



**INTERNATIONAL CIVIL AVIATION ORGANIZATION
WESTERN AND CENTRAL AFRICA OFFICE**

**Twenty-sixth Meeting of the AFI Satellite Network Management Committee (SNMC/26)
(Ouagadougou, Burkina-Faso, 19-23 Novembre 2018)**

Agenda Item 2: Review of AFISNET operational and technical statistics of availability

AFISNET Performance Monitoring

(Presented by DSNA, France)

SUMMARY
The purpose of this paper is to recall the importance of a harmonized performance monitoring system for AFISNET and build upon best practices to propose a way forward to further harmonize its implementation in the future.
REFERENCES: <ul style="list-style-type: none">▪ APIRG 18 REPORT 2012▪ APIRG 19 REPORT 2013▪ TOR SNMC▪ ICAO Annex X▪ AFISNET workshop held in Dakar from the 23rd to the 25th of January 2018

1. INTRODUCTION

1.1 The subject of performance monitoring has been present since the creation of SNMC. AFISNET's performance monitoring is the foundation on which the proactive network management culture of SNMC is built.

1.2 Much progress has been made already to harmonize performance monitoring within SNMC and within other satellite network management committees. This is mainly because SNMC believes in the importance of performance monitoring in maintaining and improving the quality of AFISNET. Moreover, most of the Air Traffic Management (ATM) deficiencies experienced by Air Navigation Service Providers (ANSP) who use this network could either be expressed or explained by accurately recorded and harmonized performance monitoring statistics.

1.3 This paper recalls the need of performance monitoring, highlights the indispensable role of harmonization in monitoring the performance of a network and proposes ways in which further harmonization can be achieved in monitoring the reliability of AFISNET as it plans to support more services in the future.

2. DISCUSSION

2.1 Need for Performance Monitoring Within SNMC

2.1.1 Performance monitoring is central to the mandate of SNMC. In its terms of reference, SNMC is mandated to “decide on the type and levels of service to be provided, and monitor the performance of the network to ensure that service delivery meets the required service performance level (RSPL) and the required communication performance (RCP) criteria previously predetermined when applicable, in accordance with the manual of required communication performance” (TOR 1.3)

2.1.2 The core members of SNMC are ANSPs whose work relies on the quality performance of AFISNET. It’s in line with this that SNMC is also mandated to “Ensure that participating states/organisations provide statistics on the network performance and investigate service delivery complaints from users” (TOR 1.5)

2.1.3 With the continuous growth in traffic within the AFI region and even further growth projected for the future (19th AFI TFG), the need for performance monitoring of AFISNET which shall support this traffic is even more important in order to maintain the required safety level. Figure 1 below shows the passenger traffic forecast for AFI by route group.

