Impact of new methods of observation on the development of telecommunication networks: example of integration of weather radar in mountainous area

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Abstract:

As part of WIGOS implementation and being an integral part of the design of basic observation networks, telecommunications infrastructure is a major component to which particular interest should be granted. The surface observation network of the National Meteorological Service of Morocco is constantly changing. Advances in observing systems and the adoption of central concentration solutions induce a continuous improvement of telecommunications networks to meet the demands of such observation technologies. This paper present the experience of the Moroccan national meteorological service related to the integration of observing systems in the telecommunication network and measures taken accordingly. In this paper, it will be also described the evolution of telecommunication networks following the introduction of new observing systems and summarizes the results of the feasibility study conducted to select the most appropriate telecommunication solution to integrate the new weather radar of Debdou located in a mountainous region not covered by the usual solutions of telecommunication.

1. Introduction

The National Meteorological Service of Morocco (DMN) is on its third director telecommunication scheme implemented in 2008. This scheme is based on VPN technology (Virtual Private Network) which allows the connection of all meteorological stations at the national level including weather radars and meteorological stations at airports (Fig 1.). The choice means of telecommunication and the optimal flow rate to adopt for each site depends on several factors, in particular, its geographic position, network coverage, means of telecommunication available, size and frequency of files and data to be exchanged.

Besides the known advantages of using VPN in terms of privacy, security and VPN by the DMN has not only allowed to interconnect all sites together (any to any) promoting the exchange of information on all levels: local, regional and central but it has also enabled the development, in 2009, of the Intranet which offered to all meteorological stations simultaneous and instantaneous access to the needed information such as: on-site observations (observations from manned and automatic stations), remote sensing observations (obtained from the national lightning detection network, satellite receiving systems and weather radar network), weather numerical modeling outputs and weather forecasting products.

Figure 1. The VPN network of the DMN.
2. The Moroccan weather radar network

The first meteorological radar was installed in 1985 as part of the national weather modification project. In 1995, four new weather radars were acquired composing the national weather radar network. All these radars manufactured by EEC were connected centrally using leased lines with a flow rate of 256 kbps. In 2006, the DMN has launched a major project for the modernization of the existing network and the acquisition of a new radar to cover the central part of the High Atlas mountains and the neighboring regions.

As part of this project, the weather radar network has been integrated into the VPN telecommunication network and hence the radar products and in particular volumetric products are available at all levels. Another advantage lies in the fact that these telecommunication connections are also subject of the same quality of service provided by telecommunication company particularly the continuous monitoring and technical assistance 24h / 24h.

In 2013, DMN acquired its seventh weather radar enabling to cover the eastern north part of the country. The latter was also integrated in the VPN.

3. The Weather radar of Debdou

Debdou is a small town situated in a valley at 52km in the south of the city of Taourirt in north-eastern part of Morocco. It is located at the entrance of the famous plateau of the oriental with an altitude of more than 1600m above the sea level (Fig 4). Weather radar of Debdou was installed on the plateau in the site called Lgaada just above the valley (Fig 5).
Choosing the optimal solution for connecting the radar site to the VPN network was not an easy task and required a technical and also financial feasibility study.

Two solutions have been studied. The first consist on a direct connection to the VPN network using wireless technologies such as satellite communication VSAT or radio links (FH).

The second is an indirect solution linking, first, the radar site to the meteorological station of Taourirt and from this station to the central headquarters through a leased line.

From technical point of view, all these means of communication (VSAT, FH and LL) allow to have guaranteed flow rates broadly covering those needed. The reliability rate of such means is also very high above 99.95%.

If the implementation of VSAT or FH is easier requiring short time and some telecommunication equipments, the implementation of the LL is more complex requiring a very long time since the LL is not present in the city of Debdou and its extension to the radar site will be a very difficult and onerous task.

The comparative cost analysis whatsoever related to the fees of subscription or those related to the costs of installation shows that LL is not a solution to ignore as the cost of its implementation remain high but very accessible compared to the sum of subscription fees of VSAT to be paid regularly.

The decision was thus taken to choose the FH for the simplicity of its implementation, its reliability and its acceptable cost.

4. WiMAX a new wireless technology to explore

One of the significant advantages of advanced wireless systems such as WiMAX is the fact that this relatively new technology enables communication over a maximum distance of 30 miles. Of course, the longer the distance, the slower the speed, but it’s still faster and has a longer range than WiFi. Ideally, speeds of around 10MBps could be achieved with a range of 1 – 6 miles. Another advantage is its spectral efficiency.

WiMAX has been very successful as it’s easy to use, low cost, and relatively fast.

Like all wireless technologies, WiMAX can operate at higher bitrates or over longer distances but not both. Operating at the maximum range of 50 km (31 mi) increases bit error rate and thus results in a much lower bitrate. Conversely, reducing the range (to under 1 km) allows a device to operate at higher bitrates.

5. Connecting Debdou site using WiMAX

Given its simplicity and flow rates that can be supported, a feasibility study was launched to connect the radar site of Debdou to the meteorological station of Taourirt.

Figure 6. Different ways to use the WiMAX

Figure 7. the proposed scheme to link radar site to the meteorological station of Taourirt
The site survey shows that the city of Taourirt is visible from the radar site, and that no natural obstacle is present on the 50.6km long way path except the tip situated 10km from Taourirt.

Figure 8. Morphological situation between radar site and the meteorological station of Taourirt

The analysis of the attenuation provided by the Fresnel ellipsoid (fig 9.) shows that the antenna of issuance must be elevated enough to surpass the obstacle and especially during the rainy episodes.

Figure 9. Fresnel analysis of the signal propagation

Table 1 shows the values obtained for the signal loss along the defined path.

As a conclusion, the WiMax could be an easiest an cost effective mean of telecommunication to connect the weather radar of Debdou to the meteorological station of Taourirt. Taking into account that the city of Taourirt is located at the limit of the use of the WiMAX (51 Km) and the presence of a natural obstacle near of the city, it’s suggested to use a relay that may cause some difficulties related to some administrative procedures.

Table 1. Results obtained for the signal loss

6. Conclusion

This paper presents the experience of the Moroccan national meteorological service related to the integration of weather radars in the telecommunication network and measures taken accordingly. It’s providing an example of the continuous evolution of national telecommunication networks to concentrate and connect the acquired new observing systems in a cost effective manner taking into account the new technologies in matter of telecommunication.