Impact of Newly Installed Black Mesa Cell Tower on Signal Strength on Concho Road near White Antelope and surrounding vicinity

Before and After Measurements: September 1, 2024 - May 5, 2025

Executive Summary

Main conclusion: any data presented at the September 24, 2024, meeting of the Navajo County Board of Supervisors concerning the signal quality of cell reception along Concho Road should now be considered obsolete and irrelevant. The new tower on Black Mesa greatly improves the cell reception and obviates the need for another tower near the intersection with White Antelope Road.

This paper argues that a new cell tower proposed by SBA Communications for construction near the intersection of Concho Road and White Antelope Road is not needed, because the newly constructed tower on the nearby Black Mesa has improved signal strength and cell phone reception.

The author, with some help from friends, collected data on the strength and quality of Verizon cell signals at various locations within a 3-mile radius of the intersection of Concho Road and White Antelope Road in Navajo County, Arizona on September 1, 2024, May 5, 2025, and May 8,2025. The cellular signal strength that we measured on September 1, 2024, at various locations in the area was generally "poor" with RSRP values ranging from -101 to -127. Also, negative values were measured for the SINR0 and SINR1 metrics. At the time of the September 24, 2024, Navajo County Board of Supervisor's meeting the new Black Mesa cell tower had **already been approved** for construction. Reg Destree, an SBA subcontractor, seems to have based some opinions on then-current signal quality measurements; he may have not fully accounted for the future impact of the new Black Mesa tower on quality of service.

We made measurements on September 1, 2024, of both signal strength (RSRP) and signal quality (RSRQ, SINR0 and SINR1) values at the White Antelope intersection and other nearby locations. These measurements were made prior to the September 24, 2024, Board of Supervisors meeting. We also measured at the same locations on May 5 and May 8,

2025. The improvement in received signal strength and quality was dramatic. Signal quality metric improvements ranged from 24 dB to over 60 dB. As documented in Table 2, converting from a logarithmic (dB) scale to linear power ratios the SINR0 measurements shows improvements ranging from a multiplicative improvement factor 245-fold (Hansa TRL at White Antelope location) to an improvement factor of 194,984 (White Antelope at Concho HWY).

Introduction

The installation of a new cell tower on Black Mesa on February 22-23, 2025, has had a notable impact on the signal strength received on Concho Road near White Antelope Road and the surrounding area. To quantify this improvement, signal strength measurements were taken at various locations on different dates: September 1, 2024, before the tower's construction, and May 5-8, 2025, after the new Black Mesa tower became operational. This report summarizes the findings, focusing on the comparative analysis of signal strength before and after the installation.

Methodology

Signal strength measurements were conducted using an iPhone 16 Pro, which accurately registers values in decibel-milliwatts (dBm). Apple enables user access to these measurements through the dialing sequence *3001#12345#*. Our data collection process required revisiting the same locations on both dates to maintain consistency.

An Excel spreadsheet (included below) was created to organize and present the data. The spreadsheet has columns for location, date, and signal strength readings (dBm) and signal quality measurements shown by the iPhone both before and after the cell tower installation.

The signal strength measurements made from a single iPhone cannot be a substitute for a full field survey of signal strength and quality by a professional engineering organization. However, our measurements do indicate that new full study is needed.

Results

The data from both dates reveal significant improvements in signal strength and signal quality at the tested locations. Measurements before the new tower installation had lower dBm values, indicating weaker signal strength. After the tower became operational, the signal strength showed a marked increase at all locations.