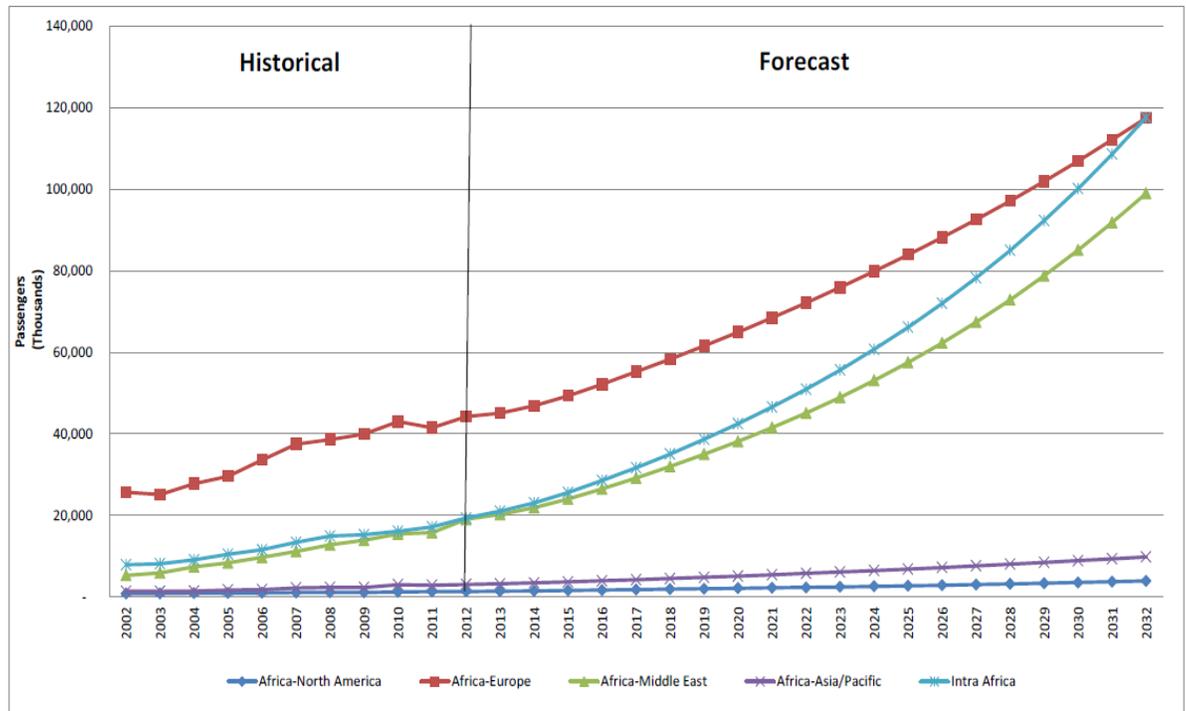


Figure1: Passenger traffic forecast by route group (19th AFI TFG)



- 2.1.4 The services using AFISNET (ATS/DS, AFTN, AMHS, AIDC, extended VHF....) are critical and demanding. Therefore, the monitoring of how well AFISNET supports these services should give a clear view of the evolution of the quality of this network so that AFISNET's credibility for future use could be demonstrated to its users.
- 2.1.5 Performance monitoring is also seen by ICAO as vital. ICAO has already defined eleven performance areas, the performance monitoring of AFISNET is linked to three of them: safety, air navigation efficiency and capacity (*ICAO doc 9883*).
- 2.1.6 Since the initial deployment of AFISNET initially named AEROSATEL, this network has quickly grown to more than one hundred stations. This growth has augmented the amount of data that could be collected to effectively monitor performance. It also increased the necessity of performance monitoring of AFISNET in order to maintain the RCP.
- 2.1.7 As the process leading to the evolution and reengineering of AFISNET progresses, performance monitoring has to be highlighted and integrated into the requirements of the new version of the network, in order to clearly demonstrate the added value brought by this evolution in terms of safety and performance.
- 2.1.8 With recurrent problems within AFI like missing flight plans and OPMET (*SNMC 25*), performance monitoring is expected to clarify the role of network quality in these problems, thanks to a proper isolation of the faulty part of the network, a lasting improvement of the service.
- 2.1.9 Harmonising the performance monitoring for the entire AFISNET will consolidate the voice of SNMC members in international meetings and towards regulators, suppliers, and would-be users/customers, thanks to collection, integration and statistics analysis from all stations by the SNMC entity.
- 2.1.10 With safety in air transport being a major goal of every ANSP, performance monitoring is a very useful tool in the accomplishment of this goal. This is because, safety studies which maintain quality, monitor changes and validate plans for the future, require data that is accurately collected and harmonised from the entire network.
- 2.1.11 As a Network Management Committee, SNMC is encouraged to promote a proactive network management environment in which: network problems are prevented before they occur and network quality trends are evaluated and compared to what is required. Performance monitoring therefore serves as the main instrument to be used in grounding the proactive network management culture.

2.2 Accomplishments of SNMC in harmonising performance monitoring

2.2.1 AFISNET was considered as an affordable and economically sustainable means to solve ATM deficiencies by supporting services like: Aeronautical Fixed Telecommunication Network (AFTN), Air Traffic Service Direct Speech (ATS/DS), ATS Message Handling System (AMHS), ATS Inter-facility Data Communication (AIDC), surveillance data, ADS-B/C, CPDLC, GNSS etc. To ensure that AFISNET supports current services efficiently and meets the demands of services that it will have to support in the future, SNMC in its previous meetings has put a high priority on the monitoring of AFISNET performance.

