Scientific Case Study

Out-of-Footprint reception of the SNRT (Morocco) carrier from the MENA beam of the Es'hail 1 at 25.5°E satellite on 11,180 MHz, V-pol., in Central Europe (Lučenec, Slovak Republic), with a technological analysis of the DVB-S2/8PSK Multistream standard and the PLS Gold 253312 code

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Abstract

This study documents and scientifically analyses the achievement of stable Out-of-Footprint (OOF) reception of the carrier frequency of the Moroccan broadcaster SNRT at f = 11,180 MHz, vertical polarisation, distributed via the MENA (Middle East and North Africa) beam of the Es'hail 1 at 25.5°E satellite, from a reception site in the town of Lučenec, southern part of central Slovakia. The measurement was carried out over the unit length t ≥ 72 hours which, under the methodology of the author Roman Dávid ("Visualized Proof", 2020), constitutes the minimum acceptable unit for a scientifically relevant OOF observation, with a total of 259,200 signal samples recorded. The results demonstrate an uninterrupted Lock and 100% Quality throughout the entire measurement period, without a single instance of picture pixelation, with a peak value of MER = 13.4 dB and a signal-to-noise ratio in the range of SNR = 12.4–12.6 dB, despite partial shadowing of the satellite trajectory by an apple tree in the immediate vicinity of the reception site. Particular attention is given to the Multistream technology standard within DVB-S2/8PSK, using the identification code PLS Gold 253312, in the context of the migration of SNRT's signal distribution from the original Eutelsat 21B at 21.5°E (Western Ku) satellite to the new Es'hail 1 at 25.5°E position.

1. Introduction and Research Objective

The subject of this case study is the scientific documentation and interpretation of the results of long-term signal monitoring carried out by the author, Roman Dávid, within his independent research centre dxsatcs.com. The aim is to demonstrate and analyse the physical conditions under which, in the zone outside the primary coverage (Out-of-Footprint, OOF) of the MENA beam of the Es'hail 1 at 25.5°E satellite, it is possible to achieve long-term, scientifically verifiable reception with parameters comparable to, or approaching, those of standard reception within the declared coverage zone.

The Lučenec zone (central Slovakia) is geographically located outside the primary coverage area of the MENA beam, which is directed towards the Middle East and North Africa. Achieving stable reception at this location is therefore, from the standpoint of standard footprint chart theory, an exceptional phenomenon that requires a precisely defined measurement methodology for the results to be considered scientifically unquestionable.

This study also builds on the author's previous case studies (Express AM7 at 40°E, Rascom QAF-1R South and North beam), which were prepared using the same "Visualized Proof" methodology, and extends the OOF documentation series to a technologically distinct aspect — the analysis of Multistream transmission within the DVB-S2 standard.

2. Geographic and Geometric Parameters of the Reception Site

The reception site is located in the town of Lučenec, Slovak Republic, at coordinates φ = 48.3331° North latitude, λ = 19.6664° East longitude (values verified through the independent tool DishPointer.com prior to inclusion in this study, in accordance with the author's standard procedure for validating geometric data).

For the satellite position 25.5°E ES'HAIL 1, the following dish-pointing values were calculated for the given reception site: azimuth (true/geographic) = 172.2°, azimuth (magnetic) = 166.2°, elevation angle = 34.2°, and LNB skew = −5.2°. These values represent a key input parameter for correctly pointing the reflector and must be independently verified before each signal session, since even a minimal deviation from the calculated azimuth or elevation can have a critical effect, in an OOF zone where the received signal is typically significantly attenuated, on the resulting carrier-to-noise ratio.

The elevation angle of 34.2° for a satellite on the geostationary orbit at 25.5°E, viewed from central Slovakia (φ ≈ 48.3° N), is sufficiently favourable in terms of orbital inclination for a D = 450 cm reflector to concentrate even the energetically weak sidelobe of the MENA beam into a gain sufficient for a stable receiver Lock, which is a key prerequisite demonstrated further in this study.

3. Physical Basis of Out-of-Footprint Reception from the MENA Beam

A satellite antenna's footprint does not represent a sharply bounded geometric limit, but rather a continuously decreasing function of effective isotropically radiated power (EIRP) from the centre of the beam towards its edges. The boundaries drawn on published footprint maps typically represent iso-EIRP contours (e.g. −3 dB, −6 dB from the maximum), not the physical zero of the signal. It is precisely in the space beyond this declared contour, where EIRP falls by a further several tens of decibels, that the OOF reception zone lies, whose successful exploitation depends on the product of three factors: the residual EIRP towards the given geographic location, the gain of the receiving antenna (in this case given by the aperture area of the D = 450 cm reflector), and the noise figure of the receiving chain (LNB + TBS 5927 tuner).

