Poster: Power Out, Internet Down? Measuring Internet Resilience in South Africa

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Abstract

South Africa's frequent electricity outages—both planned and unplanned—not only disrupt daily life but also impact Internet infrastructure in this critical regional connectivity hub. This study analyses the relationship between power outages and Internet resilience by correlating end-user performance metrics, amateur radio activity, and BGP routing data with detailed outage records. We find that network performance degrades only during unplanned outages, revealing heightened vulnerability during unexpected events. Amateur radio activity shows a weak negative correlation with both planned and unplanned outages, while BGP announcement patterns vary, showing both positive and negative correlations depending on the month. These results show how outage types shape connectivity and give us a deeper insight into the resilience of the Internet in South Africa.

CCS Concepts

• **Networks** → **Network measurement**.

Keywords

Internet Traffic, PSKReporter, Power Outages, Load Shedding

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1 Introduction

Electricity outages in South Africa are a frequent and long-standing crisis. Due to insufficient generation capacity, coal supply instability and grid failures, these outages—both planned (load shedding) and unplanned (manual load shedding)—affect not only daily life, but also the performance of the country's Internet infrastructure. South Africa is a critical connectivity hub for the continent, hosting Internet Exchange Points (IXPs), Internet Service Providers (ISPs), and multiple submarine cable landing stations. This presents a unique opportunity from an Internet measurement perspective.

While other studies around South Africa focus on social and economic consequences [6, 7], which are well recognised, this study focuses on a different perspective, one that is less visible: the impact of electricity outages on internet connectivity, end-user performance, and amateur radio activity. Similar work looks into the impact of the Russian invasion on Ukraine's Internet [4] and the economic and political impact on the Internet in Venezuela [1].

We study 3 data sources: *i)* BGP routing data (from RIPE RIS), *ii)* NDT measurements (from M-Lab), and *iii)* amateur radio PSKReporter data. By correlating the datasets with *i)* planned electricity cuts (load-shedding) and *ii)* unplanned outages, we offer a fresh perspective on Internet resilience and demonstrate that planned cuts have a considerably smaller impact than unexpected disruptions.

2 Datasets

Power Outage Data: Eskom is South Africa's state-owned electricity utility. To study the impact of electricity outages on internet connectivity, we use two types of outage data: 1: *load shedding*: a scheduled power cut implemented to prevent national blackouts—with stage-level information obtained from the EskomSePush API [3]. 2: *Manual Load Reduction (MLR)* events: unplanned outages caused by vandalism or localized overloads—were collected through a formal request through Eskom's Data Portal [2].

We analyse the impact of both load shedding and MLR events on the internet in South Africa using three datasets:

Routing Data: We use the BGP update data from the RIPE RIS Route Collector RRC19, located in Johannesburg [5]. The goal is to detect instability at the prefix level correlated with power outages.

Network Diagnostic Test (NDT): We use historic speedtest data from the M-Lab NDT platform to quantify internet quality (throughput and latency) during power outages.

Amateur Radio (PSKReporter): We obtain a full, unsampled feed of amateur-radio digital-mode reception reports from the PSKReporter service (`pskreporter.info`). PSKReporter is a worldwide, crowd-sourced platform that logs every digital-mode transmission that is received and reported by participating stations. Because a report can only be generated when a station has both power and an Internet connection, the dataset serves as a natural probe of how power or connectivity outages affect signal availability. In contrast to the Internet-based measurements (e.g., NDT, BGP) that are commonly employed to study outage impacts, PSKReporter enables us to study the effects of power separate from Internet outages. This is possible as a transmitter needs only power to send a transmission and the dataset also captures transmissions originating in South Africa that are received elsewhere.

Ethics: All datasets used in this study are publicly available. Amateur radio transmissions are legally unencrypted and publicly receivable; our analysis relies on aggregated, self-reported station data from pskreporter.info. No individual tracking is performed.

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3 Planned vs Unplanned

We show that it is relevant to distinguish planned outages, announced days ahead, from unplanned ones. Since citizens and organizations can prepare for scheduled cuts, their impact on Internet and radio data is smaller than that of unexpected disruptions.

