WIMEA-ICT
Improving East Africa's Weather Information Management through the Application of Suitable ICTs

REPORT ON INSTALLATION OF GENERATION (Gen) 3 WIMEA-ICT AUTOMATIC WEATHER STATIONS IN UGANDA

Contents

List of figures

1. Introduction

Installation of batch 1 of Gen 3 WIMEA-ICT Automatic Weather Stations in Uganda took place from 15th September to 27th October 2018. The activity followed the assembly process, which had taken place in the WIMEA-ICT lab at Makerere University Uganda and thereafter distributed to the other two partners, including Tanzania and South Sudan. Having designed nine AWS stands, the National Meteorological Authority (UNMA) proposed 9 sites for installation. These are indicated in table 1. Alongside each of the proposed sites were AWSs and manual stations to be used for benchmarking purposes.

Table 1. Sites selected for Batch 1 WIMEA-ICT AWS deployment

No.	Location	Region	Date of installation
1	Entebbe Buku	Central	15th September 2018
2	Lwengo (NARO)	Central	27th September 2018
3	Mubende (Mubende district)	Central	27th September 2018
4	Ikulwe (Mayuge district)	East	25th October 2018
5	Nawaikoke (Kaliro district)	East	25th October 2018
6	Bugaya Buyende district	East	25th October 2018
7	Kamuli NARO	East	26th October 2018
8	Kidera (Buyende district)	East	26th October 2018
9	Jinja	East	27th October 2018

At the time the stands were designed, other AWS components were being designed. For example, the rain gauge design changed and a low power gateway was designed and required an attachment to the stand. These changes necessitated modifications to the AWS stands, which took more time than anticipated, hence delayed deployments.

2. The AWS Stand

This section describes the design of the stand. Mild steel pipes were used because it is cheap and available on the local market. Below are the details of the pipe specifications.

1. Metallic stand (totaling to 10.5m in height)
    a. Lower side (76mm 6m long)
    b. Middle pole (63mm and 2.5m long)
    c. Upper pole (50mm and 2.5m long)- half a metre to be placed under the ground.