In the case of Lučenec as an OOF location, the sidelobe of the MENA beam towards central Europe is attenuated, but not to a degree that prevents demodulation. The measured SNR value in the range of 12.4–12.6 dB and MER = 13.4 dB demonstrate that, even under this attenuation, the received power remains above the threshold required for the 8PSK modulation scheme with FEC 3/4, whose theoretical QEF (Quasi-Error-Free) threshold in practice is on the order of 6–7 dB Es/N0. The measured margin of approximately 5–7 dB above this theoretical threshold represents a real link margin, which explains the observed one-hundred-percent Lock stability throughout the entire 72-hour unit without a single dropout.

A particular element of this study is the fact that the signal path between the satellite and the reflector was partially shadowed at the reception site by the crown of an apple tree growing in the immediate vicinity. In terms of electromagnetic wave propagation at a frequency of 11.18 GHz (wavelength λ ≈ 2.68 cm), a vegetative obstacle constitutes an attenuation mechanism combining absorption by water contained in leaves and stems and diffraction scattering at the edges of leaves and branches. The fact that, despite this additional obstacle, not a single Lock dropout nor a single instance of pixelation occurred across the 259,200 measured points indicates that the actual link margin of the received signal during moments without direct foliage shadowing was likely higher than the average measured value would suggest, and that the shadowing caused only a partial, not a complete, interruption of the line-of-sight to the satellite.

4. Migration of SNRT Signal Distribution from Eutelsat 21B to Es'hail 1

The Moroccan broadcaster SNRT (Société Nationale de Radiodiffusion et de Télévision), in the course of its distribution strategy, ended the transmission of this carrier via the Western Ku band of the Eutelsat 21B at 21.5°E satellite and moved distribution to the new position Es'hail 1 at 25.5°E. From the standpoint of OOF research in central Europe, this change in orbital position by approximately 4° eastward represents a qualitatively different geometric situation — it changes not only the azimuth and elevation required for pointing the reflector, but above all it also changes the position of the reception site relative to the MENA beam, since this is a different satellite with its own antenna system configuration and its own beam shape.

For this reason, the parameters and azimuth-elevation data valid for the previous Eutelsat 21B position cannot be mechanically transferred to the new Es'hail 1 position — every change of a satellite's orbital position requires a complete recalculation and independent verification of pointing data, which in this study was consistently observed through validation via DishPointer.com.

The change of carrier platform also provides a unique opportunity to compare the behaviour of the same broadcaster and the same type of transmission (Multistream, PLS Gold) on two different satellite positions and two different configurations of the MENA beam, making this case study part of the author's broader research framework focused on comparative analysis of OOF reception across multiple satellite platforms.

5. Technological Analysis of the Multistream Standard (DVB-S2) and the PLS Gold 253312 Code

The DVB-S2 standard (ETSI EN 302 307) defines an optional Multi-Stream extension (MIS — Multiple Input Stream) that allows multiple independent transport streams (e.g. different broadcasters or regional programme variants) to be multiplexed within a single physical transponder carrier into a common physical-layer frame (PLFRAME). The individual streams are distinguished from one another via the ISI (Input Stream Identifier) field carried in the BBFRAME header, which allows the receiver to selectively demultiplex only the desired stream without having to demodulate and decode the entire aggregated data stream.

A key physical-layer element for synchronisation and identification is the PLS (Physical Layer Signalling) field, which is modulated using so-called Gold sequences — pseudo-random binary sequences with defined autocorrelation and cross-correlation properties, enabling the receiver to achieve rapid and reliable synchronisation to the start of the physical frame even at the low signal-to-noise ratios typical of OOF reception. In the analysed session, the specific PLS Gold code with root index 253312 was identified, which uniquely identifies the given signal configuration and allows the TBS 5927 receiver, in conjunction with the EBS Pro platform, to deterministically find and lock onto the correct data stream within the aggregated Multistream carrier (in the measured session, the specific input stream selected was designated MIS = 16).