Approach: We link the power-outage information to all three datasets as follows. The manual-load-reduction (MLR) dataset is aggregated by hour. For each observation in the three measurement sets, we simply find the nearest hour-stamp in the MLR record and pair them together before calculating the correlation. Load-shedding data are recorded only when a stage change is announced, so they do not have a regular time grid. We first sort these stage entries chronologically. Then, every measurement (NDT, BGP, or PSKReporter) is assigned to the most recent stage that had been announced at the time the measurement was taken. This can be stage 0 in case of no load shedding. This yields a consistent current stage label for each observation, which we use for the our correlation analysis.

NDT Speedtests: We focus on mean throughput and RTT as indicators of network performance, assessing if power outages correlate with changes in these metrics. Here we expect that unexpected power outages will lead to spike in tests carried out by citizens or organisations. Table 1 shows the correlation between the manual load shedding or scheduled load shedding stages and the performance metrics (*throughput* (Mbps) and *RTT* (ms)) across three major cities in the time of January 2023 to December 2024. These results show a correlation between MLR events and both throughput (weak negative correlation) and RTT (moderate positive correlation), confirming that unplanned power outages degrade internet performance. In contrast to MLR, scheduled load shedding stages show no correlation with both throughput and RTT, possibly due to mitigation strategies such as battery backups or ISP rerouting.

Table 1: Correlation between MLR or scheduled load shedding stages and performance metrics

City	$r_{\text{throughput}}$	$p_{\text{throughput}}$	r_{RTT}	p_{RTT}
Correlation with load shedding stages				
Cape Town	−0.018	0	0.002	2.02×10^{-16}
Johannesburg	0.008	0	0.003	9.46×10^{-77}
Pretoria	−0.027	0	0.002	1.33×10^{-6}
Correlation with MLR				
Cape Town	−0.238	3.40×10^{-224}	0.532	0
Johannesburg	−0.107	3.48×10^{-46}	0.433	0
Pretoria	−0.228	3.04×10^{-205}	0.369	0

Amateur Radio: We investigate how power outages affect amateur radio activity by analysing PSKReporter spot counts. Figure 1 shows both the number of PSKReporter spots *i)* transmitted from and *ii)* received by stations in South Africa during power outages in September 2023. *Received* refers to reports sent from stations in South Africa to PSKReporter over the Internet, requiring Internet connectivity. *Sent* refers to transmissions from these stations that were picked up by other stations worldwide, requiring power but not necessarily Internet access. Figure 1 illustrates that when MLR

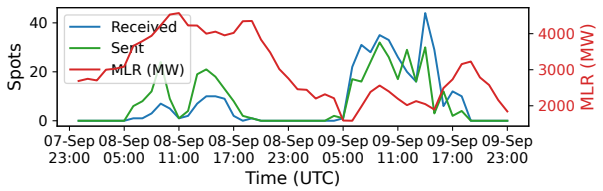

Figure 1: Hourly manual load reduction (MW) and radio spot counts during 8–9 September 2023.

(red line) increases, both sent and received spot counts drop, reflecting a negative relationship between load shedding and amateur radio activity. A drop in spots is generally directly correlated with internet or power outages. We computed the Pearson correlation coefficients between radio activity and both outage metrics. Unlike the NDT data, we observed weak negative correlations (approximately -0.2) for both planned and unplanned outages, indicating that as load shedding increases, radio activity decreases, especially transmissions. These results confirm the dependence of amateur radio communication on grid power availability.

BGP: We next study if the power outages lead to an increase in the number of BGP announcements and withdrawals (e.g., due to route flappings following a loss of power). To do that, we filter all BGP update files for all prefixes that we geolocate to South Africa in January to March 2023. Overall, we observe a weak positive correlation between BGP announcements and both planned and unplanned outages. However, some anomalies emerge—for example, in February, the correlation is weak and negative ($\approx$ -0.28), while in other months (e.g., January) the correlation is moderate to strong and positive ($\approx$ 0.56). As expected the correlation for planned outages is slightly higher ($\approx$ 0.2 compared to $\approx$ 0.1), likely due to organisations having advance notice and rerouting traffic to avoid disruptions. These results suggest that power outages contribute to instability in the region's routing, as reflected in fluctuations in the number of BGP announcements and withdrawals.

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