Development of Internet of Things Monitoring System for Transmission Tower Weather Sensors

Shih-En Chien1) , I-Ming Cheng1), Kai-Ping Hsiung2)
1)High-Voltage Research Laboratory of Taiwan Power Research Institute(TPRI)
2)Power Supply Department of Taiwan Power Company(TPC)

I. Introduction

As the result of climate change, the occurrence and severity of extreme weather events, such as intense typhoons and heavy downpours, have been increasing. The changes not only cause damages to transmission lines (including tower and tower bases), but also jeopardize the stability of power supply.

This study aims to verify the resilience of TPC tower bases when they have to confront with harsh weather conditions, and to expedite the full implementation of smart grid by adopting the internet of things (IoT) technologies and installing wireless mini weather stations on transmission towers that are vulnerable to climate change influences. The sensors used for weather stations include ultrasonic anemometers and rain gauges.

Three overhead power lines are selected for the installation, namely: the Pinglin-Yuanshan 161 kV line, the Shenmei-Dongshan 345 kV lineand NPP3-Fenggang 161 kV line . The Pinglin-Yuanshan and the Shenmei-Dongshan lines are under the administration of Taipei Power Supply Branch, whereas the NPP3-Fenggang line is under the administration of Kao-Ping Power Supply Branch.

II. System Composition, Functions and Structure

The monitoring system is composed of mini weather stations, a database server and a web application for condition monitoring and data analytics.

The mini weather stations are self-powered and capable to collect real time data. The data collected is then transmitted wirelessly to the database server. The methods of observation are based on the guidelines of the Central Weather Bureau (CWB).

A total of fifteen transmission towers are selected from the three transmission lines, and the serial numbers of the towers are shown in Table 1. One mini-weather station is assigned to each of the towers.

Table 1. Serial numbers of the selected transmission towers

Location	Serial Number	Number of Towers
New Taipei City and Yilan County	Pinglin-Yuanshan line: #34、#35、#36、#50、#51 Shenmei-Dongshan line: #87、#88、#94、#95、#96、#97	11
Hengchun region	NPP3-Fenggang line: #55、#56、#57、#58	4
	Total	15

Wireless sensor networks (WSNs) are formed by nearby weather stations, and each station acts as a gateway node connecting to the Internet. Weather data collected from each station will be gathered at the gateway node through WSN and then transmitted to the database server over the Internet. The database server is installed at TPRI Shulin Branch.

As for the WSN, each weather station is connected to its adjacent stations to form a chain-like network, and the chain station acts as the gateway node. The collected data, such as wind direction, wind speed, rainfall, battery percentage, is passed along the chain to the gateway node. In the event of a failure along the chain, data may skip the faulty station and pass along the backup routes .

The weather stations are powered by solar panels along with energy storage device such as batteries. When the battery power drops below a certain level (≦30%), a warning notification will be given automatically through the web application.

The features of the web application includes: (1)responsive web design (RWD), (2)user interface, (3)data visualization and data searching capabilities, and (4)embedded map marked with locations of the monitored towers (in different colors according to the current alarm level of the tower).

The warning mechanism is a '3 value 4 level system,' consisting 4 alarm levels separated by 3 threshold values, as shown in Figure 1. The 3 threshold values are respectively: attention value, alert value and action value, and can be adjusted in the web application. The 4 levels are represented by 4 different colors, namely green, yellow, orange and red. When any tower is on orange or red alarm level, the web page will jump out a scrolling marquee as a warning.

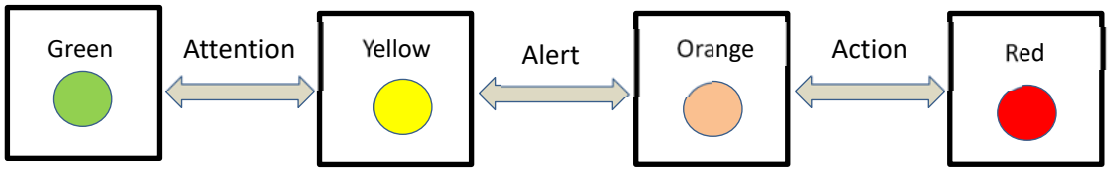

Fig. 1. The 3 values and 4 levels warning system

The system schematic of hardware and software are shown in Figure 2.

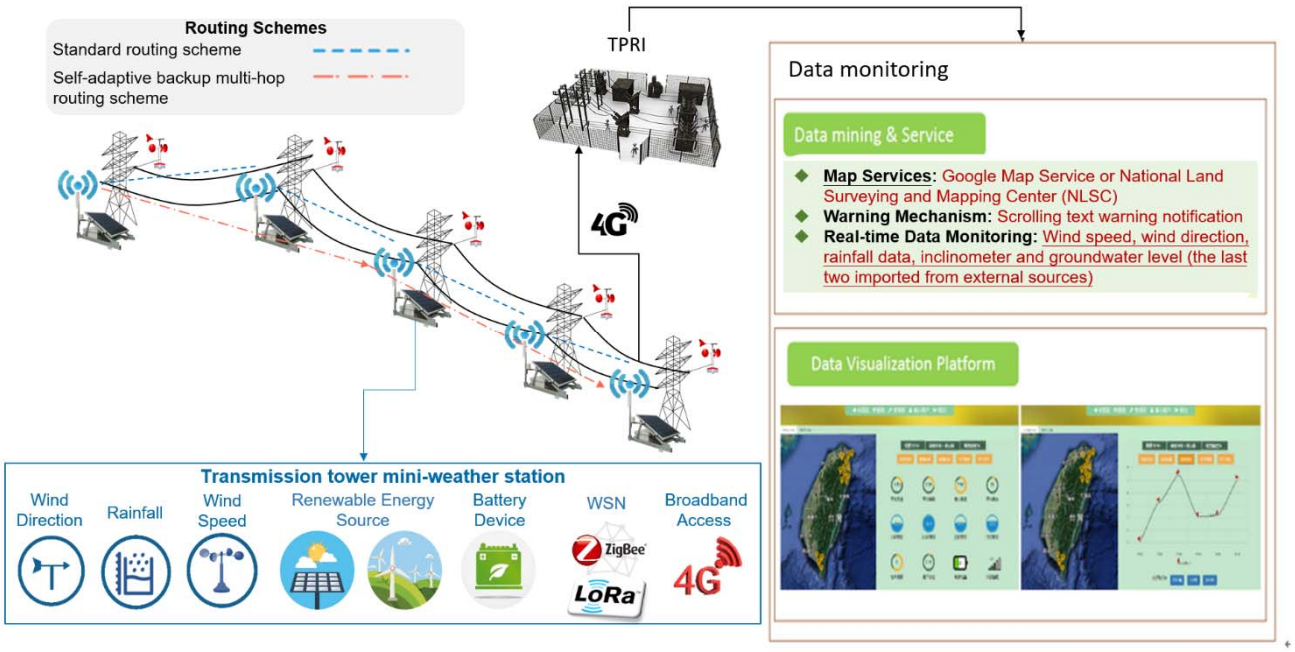

Fig. 2. System schematic diagram

III. Research Results

The installation of the monitoring system had been completed in October 2019, and up to now there have been no errors in data transmission, which is a proof of the stability and reliability of the system. The collected data of this study can be used on analyzing local wind fields, verifying the resilience of tower bases, revising the current warning mechanism, etc.