From the point of view of OOF research, the use of Gold codes in the PLS field also has a practical significance beyond the ordinary operational context: given their robust correlation properties, synchronisation to the PLS field is possible even at Es/N0 values lower than those required for actual demodulation of the payload data at the chosen MODCOD, meaning the receiver can reliably identify the presence of the carrier and its Multistream configuration even before it would be able to begin error-free decoding of the content itself — this property partly explains the exceptional Lock stability observed in this study even during moments of temporary shadowing of the signal path.

The measured transponder parameters — symbol rate 27,497.381 kS/s, 8PSK modulation, FEC 3/4 — combined with Multistream and PLS Gold 253312, confirm that this is a modern, efficient transmission configuration optimised for maximum utilisation of available transponder bandwidth (measured carrier width 32.996 MHz) while maintaining sufficient noise immunity for reliable reception even in the peripheral regions of the footprint.

6. Signal Monitoring Methodology — "Visualized Proof"

The measurement was carried out in accordance with the "Visualized Proof" methodology, which the author Roman Dávid published in 2020 and which defines the unit length of continuous monitoring $t \geq 72$ hours as the minimum time unit required for OOF reception results to be considered statistically and scientifically relevant, rather than a random or short-term phenomenon conditioned by favourable atmospheric circumstances.

The signal chain consisted of a Prodelin reflector with a diameter of D = 450 cm in a prime-focus configuration, a TBS 5927 USB tuner supporting DVB-S2/S2X, and the EBS Pro software platform, which is the author's sole monitoring software used for continuous recording of the Level, Quality, SNR and BER parameters at regular time intervals.

Over the monitored period, a total of 259,200 individual signal samples were recorded, which, for a unit length of 72 hours, corresponds to a sampling period of 1 second ($72 \times 3600 = 259{,}200$). This sampling density ensures that even short-term transient phenomena on the order of a few seconds (for example, temporary shadowing by foliage in the wind) would have been captured in the record, reinforcing the scientific weight of the conclusion regarding the complete absence of Lock dropouts throughout the entire measurement unit.

7. Measurement Results and Their Analysis

The Quality curve (blue trace) remained at a constant level of 100% throughout the entire 72-hour measurement unit, without a single drop, which is both graphical and numerical evidence of an uninterrupted Lock. At the same time, both preBER and BER values remained below the threshold of 1.0×10^{-7} throughout, which corresponds to the criterion of practically error-free reception (Quasi-Error-Free) at the transport-stream level, i.e. without visible pixelation or picture dropout at the decoder output.

The SNR curve (magenta) moved within a narrow band during the measurement, with a peak (best) measured value of 12.4 dB to 12.6 dB, the single highest value being recorded in the log as "Best signal: 12.4 dB", achieved in the early morning hours of the monitoring session. The MER (Modulation Error Ratio) value reached a peak level of 13.4 dB during the session, which represents an independent confirmation of the quality of the demodulated 8PSK constellation and is consistent with the measured SNR value and the observed one-hundred-percent stability.

The Level curve (green, signal level) showed moderate variability during the session within a band of approximately 55–65% with short-term dips, which is a typical manifestation of atmospheric and local influences (e.g. air humidity, partial shadowing by foliage) on the received carrier level; however, these fluctuations in signal level did not at any point translate into a drop in Quality below 100% nor into an increase in error rate above the threshold — confirming the conclusion stated in Section 3 regarding the sufficient link margin of the received signal.

The measured transmission performance parameters (bitrate 25.269 Mbit/s, input data stream ~23.73 Mbps, carrier width 32.996 MHz, RF level −43 dBm) confirm that this is a fully valid, stably demultiplexed and decoded Multistream data stream, not a marginal or intermittent reception at the edge of carrier detectability.

Axiomatic Conclusions

1. Out-of-Footprint reception from the sidelobe of the MENA beam of the Es'hail 1 at 25.5°E satellite is scientifically demonstrable as achievable, at the Lučenec, central Slovakia location, using a D = 450 cm reflector, at a level of one-hundred-percent Lock stability over a unit of t ≥ 72 hours.

2. The measured values of SNR = 12.4–12.6 dB and MER = 13.4 dB represent a sufficient link margin above the theoretical QEF threshold for 8PSK modulation with FEC 3/4 to prevent short-term attenuation events (partial vegetative shadowing) from interrupting reception.

3. The migration of signal distribution from the Eutelsat 21B at 21.5°E satellite to Es'hail 1 at 25.5°E represents a qualitatively new geometric and technical situation that requires independent recalculation and verification of all pointing (AZ/EL/Skew) parameters.