Key Observations:

- Average signal strength (RSRP) improved across all tested locations
- Before installation: Signal strength ranged from -127 to -101 dBm.
- After installation: Signal strength ranged from -104 to -89 dBm.
- Before installation: Signal quality (SINR0, SINR1) ranged from (-86, -92) to (-14, -36)
- After installation: Signal quality ranged from (2.9, -4) to (15.4, 29.2)

Interpretation of measurements

Comment regarding logarithmic and linear scaling

This paper contains both logarithmically scaled measurements and linearly scaled power ratios to help non-technical readers more fully appreciate the magnitude of the improvements observed. Technical readers may object that this unfairly overdramatizes the actual improvement. We answer that both types of scaling are numerically correct and are simply different viewpoints of the same underlying signal strength and quality. While technically trained people develop an intuitive understanding of logarithmic scaling, non-technical people rarely have this understanding and may fail to appreciate the large differences of performance portrayed by relatively small arithmetic differences that appear when logarithmic scaling is used.

Understanding Decibel Measurements

Decibels (dB) are a logarithmic unit used to express the ratio between two values, often in the context of signal strength or sound levels. This logarithmic scale can be challenging to interpret for those unfamiliar with its principles, as it does not increase linearly. For instance, a change of **10** dB represents a **tenfold** increase in power, while a change of **20** dB represents a **hundredfold** increase.

To illustrate this, consider the sound levels measured in decibels A-weighted (dB(A)) units, a standard for assessing perceived loudness. A whisper typically registers at around 20 dB(A), normal conversation at 60 dB(A), and a rock concert at 100 dB(A). The difference between 20 dB(A) and 30 dB(A) is not merely a slight increase—it represents sound energy 10 times greater. Similarly, moving from 30 dB(A) to 40 dB(A) involves an energy increase another 10 times greater, resulting in a cumulative 100 times increase from 20 dB(A) to 40 dB(A). This example underscores the exponential nature of decibel measurements.

In terms of cellular signal measurements seen in the appendix table, values such as signal strength (dBm) or signal quality (SINR0, SINR1) also follow this logarithmic model. A small numerical change may represent significant differences in performance, making careful interpretation critical for meaningful analysis.

Details about Appendix 1: Observational data

Description of Cellular Service Abbreviations

- RSRP (Reference Signal Received Power): Indicates the power level of the LTE reference signal received by the device, helping assess signal strength.
- RSRQ (Reference Signal Received Quality): Measures the quality of the LTE reference signal, reflecting the level of interference and overall network integrity.
- SINR0 (Signal-to-Interference-plus-Noise Ratio, Channel 0): Represents the ratio of desired signal to interference and noise on a specific channel, critical for evaluating signal reliability.
- SINR1 (Signal-to-Interference-plus-Noise Ratio, Channel 1): Like SINR0, it assesses the signal quality on another channel, contributing to a comprehensive view of network performance.

Details about Appendix 2: Signal strength comparison

Appendix 2 provides a detailed comparison of signal strength measurements taken at various locations before and after the installation of the new cell tower. The data highlights the numerical change in decibel (dB) levels by subtracting September 2024 observations from those of May 2024, offering a clear view of the improvements. More importantly, the appendix translates these dB differences into corresponding power ratios, emphasizing the exponential nature of these changes. For instance, an increase of 10 dB reflects a tenfold boost in signal power, while a 20 dB difference signifies a hundredfold enhancement. This conversion from logarithmic to non-logarithmic values allows for a better grasp of the substantial impact that the new tower has had on cellular performance.

Example Observation from Appendix 2

Date	Time	Location	ΔdBm (Difference in dBm)	Power Ratio
May 5, 2025	10:30 AM	SW intersection of White Antelope Road and Concho HWY	18	63.10

Explanation of Logarithmic Conversion

The dBm difference (ΔdBm) in the table represents the change of signal strength measured in decibel-milliwatts. To convert this logarithmic value into a linear power ratio, the following formula is used:

Power Ratio = 10^ (ΔdBm / 10)

For the example entry:

- ΔdBm = 18

- Power Ratio = 10^ (18 / 10) = 10^1.8 ≈ 63.10

Thus, the signal received at the SW intersection of White Antelope Road and Concho HWY on May 5, 2025, is approximately 63.1 times more powerful compared to the measurement from September 2024.

