architecture.
- Discussing the detailed subject after the first meeting with Prof. Smith
  - A service was decided to inform customized data to each farmer. The data will be coming from WHIN.
    - It might be biased in weight from clustering to service if an interface showing analyzed data for the growth of crops would be made.
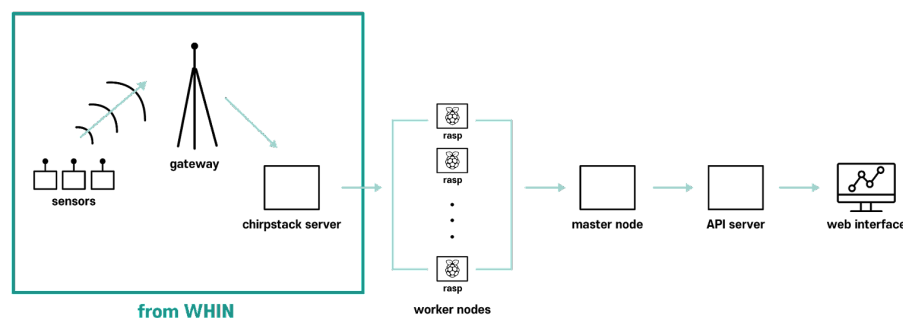 - A short paper was written including explanations about the detailed topic with physical architecture.

Fig. 1. Prototyping physical architecture.

- ■ Fig.1 is a prototyping physical architecture. Some Raspberry Pi(RPi) will be attached to the chirpstack server from WHIN and the RPis will be nodes in the clustering system with Kubernetes. The nodes are controlled by the master node.
- ● Sharing opinion by reading paper: "Network Performance Evaluation of Container Server-based LoRaWAN IoT for Field Worker Monitoring System" similar with this project's subject
  - ○ Summary
    - ■ The development of worker's health monitoring system by Gerda Iswari et al uses microcontrollers for parsing data, sends those data to server by using LoRa based on Message Queuing Telemetry Transport(MQTT) and monitors worker's health through a website.
    - ■ Their goal was to test CPU and memory usage to prove that Docker is better than Virtual Machine. However, Docker's CPU usage was higher than Virtual Machine and they tested website's latency only for Docker, so their test was sloppy.
  - ○ Connection with this project
    - ■ Testing
      - ● A test with virtual users by using Apache JMeter and HTTP request testing was useful. However, its result was not reasonable, as the conclusion was obvious. Gerda Iswari et al said that in the listener response latencies over time, it can be seen the amount of latency or the duration between the end of the request and the beginning of the server response [2].
      - ● It was tested as server-side and client-side. This separation is necessary for this project.
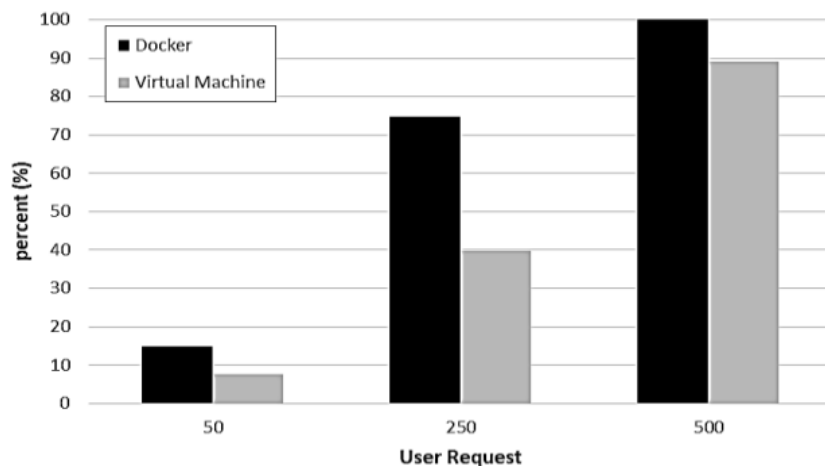   - ■ Comparison of CPU usage between Docker and Virtual Machine

Fig. 2. CPU usage comparison [2].

- ● The graph above shows that CPU usage on Docker is higher, even though the number of user requests is the same [2].
- ● Contrary to expectation, Docker's CPU usage was higher than Virtual Machine.

- If the user request size is expanded, it will be able to have a different outcome. As Docker shows log scale though Virtual Machine shows linear scale in the graph above, a result is guessed that Virtual Machine's CPU usage will become higher than Docker's.
- As a result of the research, excessive CPU usage is a weakness of Docker. The CPU usage should be limited by setting to solve this problem.
  - It will be ideal if this project can prove that CPU usage is decreased by using Kubernetes.
- The second Meeting with Prof. Smith
  - Getting some feedback and questions about the short paper.
    - WHIN is employing the network service provided by senet [3]. Nowadays, senet almost puts to use LTE in their systems instead of LoRaWAN.
    - Q1. Which do you want to get data from WHIN or own LoRaWAN gateway?
    - Q2. What is the need for worker nodes in Fig. 1? Is it necessary to apply distributed processing while dealing with a small amount of data?
- Discussing the detailed subject after the second meeting with Prof. Smith
  - Answering to the above questions
    - A1. Deciding to build our own LoRaWAN gateway for researching LoRaWAN structure.
    - A2. Keeping in mind scalability about the clustering system. The clustering system will be effective if this service manages more farm data because it needs to control more user requests.
  - Concerning where is better to containerize
    - There is not enough time to build our own LoRaWAN gateway and containerize the chirpstack.
    - To containerize the part of deploying like the upper paper was decided.
- The third meeting with Prof. Smith
  - One LoRa gateway is enough to cover many gateways. The three LoRa's cost is high.
  - Recommending ThingsBoard which is an IoT platform. It can be used as a simulating system for experiments using sensor data from a real farm.
  - After making a testbed farm in K-SW square and testing, real data from Prof. Smith's farm will be used in this project.