4. The robustness of the Gold sequences used in the PLS field (PLS Gold code 253312) enables reliable receiver synchronisation to the physical layer of a Multistream carrier even under the low signal-to-noise conditions typical of OOF reception.

5. The sampling density of 259,200 measurements per 72-hour unit (1 sample/s) is sufficient for the statistically reliable exclusion of short-term, unrecorded Lock dropouts, whereby the results of this study meet the criteria of the "Visualized Proof" methodology.

Table of Technical Parameters

Reception site	Lučenec, Slovak Republic (φ = 48.3331° N, λ = 19.6664° E)
Satellite	Es'hail 1 at 25.5°E (ex-Eutelsat 25B) — MENA beam
Previous distribution position	Eutelsat 21B at 21.5°E (Western Ku)
Receiving antenna	Prodelin, prime-focus parabolic reflector, D = 450 cm
Receiver (tuner)	TBS 5927 USB DVB-S2 tuner
Monitoring platform	EBS Pro (author's sole software)
Frequency / polarisation	11,180 MHz (measured 11,179.999 MHz) / V (vertical)
Symbol rate	27,497.381 kS/s
Standard / modulation	DVB-S2, Multistream / 8PSK
FEC	3/4
PLS code	Gold, root 253312
Selected input stream (MIS)	16
Azimuth (true / magnetic)	172.2° / 166.2°
Elevation	34.2°
LNB skew	−5.2°
Monitoring unit length	t ≥ 72 hours (recorded uptime 72:27:16)
Number of signal samples	259,200

Lock stability	100%, no dropout
Quality	100%, no drop
preBER / BER	$< 1.0 \times 10^{-7}$
SNR (range / peak)	12.4–12.6 dB / best value 12.4 dB
MER (peak)	13.4 dB
RF level	−43 dBm
Bitrate / input stream	25.269 Mbit/s / ~23.73 Mbps
Carrier width	32.996 MHz
Path obstruction	partial shadowing by an apple tree crown near the reception site

Conclusion

This case study scientifically documents and confirms that Out-of-Footprint reception of the carrier frequency of the Moroccan broadcaster SNRT at 11,180 MHz V-pol., distributed via the MENA beam of the Es'hail 1 at 25.5°E satellite, is achievable from the Lučenec (central Slovakia) location at a level of complete Lock stability and error-free picture quality throughout the entire 72-hour monitoring unit, even despite a partial vegetative obstacle in the signal path. The analysis of Multistream technology and the PLS Gold 253312 code confirms that the current generation of the DVB-S2 signalling layer provides sufficient robustness for reliable carrier identification and demultiplexing even under conditions typical of OOF reception. The results were achieved in accordance with the author's "Visualized Proof" methodology and extend his existing series of OOF case studies to a new satellite position and a new technological aspect of signal distribution.

References and Bibliography

[1] ETSI EN 302 307-1/-2 — Digital Video Broadcasting (DVB); Second generation framing structure, channel coding and modulation systems for Broadcasting, Interactive Services, News Gathering and other broadband satellite applications (DVB-S2 / DVB-S2X).

[2] Dávid, R. (2020): Visualized Proof — signal monitoring methodology for Out-of-Footprint zones, dxsatcs.com.

[3] Dávid, R.: Case study Express AM7 at 40°E — Indian beam, 73 h 20 min monitoring, dxsatcs.com.

