A New Wireless Telemetry System for Meteorological Application

Lanre Daniyan, Okeke Pius, Najib Yusuf, Nasiru Aliyu

Abstract

In recent years, one of the technologies that have really transformed the mode of interaction between humans and equipment is the Machine-to-Machine communications technology often referred to as M2M communication technology as it allows instructions, control signal, monitoring, data transfer, and other form of communications to be exchanged between distant stations. Over the years, remote machine communications have not really been embraced for meteorological applications partly because of the old and still existing form of meteorological equipment design. This new wireless meteorological telemetry technology is adapted on the Nigerian Environmental Climatic Observing Programme (NECOP) stations network to break the limitations and challenges associated with the deployment and operation of remote field equipment. This paper presents a new method of meteorological data retrieval system and how it solved many challenges existing in data retrieval especially from remote data logging stations.

Key words: DCE, DTE, M2M, Modem, NECOP, Telemetry, VLBI,

1 Introduction

M2M technology evolved in United States about thirteen years ago and it has found diverse applications across various fields ranging from military and control, to cellular applications. Over the years, in meteorological systems, various means were adapted to ease and facilitate data transfer from a remote location to a data centre, especially where the two locations are separated by very wide geographic area, and this challenge of data retrieval becomes greater when such meteorological stations are located so remotely. The problem becomes more compounded when the number of meteorological stations in view becomes large like the NECOP stations that have a spread that covers the whole of Nigeria with the central server located in CBSS, Nsukka, Enugu State, South Eastern Nigeria.

The initial problem on NECOP was the conventional telemetry system using the defunct Nigerian Telecommunications (NITEL), being the only cable network provider with national coverage, as the backbone

to establish a network of meteorological stations with the central server. NITEL was dead shortly after this was concluded and this led to a vigorous work that led to the birth of the new wireless meteorological telemetry system in Nigeria.

2 Existing Meteorological M2M Communications and their attendant limitations

Basically, there existed four means for data retrieval from a remote station before the new wireless telemetry system. First is the Direct Connect system which enable user to visit the remote site of the data logging station and interact with the station via cable link (often serial) between the user's data collating system and the station datalogger. This system is equally useful in programming and instructing such stations for some particular pattern of operation but ease of access is a big issue considering the fact that in modern times, meteorological stations or similar data generating stations are usually deployed in several locations which could have a separation of a whole geographical area. The huddle here is the stress of going about visiting such stations at regular interval because every interaction will demand someone physically present at the station site. The second means which is the deployment of directional Radio system using a modem and Yagi antenna. This system is suitable particularly where the separating distance between the data generating station transmit Yagi antenna and the receiving station is within about a hundred meters without obstruction. This system is impracticable for a network of several and still expanding stations such as the NASRDA Centre for Basic Space Science Nigerian Environmental Climatic and Observing Program (NECOP) Stations deployed to characterize a very large geographical area like Nigeria. Challenges often associated with this system include obstructions from buildings, trees, traffics and fading of signal which has grossly limited its popularity. The third means that gained some level of popularity in the past one decade is the IP data retrieval system which entails data transmission over the internet. This is particularly useful in environments where there is easy access to internet infrastructure and where the data recording system or the remote station can be hooked on internet. This is widely used in networks like the radio telescope VLBI systems in transferring VLBI data to data centres based on the fact that internet infrastructure is basic in observatory operations.

In meteorological systems, where the site to be characterized is remote and most times without such facilities, one is left with no other option other than to either install such station close by for ease of access or create a remote office and employ someone to oversee the station operations. This is grossly uneconomical considering the cost of bandwidth for IP telemetry knowing the huge cost of bandwidth especially in Africa, that runs continuously only to be used for occasional data transmission. The fourth means which once existed in Nigeria especially for facsimile applications though not widely used for meteorological system is the deployment of cable modems. This involves

getting a land line telephone provider to run a telephone line to each of the site of the stations to feed a cable modem attach to such data generating equipment for data retrieval. This is not without its attendant challenges which include availability of single network operator, land line provider all over the target areas in order to cub inhibitions such as operators interconnectivity issues and the attendant trunk dependent phone bills. Besides this, no land line telecommunication provider exits in Nigeria today. The last that existed was NITEL which NECOP used sparsely before migrating the large network of the meteorological stations to the new wireless meteorological telemetry system. Another problem of this physical links is the environmental problems which include cable cut, lightning, tampering and its frail nature.

3 The New Wireless Telemetry System on NECOP Network

The Nigerian Environmental Climatic Observing Program (NECOP) is one of the major projects of NASRDA Centre for Basic Space Science. It is a project designed to establish a large network of observing stations that is carrying out basic measurement of meteorological and climatological variables in real time, with an update cycle if five minutes. Variables being generated from each location include air temperature (degree C), relative humidity (%), precipitation (mm), atmospheric pressure (mbar), wind speed (m/s), wind direction (^{O}N), solar radiation (W/m^2), soil moisture (%), soil temperature (^{O}C), rain rate (mm/min) and other derived variables.