2.2.2 In order to monitor the performance of the entire VSAT network, ICAO APIRG18 meeting held in 2012 endorsed a performance monitoring strategy based on a four levels reporting index:

- **Level 1:** Space segment (CO + NO)/NO
- **Level 2:** Radio frequency and related equipment Eb/No
- **Level 3:** Multiplexers or interfaces base band equipment
- **Level 4:** Terminal equipment

The ANSPs using AFISNET are responsible for monitoring performance at each of these four levels. Figure 2 below expresses these four levels performance monitoring strategy.

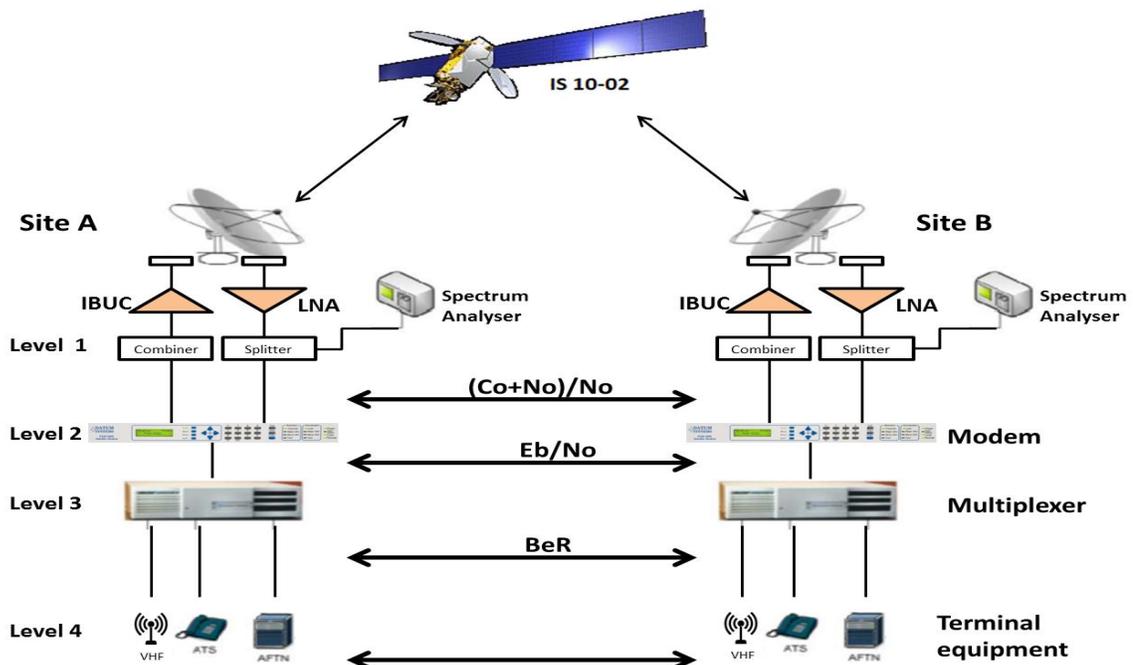


Figure 2: Four level VSAT performance monitoring approach between Site A and Site B.