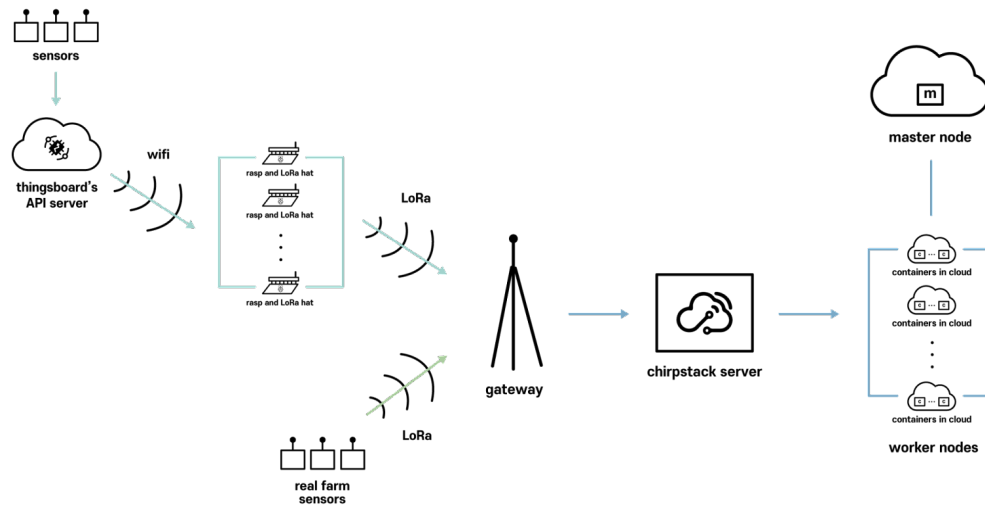● Discussing the detailed subject after the third meeting with Prof. Smith

Fig. 3. Modified physical architecture.

○ The Fig. 3. is modified physical architecture showing data flow and general system. The data from one real farm will be transmitted to LoRa and from ThingsBoard will be changed from Wifi to LoRa through RPi as a mediator. One gateway will give the data to chirpstack server and some programs such as DB server, API server, and interface will be containerized as a worker node. The master node on the right will manage all the worker nodes with Kubernetes.

Things to do by next week

● Dividing up the work: Kubernetes, Backend, Frontend and Network
● Designing wire frame and system architecture
  ○ Detailed functions will be selected.
  ○ Each other's opinions will be shared.
  ○ Detailed system architecture will be modeled based on wire frames.
● Writing a draft of the Abstract
● Buying RPis, LoRa hats, Google Cloud Platform(GCP) credit

Problems or challenges:

● Struggling with choosing topic in detail
  ○ It was hard to make a choice on the detailed subject as not knowing well how to WHIN get their data.
  ○ Confused and delayed time to decide the topic due to less sharing of each opinion among team members.
● Taking a direction of the project
  ○ Previous plan

- - - Planning to get WHIN's weather data from LoRaWAN and containerize the chirpstack under the topic of "Network Performance Evaluation of Clustered Server-based LoRaWAN IoT for Smart Farm Platform".
  - Discovering what the problem was after that meetings
    - - WHIN gets weather data from LoRaWAN is known before, however, they are receiving it from LTE, not from LoRaWAN.
      - - Having difficulty deciding a topic due to WHIN's LTE is too sturdy to handle and it's hard to connect the test system to a network which is actually being served.
  - Deciding with between two structures
    - - Two opinions were suggested. One is to containerize LoRaWAN and the other is to containerize the applications. To focus on a clustering system using Kubernetes, the latter one was chosen.
  - Conclusion
    - - According to this, not using data of WHIN is decided. Thus, setting own LoRaWAN and making use of ThingsBoard which Prof. Smith suggested.

References

[1] "ThingsBoard Documentation." ThingsBoard. https://thingsboard.io/docs/

[2] Gerda Iswari, Rahardhita Widyatra Sudibyo, Haryadi Amran Darwito and Md. Manowarul Islam, "Network Performance Evaluation of Container Server-based LoRaWAN IoT for Field Worker Monitoring System," in 2021 *Int. Electron. Symp. (IES)*, Sep. 29-30, pp. 653-657.

[3] "Migrating an Internet of Things (IoT) Sensor Design to LoRaWAN," Semtech, Camarillo, CA, USA, White Paper, 2018. [Online]. Available: https://info.semtech.com/migrating_sensor_design_white_paper_download