It is an expanding network of about fifteen stations across Nigeria, from Sokoto, Yola, Abuja down to south coastal areas like Port Harcout and Lagos while CBSS centre in Nsukka, south east Nigeria serves as the Server Centre or Data collating centre.

At the inception, the telemetry system was based on the option number four mentioned above which required telephone lines from a single operator to be run to each of the stations, it equally entails equipping the stations with a land line modem. The only land line telecom provider with presence across Nigeria then was NITEL which later collapsed with the advent of GSM telephony. This development render all communications and data transmission to the data centre impossible and therefore underscore the need of an alternative data retrieval system on NECOP station network. This gave birth to a new wireless meteorological telemetry system.

4 The Architecture of the New Wireless Meteorological Telemetry System

The advent of GSM communications in Nigeria marked the beginning of technological revolution across Nigeria. Different technological applications sprung up to use the telecom cellular infrastructure as backbone to implement several systems. We hence designed the wireless meteorological telemetry system architecture in a way that put each

of the meteorological stations in a GSM cellular environment classified as 2.5 generation in telecommunications technology hierarchy which has the capability for high speed data transfer. This is achieved by equipping each of the stations with an "Open AT" modem and associated Data Terminal Equipment (DTE) in order to achieve auto response to a call request, interpret the accompanying instructions with the data request, fetch the data and transmit via GSM base station to the server at the data centre in Nsukka. The graphical representation is given below.

Fig 1: Architecture of the Wireless Telemetry System

All the fifteen stations are now being operated using this wireless systems. We structured the wireless system to eliminate all communication cables & connections associated with weather stations data transmission. Each of the station lies in a cellular environment, GSM, GPRS or EDGE network. With these, data, commands, instructions are transmitted wirelessly via basestations between the stations and the central server. The attendant result is that what it takes to communicate with the closest station is equally what it takes to relate with the farthest station and hence bills are no longer trunk dependent but time dependent thereby making the system more cost efficient. At the server, specialised software for telemetry and programming receives the data and auto lodge it in a directory in the software environment. This server is in Nsukka, south east Nigeria, and the stations are all spread all over Nigeria thereby rendering the issue of separating distance irrelevant as no physical connection is necessary between the stations and the server. Each station is equally equipped with a unique identity module which enables requests to be directed to a target station.

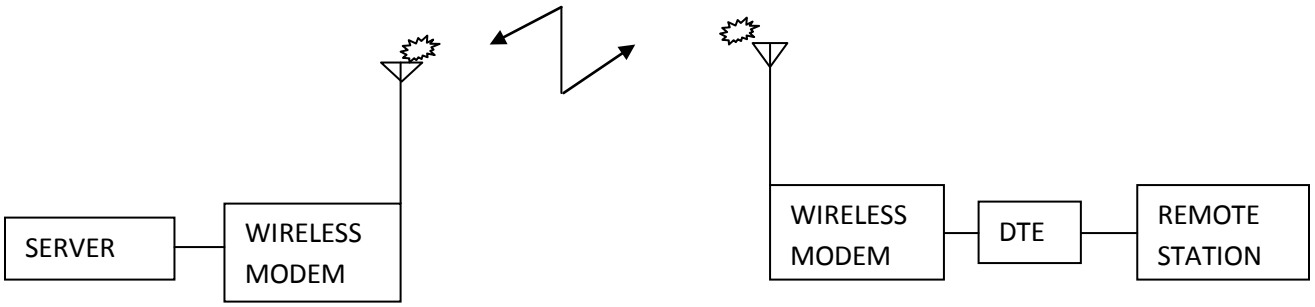

Fig 2: Block diagram of the wireless meteorological telemetry architecture

At the station end, a Data Terminal Equipment (DTE) is installed to link the station modem to the station datalogger for Read – Write events; this will exchange instruction between the two devices and help fetch and preserve the data format for the modem to modulate and transmit.

5 Comparative Benefits of the New Wireless Meteorological Telemetry System

- It made physical distance to meteorological stations irrelevant
- It makes multiple location data / multi data collection achievable
- It has made citing a meteorological station in locations hitherto thought to be difficult terrains.
- It has very high links reliability.
- It has very high remote station availability.
- It has eliminated "billing/distance" which is associated with cable telemetry systems and enthroned a much cheaper & unilateral "billing/time".
- It has makes managing the expanding NECOP network extremely easier.
- It has eliminated the frail physical links.
- It has eliminated fixed systems, hence making the Modem Server Mobile.
- It provides better "real – time" activities.

6 Conclusion

The new wireless meteorological telemetry implemented on NECOP network is one the best applications that has evolved from the advent of cellular telecommunications in Nigeria. We developed a telemetry system that has found its usefulness across different fields as efforts are on to adapt the same technology for seismic monitors across the country. The Nigerian Environmental

Climatic Observing Stations, though well spread all over Nigeria, they are all easily commanded and controlled from a central location without any physical link which are known for incessant interruptions. It has made possible the characterization of environments hitherto thought unsuitable for the installation of meteorological stations considering the difficulty in accessibility to cable telephony or Internet infrastructures in very remote terrains. The reliability it offers makes it possible to operate very large number of remote stations even on terrains where all the existing meteorological systems are deemed unsuitable for.