- 2.2.3 ICAO also concluded on the set of performance indicators to be monitored for some current and future services that use VSAT networks. For **ATS/DS** the five indicators are: **availability, BER, latency, call back probability and set up time**. **AFTN** had four major indicators: **availability, transmission time, circuit loading and transmission speed**. **AMHS** and **AIDC** are monitored through **availability, circuit speed and transmission time**. For each of these indicators ICAO has developed a minimum performance target endorsed by ICAO SP AFI RAN (2008).
- 2.2.4 The APIRG 18 meeting agreed to a monitoring methodology developed by the South Atlantic Informal Group (SAT) which is based on the use of performance data collection forms (**PDCF**). During APIRG 19 meeting in 2013, the secretariat was requested to finalize and circulate these forms to states for implementation as from 1st January 2014. This was to ensure harmonization of performance measurement methodology within and between ICAO regions. The APIRG 19 meeting also decided that the best practices adopted by APIRG for Aeronautical Fixed Service (AFS) will be amended to include the PDCF (*Decision 19/35*).
- 2.2.5 With data collected in a similar way by all states and submitted to the ICAO regional office monthly through the PDCF a major progress was expected in the performance monitoring of the entire AFISNET. It was however noted by the secretariat that not all SNMC members were submitting the required information in a timely manner even after the PDCF forms were finalized and transmitted to states for implementation. This made it difficult for SNMC to fully benefit from the valuable information that could be exploited from the data in these forms.
- 2.2.6 Currently, much is already being done within SNMC to monitor the performance of AFISNET, mainly through the monitoring of ATS/DS and AFTN. The availability of these services are recorded on a monthly basis and presented during the SNMC meeting by each ANSP. These statistics presented each year have been very useful as it gives a clear view of the progress of service availability, identify deficient links, and forms the basis to strategize on mitigating the underperformance of circuits whose availability fail to meet the required availability percentage.
- 2.2.7 Despite the progress made on performance monitoring within SNMC, much is still to be done to assess the real performance of AFISNET. The monitoring of a network begins with the monitoring of the end services supported by this network, which gives only a partial view of the performance of the network, and shall continue with the monitoring of the network itself, independent of the services, for more accuracy and efficiency.

2.3 Next Steps in AFISNET Performance Monitoring for Future Challenges

- 2.3.1 The progress towards a more harmonized implementation of best practices on performance monitoring of AFISNET will benefit every stakeholder of this network especially the core members of SNMC.
- 2.3.2 The objective of performance monitoring is not perfection through a complex monitoring system but a means to collect accurate, homogeneous and thus interpretable data. This is achieved by using a monitoring system that could be implemented by every single station that constitutes AFISNET. In order to be effective, this system has to be simple enough, cheap enough and easy enough to be implemented by every party involved.
- 2.3.3 SNMC unites all AFISNET users. It could leverage its position to enhance the collection, integration, interpretation and presentation of a unified single view of the AFISNET network performance, regardless of user services.
- 2.3.4 The statistics that are consistently collected and recorded over a long period of time, will lead to a more effective monitoring of the evolution of AFISNET performance. These statistics will more explicitly bring out the potential degradation in quality of not only some particular links but the whole AFISNET.
- 2.3.5 When we focus on monitoring the VSAT link itself independent of the services, the four level performance monitoring strategy makes it technically obvious that it is most effective to monitor the **Eb/No: the energy per bit to noise power spectral density**. Monitoring the Eb/No is not only effective but very easy and practical, needing very little extra instrument and expertise. It could thus be easily implemented by every station of AFISNET.
- 2.3.6 In order to harmonize the implementation of performance measurements of Eb/No, the procedure for its measurement as well as the format for recording has to be the same in all the stations. The procedure should clearly define: what should be measured, when it should be measured, how it should be measured and why it is measured. When this is done, the data collected from all stations can be easily combined and exploited.
- 2.3.7 The monitoring of AFISNET through measurement of Eb/No will have more impact if it is automated. The measurements will be recorded automatically and just exported when needed with the use of a supervision personal computer (PC), this procedure requiring few work load and providing optimum benefit can be summarized below:
- **What should be measured:** Eb/No.
 - **When should it be measured:** every minute.
 - **How it will be measured:** Use a supervision PC and configure to record automatically.
 - **Why it is measured:** Monitor the entire AFISNET though signal strength of each link.