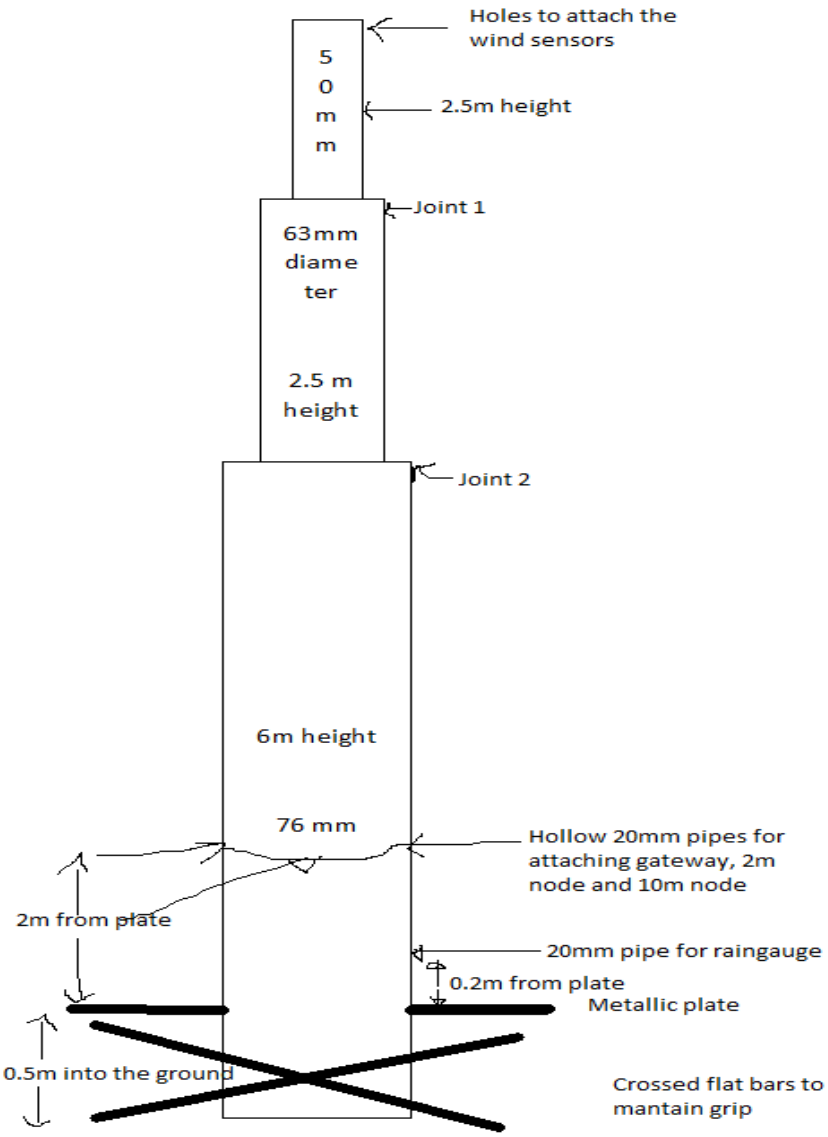

Figure 1. Sketch for the AWS stand being used in Uganda

Below are some photos of the actual stand

Figure 2. Joint attached to the smaller pipe, to make it fit in the bigger diameter lower pipe. The hole is for tightening the pipes during deployment

Figure 3. Two of the main pipes joined during deployment

Figure 4. Metal plate that separates the area to go below and above the ground

Figure 5. Rain gauge fixed to its base. The hollow pipe has a diameter of 25mm to enable it enter into another pipe, which is attached to the stand

Figure 6. Sample deployed WIMEA-ICT AWS

Figure 7. Protrusions for attaching sensors, approximately 2m from the ground and showing how the 2m node is attached.

Figure 8. Lower part of the stand, which goes into the ground

Figure 9. Attaching the wind sensors to the top metallic pipe

3. Concrete works and installaton of the AWS stand

Transportation of the stands from Makerere University was done by a separate team. The same team also performed placement of the stands into the ground, a day or two before sensors were placed on the stands. Before erecting the stands, the wind vane and anemometer were attached and a cable left to enable the deployment team to attach the sensor node.

Figure 10. Laying concrete works

4. AWS installation

A team of five people, consisting of the following categories completed the installation of the AWSs.

i. Two PhD students
ii. Two Interns – Bachelor of Science in computer Engineering , Year 4
iii. One Intern – Bachelor of Science in Software engineering, Year 4

The first deployment was done with the help of 2 extra interns including one masters student, also a staff member of the University of Juba. The role of the masters student was to acquire knowledge to be used in setting up the stations in South Sudan. During the deployment exercise, the following were done

i. Attaching three nodes including 2m, 10m and ground nodes to the stands
ii. Testing data broadcasts from sender nodes to the sink node/gateway
iii. Performing calibration of the rain gauge and wind vane after installation
iv. Testing for power consumption and charging of the nodes
v. Testing data transmission to the WIMEA-ICT server. That is, wimea-ict.net[1] . Another interface is also being developed to visualize the data and is found at [2]. An example of the visualizations are presented in Figure 11.
vi. Assembling and onsite testing of the low power gateway. Below are the activities that were performed in regards to setting up the gateway
    a. Ensuring that connections were correctly done, leaving no loose connections.
    b. Observing the Light Emitting Diode (LED) color to establish if the gateway was in error mode, attempting to connect, transmitting, idle or has successfully transmitted.
    c. Testing the SD card to ensure that data was successfully saved and that the configurations including the Internet Service Provider details and number of reports were properly configured
    d. Testing signal quality and network connectivity in the area using the selected telecommunication provider. MTN or Warid, telecom were proposed by UNMA for uplink connection. We used MTN SIM cards in all sites
    e. Testing the RTC date to ensure that the time and date issued were correct

