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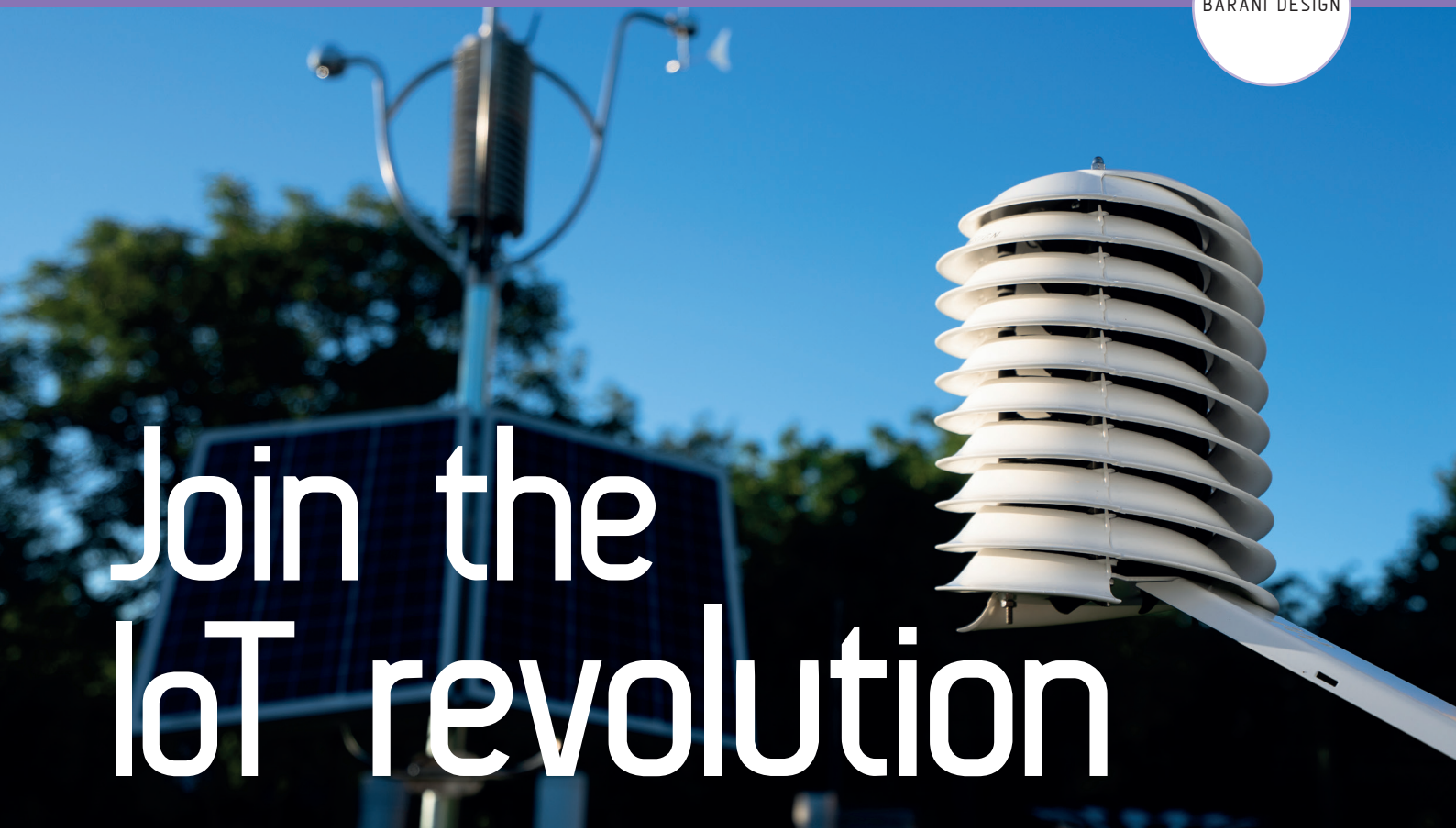

Join the IoT revolution

Many meteorological networks in Africa are not recording accurate data. However, accuracy can be improved and maintenance costs reduced with the application of new IoT technologies. By Jan Barani, CTO, BARANI DESIGN Technologies

Most people don't know that as many as 54% of Africa's surface weather stations do not report accurate data (according to the World Bank), costing millions in maintenance each year.

It is unacceptable that Africa, the second-most populous continent, has the world's least developed water, and climate observation network, with less than 300 of its weather stations meeting the WMO's observation standards.

What we do know is that simple solutions work. A simple river gauge, warning of rising water levels, can save lives, livestock, and help cities and farmers prepare for impending threats.

Foreign investment in weather networks such as the The Trans-African HydroMeteorological Observatory (TAHMO) is proof of the value of meteorological data in Africa. Yet the benefits mostly remain in the hands of foreigners; most weather networks based on all-in-one weather stations do not benefit Africans, but instead the foreign corporations who build them.

Developing Africa's own meteorological network is an opportunity to generate income – and profits – from a self-sustainable enterprise while saving lives, crops and livestock.

The idea of Africa's own weather network has been around for years, but never before have the technologies been in place to make it possible. The prohibitive cost of professional WMO-conforming weather stations and sensors with complex maintenance is partly to blame.