2.3.8 An example of a format that could be adopted is presented in figure 3 and 4 below. A simple analysis of Fig. 3 and 4 allows concluding that the problem comes from the local reception in Fig. 3 and from the remote transmission level in one location in Fig. 4. These two **theoretical** figures are intended to show that an efficient monitoring is possible and useful for a very precise technical analysis of the problem

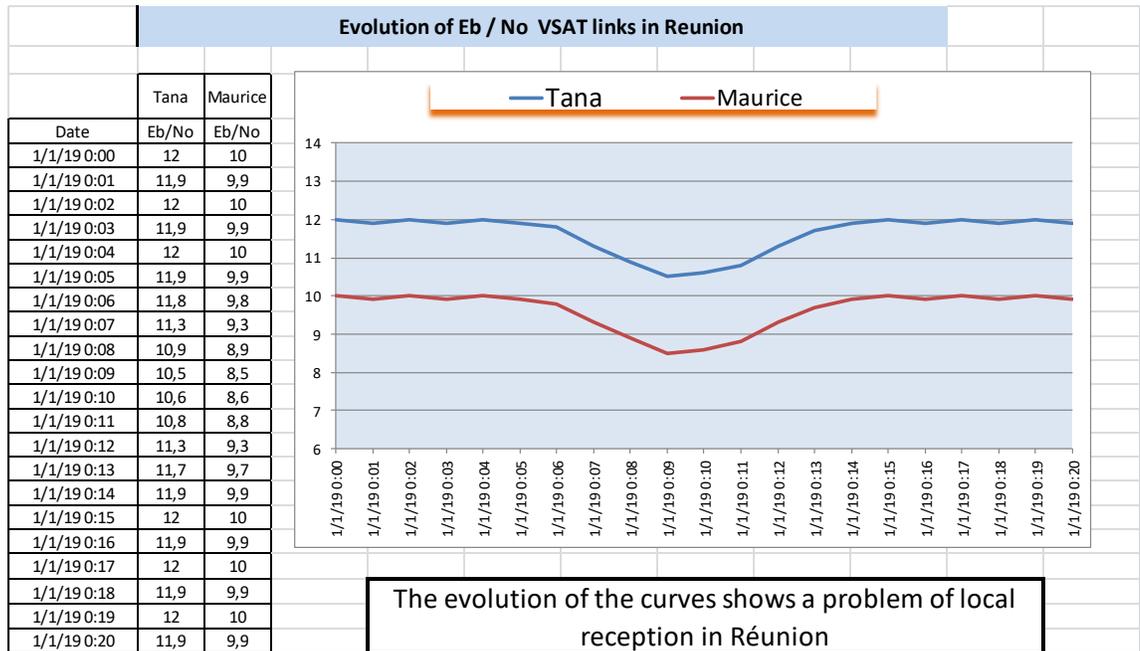


Figure 3

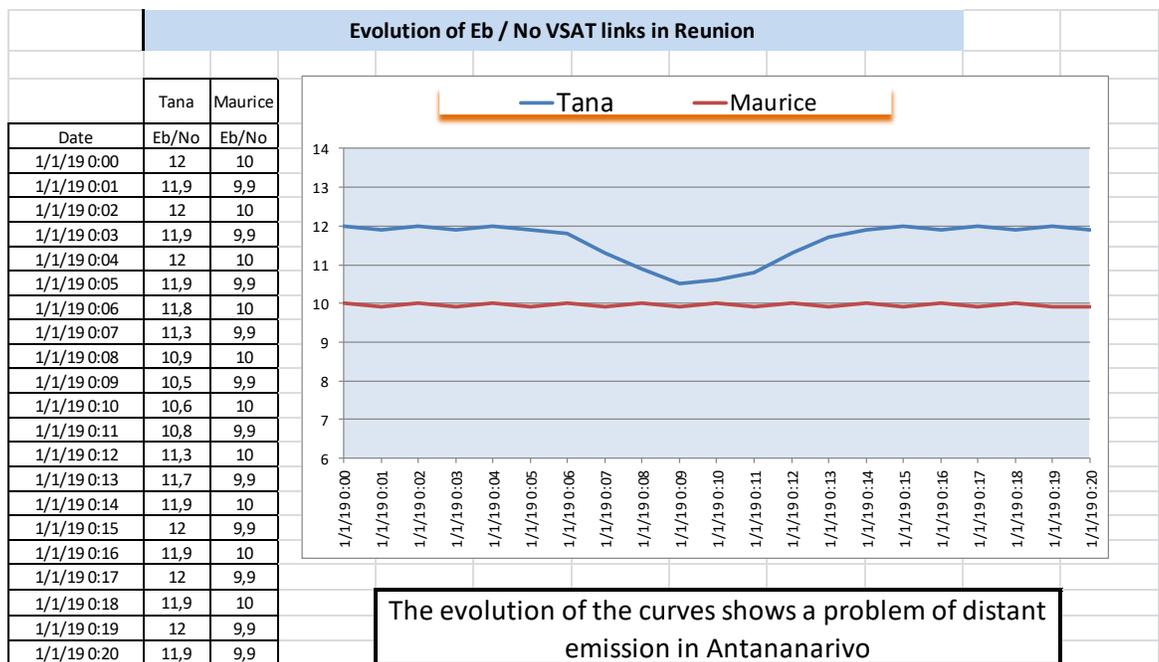


Figure 4

- 2.3.9 If the previous scenario in 2.3.7 could not be implemented by every party immediately, we could begin by a more manual and simplified scenario of Eb/No recording. Though this will give only partial benefits that could be gained through this recording, it will provide a basis of harmonization on which the previous scenario could later be implemented. This scenario involves measuring Eb/No manually only once a month, exactly at the same time for each station, for example the 1st of the month.
- 2.3.10 These measurements, when recorded, submitted to the secretariat and then published will greatly improve the performance monitoring of AFISNET. The current trend of the network quality could be observed, the future quality could be predicted, and as feedback is received preventive actions could be taken before important problems become urgent. The signal strength across the network expressed through this data will also prove AFISNET's reliability in supporting future services and users of this network
- 2.3.11 Surveillance data which represents one of the most ATM related critical services will use AFISNET in the nearest future. The ongoing validation of satellite ADS-B within AFI adds to the urgency of demonstrating the current and future reliability of AFISNET through accurate, complete and consistently collected performance monitoring data.
- 2.3.12 The measurement of Eb/No will build on what is already done within SNMC for the monitoring the availability of AFTN and ATS/DS. This measurement because of its importance is already recorded and presented in NMC by ANSPs like ATNS. SNMC stands to benefit from the huge advantage provided by harmonizing this measurement for all its members.