Figure 11. Sample data visualization of weather data

Figure 12. The Low Power Gateway used in the deployments

5. Challenges

- During Entebbe the deployment, the soil moisture sensor and the daughter card containing the pressure sensor were destroyed. The soil moisture sensor broke during the time it was being fixed into the soil while the pressure sensor fell in the grass and was accidentally stepped on
- Transporting the station stands to far places cost the project huge sums of money since it required trucks.
- The SD card in Nawaikoke failed immediately after the installation when the team had left the site
- Poor network connectivity in rural areas and especially in the Eastern part of the country caused failures in data transmission. Since after transmitting the data, the memory card is cleared, no data was sent during the time of poor network connectivity. Hence, such data was not recovered.
- There was limited skill set at the sites. We had earlier hoped to find people earlier trained to assist in maintaining the AWSs but it was not the case.
- Entebbe, Buku, which was the first site to be deployed receives limited solar insolation, which limits the battery charging, hence causing node or AWS shut down
- Since places were far from Makerere and the people on ground had not be trained on how to use the AWSs, it took long to fix problems that occurred after deployment.
- Assembling on two occasions/sites required onsite modifications since the drilled holes were not well placed, hence the failure to add nuts and bolts. This necessitated the team to drive to city centers with the stands in search for the services.
- The Ground node in Mubende consumed more power than what was anticipated, hence always switching off the node. We therefore had to return and place a solar panel in parallel.
- After leaving Entebbe, we realized that the RTC time was ahead of the actual time on the server.
- The observers do not have access to the data yet since it is a requirement for all for all users to be authenticated into the server
- We fell short of equipment at the time of deployment since some sensors were destroyed during the deployment while others had been used during the experimentation period.

6. Recommendations

Based on our deployment experience and challenges encountered, we give the following recommendations

- Training of meteorological services staff to be done again in order to introduce new concepts on the AWS design and especially the Low Power Gateway design. The students, who have been trained should train others before the end of their Internship. The next training should target staff on site especially the OCs and observers in order to be able to fix minor issues.
- Spare parts should be acquired to cater for the unplanned faults and for timely maintenance. Procuring of the spares alongside the main procurements shall also save the project money, which could be incurred in the transportation of the equipment.
- Continued monitoring and documentation should be done to ensure that unexpected problems are fixed in the duration of the project.
- Demarcating the soil sensor location to ensure that they are not stepped on or slashed.
- Providing a graphical interface for the all interested parties to access data

7. The team

Below is the team that took part or assisted in the deployment exercise

No.	Name	Institution	Responsibilities
1	Maximus Byamukama	Makerere, PhD student and Instructor	Overall – and technical aspects and especially
2	Mary Nsabagwa	Makerere, PhD student and Instructor	Overall- and coordination
3	Deo Okedi	Intern- BSC Computer Engineering student	Onsite Assembly and testing of electrical components
4	Ruth Agaba	Intern- BSC Computer Engineering student	
5	Grace Ninsiima	Intern- BSC Software Engineering student	Configuration of nodes and post deployment monitoring
6	Nicholas Mukwaya	Intern- BSC Software Engineering student	Intern -
7	David Pitya	Msc Student- Data communication student	Intern- South Sudan representative
8	Dr. Julianne Sansa Otim	Principal Investigator	Overall- Administrative functions
9	Sandra Akello	BA Business student	Accounting and funds acquisition
10	Milton Waisswa	UNMA – Manager, Station Networks	Site selection and provision of contacts
11	Fred Sebabi	UNMA- OC, Entebbe	Access to the site, support during deployment and onsite maintenance
12	Dhikusooka	UNMA- OC, Mubende	Access to the site, support during deployment and onsite maintenance
13	Kimera	UNMA- OC, Lwengo	Access to the site, support during deployment and onsite maintenance
14	Elesu Moses	UNMA- OC, Ikulwe	Access to the site, support during deployment and onsite maintenance

Acknowledgement

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References

[1] T. W.-I. Project, “WIMEA-ICT Project.” [Online]. Available: http://wimea-ict.net/.

[2] WIMEA-ICT AWS Monitor, “No Title.” [Online]. Available: http://wimea.mak.ac.ug/awsmonitor.