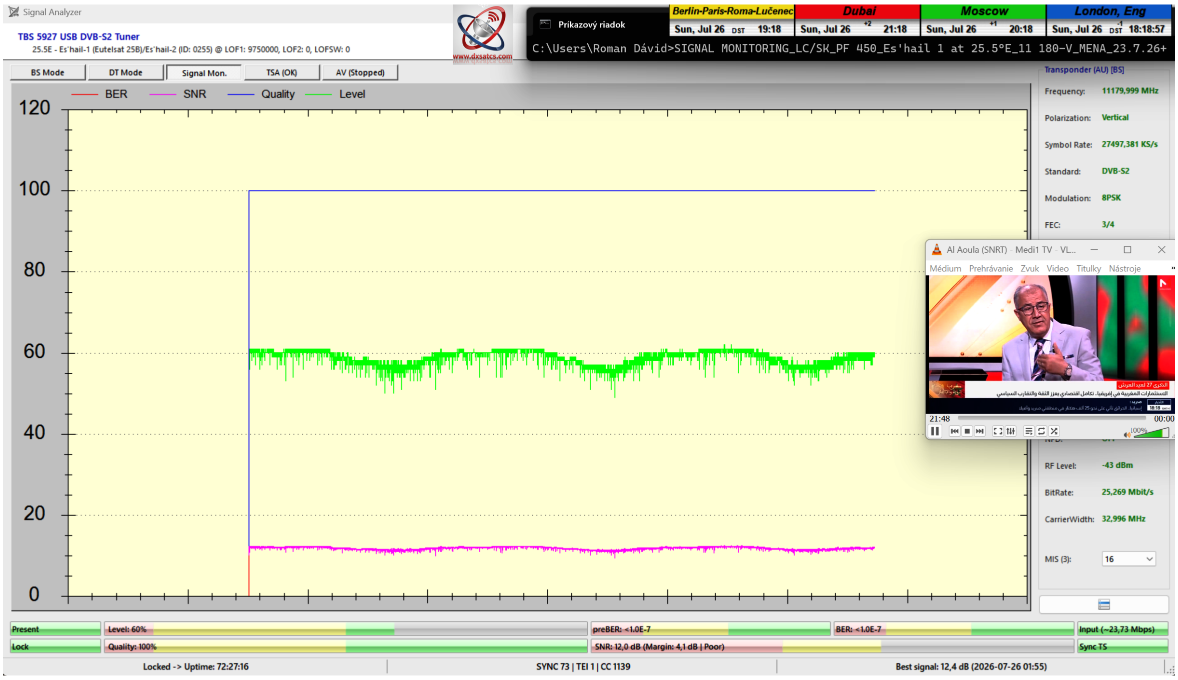
[4] Dávid, R.: Case study Rascom QAF-1R — North Africa beam and South beam, dxsatcs.com.

[5] DishPointer.com — tool for calculating and verifying azimuth, elevation and LNB skew for a given reception location and satellite position.

[6] EBS Pro — software platform for DVB-S/S2 receiver signal monitoring, used as the author's sole monitoring tool.

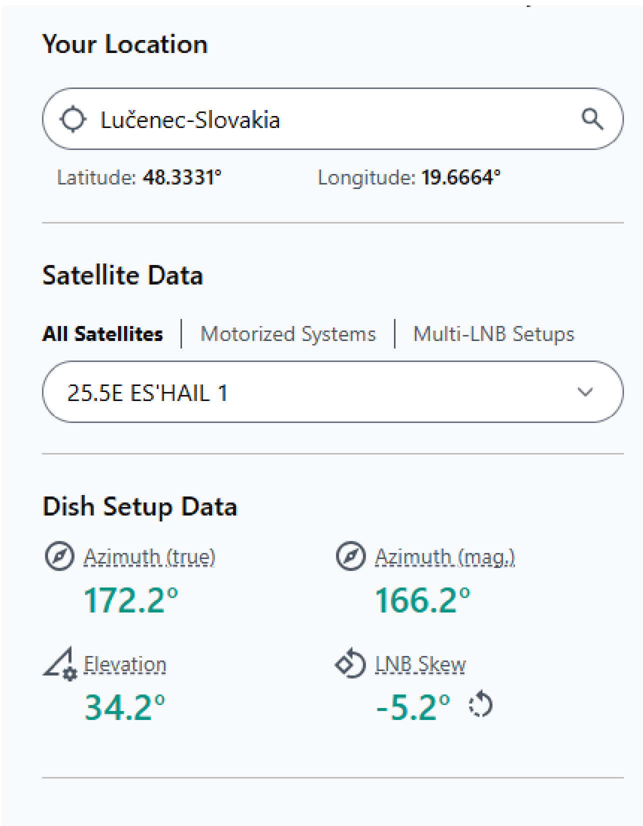
Image Appendix

Fig. 1



Screen capture of the EBS Pro signal analyser (TBS 5927 tuner) showing the Quality, SNR, BER and Level curves during the monitoring session on the 11,180 MHz V transponder, Es'hail 1 at 25.5°E, together with the transponder parameter table and the uptime value 72:27:16 documenting an uninterrupted Lock.

Fig. 2



Output of the independent tool DishPointer.com for the reception location Lučenec-Slovakia and the satellite position 25.5°E ES'HAIL 1, with the calculated azimuth (true/magnetic), elevation and LNB skew values used to verify the pointing data in this study.