However, the Internet of Things (IoT) has changed the professional automated weather observing systems (AWOS) forever.

Historically, the cost of wireless infrastructure kept wide area wireless data coverage expensive everywhere but in large population centres. However, new IoT wireless technologies like Sigfox and LoRaWAN are giving mobile phone network operators a run for their money.

The cost savings are so significant that Sigfox and LoRaWAN enable private operators or governments to create high-quality wireless data coverage at an investment cost of less than 0.5 US$/km^2 and recurring costs reaching down

Future trends: Understanding meteorological data

Near surface meteorological parameters such as air temperature and humidity are affected by many factors like vegetation, soil, sun exposure, clouds, atmospheric humidity, dust, air pollution, wind, and are highly variable and localised. Quality data demands traceability to precision standards – not in the laboratory, but in real outdoor conditions.

EURAMET is studying and preparing a European guide on calibration of thermometers in air including radiation shields, and the International Surface Temperature Initiative (IST I) is promoting a joint action between metrologists and climatologists to identify all of the components of measurement uncertainty in near surface atmospheric air temperature records, according to Andrea Merlone, chair of the Consultative Committee on Thermometry (CCT) Working Group Environment and co-ordinator of the MeteoMet project.

Vandalism-tolerant meteorological network

A high-density meteorological network based on affordable micro weather stations is inherently vandalism-proof. Larger data density allows the network to absorb a large number of end-point weather station vandalism failures while maintaining sufficient data density. Redundancy of wireless data coverage based on IoT technologies affords the network even more reliability. Combined with a micro weather station designed to prevent data access to thieves and with minimal resale or recyclable material value, this will de-incentivise serial thieves and vandals.

to 0.05 US$/km^2.

Private IoT networks can be built independently of the current GSM and LTE wireless networks, with redundancy, and can even operate cost-effectively on satellite data. The reaction of mobile phone operators has been the rollout of NB-IoT and other technologies which cut the cost of data coverage significantly compared to today's GSM/GPRS meteorological data solutions.

While high cost is still the status quo, companies like BARANI DESIGN Technologies are looking to break the cost chains of the past by leveraging the IoT revolution and Industry 4.0 to bring not only WMO precision, but complete data solutions at a never before possible combination of quality and affordability.

Combining knowledge of meteorological data alongside IoT technologies, BARANI DESIGN Technologies has created a novel MeteoHelix micro weather station which meets most WMO meteorological measurement standards.

IoT benefits for AWOS design

Not all sensor trends in professional meteorology are sensible. The phrase 'all-in-one' often means the sensor not particularly good at anything and claimed cost savings are often just imaginary.

Can IoT technologies transform WMO-compliant weather networks to make them more, precise, affordable, secure and vandalism-tolerant?

The benefits of IoT technologies translate well into AWOS design. Wireless hardware costs are directly proportional to weather station power consumption, which is minimised using Sigfox, aWAN and NB-IoT technologies. This translates into smaller batteries and solar panels, which directly affect weather station cost.

> **A solar radiation shield is the single most important component for accurate long-term temperature and humidity measurement**

Low-power with a realisable 10+km wireless range allows dataloggers and modem electronics to be located closer to sensors without the detrimental effects of self-heating, thus minimising weather station size and costs.

Addressing maintenance problems

Due to the localisation of weather phenomenon and micro climates, gradual soiling of sensors cannot be statistically removed from data by referencing to a well-maintained sensor network. All sensors must be recalibrated at regular intervals.

The effects of solar heating, sensor dirt buildup, moisture saturation and rain cooling of temperature and humidity sensors are solar shield-dependent. Near the equator, sun shielding has the dominant effect on sensor accuracy. Thus, the solar radiation shield is the single most important component for accurate long-term temperature and humidity measurement.

One new technology which promises to change that is the helical solar radiation shield. A recent WMO study has shown the helical MeteoShield to provide the best combination of sensor protection and accuracy in all weather conditions for significantly improved data quality over even fan-aspirated solar radiation shields and Stevenson screens.

The ideal IoT weather station and network

What would an ideal low-cost WMO-compliant weather station look like?

- A combined weather station featuring integrated ultra-low power wireless IoT technologies to minimise battery and solar panel size and make self-heating effects negligible.
- Measures air temperature, humidity, pressure, solar irradiation at a standard WMO two metre height, with the best possible solar shielding for high quality data.
- Keep sensors clean and accurate to allow long maintenance intervals.
- Featuring a rain gauge situated near the ground for easy maintenance and cleaning.
- Wireless wind sensor five to 10 metres high, independent of other hardware with standalone wireless transmitter for high data throughput since wind is highly variable.

To minimise field time, service of these micro weather stations should not be performed in the field. Each micro weather station should be replaced with a recalibrated one at predefined intervals.

After recalibration, each micro weather station can replace a different one during field service. In-house recalibration of each weather station will determine sensor drift and offset over time.

Such methodology will determine quickly which weather station locations require shorter or longer service intervals to maintain accuracy within the required WMO standards. This will lead to optimised network maintenance costs.