- 2.3.13 The AFISNET workshop held in Dakar from the 23rd to the 25th of January 2018, on request of DSNA, has been a good opportunity for ASECNA, ENNA and DSNA to discuss a degradation of the Eb/No observed simultaneously by several ground stations. The conclusion of this discussion was that a common cause of failure could be determined, and allowed to conclude that an increase of the transmission power from the common point would solve the problem.
- 2.3.14 A few days after this meeting, the transmit power of the suspected ground station has been increased and the problem, dating from several years ago, disappeared. This mere fact means that a regular monitoring of the received level, at the Eb/No level, and **appropriate processing and analysis** of the collected data from every ground stations could be an efficient tool, not only to solve but specially to **anticipate** them.

3. CONCLUSION

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Based on the proposal here above the following decisions are proposed:

Why	Monitor the AFISNET network performance
What	Monitor each reception at level 2 (Eb/No) every minute and send the record every month to the Network Management Centre and to the management bodies of directly connected ground stations.
Who	Each member of the SNMC
When	SNMC 26

Draft SNMC Conclusion 26/xx – Monitoring of AFISNET VSAT network

Why	Monitor the AFISNET network performance
What	Collect, process and makes the recordings and analysis available for all members of the SNMC
Who	ICAO/WACAF/SNMC Management Centre
When	SNMC 26

Draft SNMC Conclusion 26/xx – Analysis of AFISNET VSAT network

4. ACTION BY THE MEETING

The meeting is invited to:

- a) Take note of the information presented in this working paper, highlighting the importance of a harmonized implementation of performance monitoring within AFISNET;
- b) Support the DSNNA proposal to gather Eb/No for every ground station, on a monthly basis
- c) Endorse the proposed Conclusions stated here above.