Comparison of SINR0 and SINR1 Measurements to RSRP and RSRQ

Assessing Signal Quality for Cellular Users

Introduction

For cellular signal assessment different metrics are used to evaluate the quality and strength of the connection. Among these, SINR (Signal-to-Interference-plus-Noise Ratio) measurements—specifically SINR0 and SINR1—provide a critical insight into the quality of the signal a cell phone user receives. These metrics are often compared with RSRP (Reference Signal Received Power) and RSRQ (Reference Signal Received Quality), which primarily measure signal strength and reliability. However, SINR measurements often deliver a more precise evaluation of cellular signal quality.

The Importance of SINR Measurements

SINR0 and SINR1 indicate the ratio of the desired signal to interference and noise within the network. These measurements ensure the quality of signal reception by accounting for environmental factors such as interference from other networks or devices. Higher SINR values generally correspond to clearer, more reliable communication.

On the other hand, RSRP and RSRQ focus on signal strength and signal reliability, respectively, but they do not effectively capture the full scope of interference and noise affecting the user's experience. While RSRP measures the power of the signal from the base station, RSRQ evaluates the quality of the cell's reference signal relative to its strength. This makes SINR0 and SINR1 more suitable for determining the practical usability and performance of cellular networks for end-users.

Interpreting SINR Measurements: A Case Study

Appendix 2 provides detailed observational data comparing SINR0 measurements at the SW intersection of White Antelope Road and Concho HWY on two different dates: September 1, 2024, and May 8, 2025. The SINR0 value for September 1, 2024, was -38 dBm, while the measurement for May 8, 2025, improved significantly to 6.2 dBm.

To evaluate the improvement in signal quality, subtracting the initial value (-38) from the final value (6.2) yields a difference of 44.2 dBm:

- ΔSINR = 6.2 - (-38) = 44.2

This difference represents the logarithmic improvement in signal strength. Using the logarithmic conversion formula:

- Power Improvement (linear scale) = 10^ (ΔSINR / 10)

- Power Improvement = 10^ (44.2 / 10) ≈ 26,303

This calculation illustrates a stunning enhancement in signal quality—a 26,303-fold increase on a linear scale, which dramatically elevates the usability of the signal for the end-user.

Conclusions regarding SINR measurements

The analysis of SINR0 and SINR1 measurements underscores their critical role in assessing signal quality for cellular users. Compared to RSRP and RSRQ measurements, SINR metrics offer a more accurate representation of the user's experience by factoring in interference and noise. The data presented in Appendix 1 and Appendix 2 showcase the profound impact of improved SINR values, reflecting the success of recent infrastructure enhancements. These already completed improvements make the construction of a new cell tower at the intersection unnecessary.

Implications for Cellular Users

Higher SINR values directly imply better call quality, faster data speeds, and fewer dropped connections for cell phone users. While RSRP and RSRQ remain valuable for network planning and optimization, SINR metrics provide a more user-centric measure of signal quality. We believe the signals measured near the White Antelope intersection and other locations are sufficient to deliver fair to good quality cell phone reception. Please note this improvement occurred **without** the installation at that intersection of SBA's proposed 120 ft. tall tower.

Conclusions of signal strength improvements

The installation of the new cell tower on Black Mesa has significantly enhanced signal strength, signal quality and cell service reliability. The values shown in the tables are consistent with fair to good user experience using smartphones on the Verizon network along Concho Road. Locations that previously experienced weak or unstable connectivity now exhibit better and more consistent reception. The improved signal strength is expected to benefit not just individual users but also the broader community relying on mobile networks for communication.

Summary Conclusion

The comparison of signal strength and quality measurements from before and after the installation of the recently built Black Mesa cell tower confirms the positive impact of the Black Mesa infrastructure upgrade. The Excel spreadsheets included in this report provide a detailed breakdown of the raw data and corresponding calculations.

The signal strength and quality improvements should result in adequate service for commuters driving on Concho Road in the vicinity of the measurement locations.

The data and analysis presented in this report underscore the effectiveness of the new tower on Black Mesa. That new tower greatly improves cellular coverage in the area. Our data and analysis refute claims made by SBA that another new tower at the White Antelope / Concho Road intersection is required to provide service for the area.

About the Author

Thomas Freeman has lived in the area affected by the proposed cell tower since 2018. He graduated from the Massachusetts Institute of Technology in 1976 earning an S.B. degree from the Department of Mathematics. In 1977 he earned a second S.B. degree from the Department of Electrical Engineering and Computer Science after completing a total of five years of course work and writing an undergraduate thesis. In 1982 he received an M.S. degree in Computer Science from Brown University. His working career from 1976 through 2007 was primarily in the EDA (Electronic Design Automation) industry. His work included employment at the Microelectronics and Computer Technology Corporation (Austin, TX), Quickturn Design Systems, Inc. (Mt. View, CA), and Cadence Design Systems, Inc. (San Jose, CA).

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Appendix 1: Observational data

Date	Time	Location	CellID	RSRP	RSRQ	RSRP dBm improve-ment	SINR0	SINR1
9/1/24	10:04:20	Hansa TRL at White Antelope	14	-101	-15		-21	-40
9/1/24	10:17:28	White Antelope at Rock 'n Ranch	116	-108	-20		-46	-45
9/1/24	11:19:43	SW corner White Antelope at Concho HWY	14	-116	-20		-38	-61
9/1/24	11:41:16	NE corner Hay Hollow at Concho HWY	379	-123	-18		-50	-36
9/1/24	11:47:22	NE corner Hay Hollow at Concho HWY	379	-127	-20		-86	-92
9/1/24	12:22:31	Churchill west of Garden Home TRL	379	-126	-17		-14	-56
5/5/25	14:34:00	Hansa TRL at White Antelope	5853984	-93	-16	8.00	2.9	1.1
5/5/25	14:43:00	White Antelope at Rock 'n Ranch	data missing	-90	-12	18.00	6.8	6
5/8/25	8:30:00	SW corner White Antelope at Concho HWY test1	5853984	-98	-10	18.00	6.2	6.9
5/8/25	8:30:00	SW corner White Antelope at Concho HWY	5853984	-100	-11	23.00	14.9	14.8
5/8/25	8:31:00	SW corner White Antelope at Concho HWY	5853984	-104	-8	23.00	7.2	10.1
5/5/25	11:41:16	NE corner Hay Hollow at Concho HWY	5853984	-93	-13	34.00	15.4	19.2
5/5/25	15:37:00	NE corner Hay Hollow at Concho HWY	5853984	-89	-12	37.00	13.6	13.5
5/5/25	15:15:00	Churchill at Garden Home TRL	5853984	-93	-13	33.00	9.9	-4

Appendix 2: Signal Strength Comparison

Signal strength comparison, using the RSRP power ratio formula R=10((v1-v0)/10)**

Location	dBm difference	Power ratio (dB)	SINR0 improvement (dB)	SINR1 improvement (dB)	SINR0 power improvement ratio (non-dB)	SINR1 power improvement ratio (non-dB)
Hansa TRL at White Antelope	8.00	6.31	23.9	41.1	245	12,882
White Antelope at Rock 'n Ranch	18.00	63.10	52.8	51.0	190,546	125,893
White Antelope near Concho HWY (9/1 vs 5/8 #1)	18.00	63.10	44.2	67.9	26,303	6,165,950
White Antelope near Concho HWY (9/1 vs 5/8 #2)	23.00	199.53	52.9	75.8	194,984	38,018,940
White Antelope near Concho HWY (9/1 vs 5/8 #3)	23.00	199.53	45.2	71.1	33,113	12,882,496
NE corner Hay Hollow at Concho HWY	19.00	79.43	65.4	55.2	3,467,369	331,131
Churchill at Garden Home TRL	33.00	1,995.26	23.9	52.0	245	158,489