Measuring the OneWeb Satellite Network

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***Abstract*—OneWeb, the second largest low-Earth-orbit (LEO) satellite constellation, predominantly serves enterprise and government markets, presenting challenges for researchers trying to assess its network performance in practical scenarios. Consequently, the research community lacks a comprehensive understanding of the OneWeb system beyond the constellation parameters detailed in its regulatory filings and constrained simulation-based analysis. In this paper, we conduct a comprehensive network measurement study of the OneWeb satellite network, using both "inside-out" measurements for controlled user terminals (UTs) and "outside-in" measurements targeting publicly accessible UTs on the Internet. We present real-world measurements of the antenna signal-to-interference-and-noise-ratio (SINR), network latency, and throughput performance of different transport layer protocols and congestion control algorithms. Additionally, we utilize UT antenna tracking logs of connected satellites for cross-layer analysis. Our findings indicate that, while OneWeb generally fulfills its throughput service-level agreement (SLA) for enterprise and government customers, its latency performance is profoundly impacted by its constellation design. While latency remains relatively stable with minimal fluctuations during most inter-beam and inter-satellite handovers, notable latency variations occur during satellite network portal (SNP) handover events in certain geographical areas. This issue is partly due to the absence of inter-satellite links (ISLs), which presents a significant obstacle to OneWeb's pursuit of seamless global coverage and robust network resilience.**

***Index Terms*—LEO, satellite communication, network measurement**

I. Introduction

Traditionally, geosynchronous equatorial orbit (GEO) satellite networks have served as a supplementary backup to the terrestrial Internet. They offer global coverage but face challenges such as high latency and limited total system throughput, mainly because they rely on limited high-throughput satellites to cover large regions, rather than a constellation of satellites. The advent of low-Earth-orbit (LEO) satellite constellations is set to revolutionize connectivity by providing low-latency and high-throughput Internet service with global coverage. Among the existing LEO constellations, such as SpaceX's Starlink, Eutelsat's OneWeb, Amazon's Project Kuiper, Telesat's Lightspeed, and China's Spacesail (Qianfan), Starlink is the leading player in the industry, serving more than 5 million users across 125 countries and territories as of February 2025 [1]. This success is largely driven by the reduced launch costs by reusable rockets and the mass production of small satellites.

Due to the widespread availability of Starlink hardware and service subscriptions, the research community has developed a comprehensive understanding of the Starlink system, including the physical layer signal beacon and beam pattern analysis [2]–[8], the access network [9], [10], backbone topology [11], [12], global network performance [13], [14], and the optimization of transport layer protocols and application performance [15], [16]. However, the limited access to OneWeb services, primarily because of the company's focus on enterprise and government markets, has impeded the research community's ability to fully understand the real-world performance of the OneWeb system and effectively compare different LEO satellite constellations in practice. Consequently, most existing research [17]–[19] on the OneWeb system is confined to theoretical analysis based on regulatory filings to the International Telecommunication Union (ITU), Federal Communications Commission (FCC) and other regulatory bodies.

In this paper, we present a comprehensive measurement study of the OneWeb system, using both the "inside-out" measurements from controlled user terminals (UTs) in North America, and "outside-in" measurements targeting publicly accessible OneWeb UTs on the Internet. Our study covers UT models from different hardware vendors including Hughes and Intellian, and spans various geographical regions of different latitudes. Our cross-layer measurements include antenna signal-to-interference-and-noise-ratio (SINR) at the physical layer, along with network latency and throughput performance of different transport layer protocols and congestion control algorithms. Additionally, we correlate our measurements with the information of connected OneWeb satellites, obtained either directly from UT satellite tracking logs or indirectly inferred from the azimuth and elevation angles of the satellites. This allows us to investigate the impact of various handover events. Our findings indicate that, while OneWeb generally fulfills its service-level agreement (SLA) to enterprise and government customers, especially maintaining the throughput SLA with minimal latency fluctuations most of the time during our measurements, the latency performance can be significantly affected due to the satellite network portal (SNP) handover events in certain geographical regions. SNPs are analogous to ground stations in other satellite constellations. We also discuss the limitations and challenges of OneWeb due to the lack of inter-satellite links (ISLs) in its current system and the necessity of positioning SNPs worldwide strategically to achieve seamless global coverage.

We publicly release the dataset and artifacts associated with this paper[1], which include the latency dataset and UT

[1] https://github.com/clarkzjw/tma25-oneweb

antenna satellite tracking logs spanning from December 2024 to April 2025. Additionally, we are committed to providing future monthly updates. The rest of this paper is organized as follows. Section II introduces existing research on the OneWeb satellite network. Section III provides an overview of the OneWeb system, including its constellation design and ground infrastructures such as SNPs and Points-of-Presence (PoPs) worldwide. Section IV presents the "inside-out" measurement approach for controlled OneWeb UTs, including results on antenna SINR, network latency and throughput, and discussing the impact of different handover events. Section V details the "outside-in" approach for discovering and measuring accessible OneWeb UTs on the Internet. Section VI discusses existing challenges for the OneWeb system. Finally, Section VII concludes this paper with our future work.

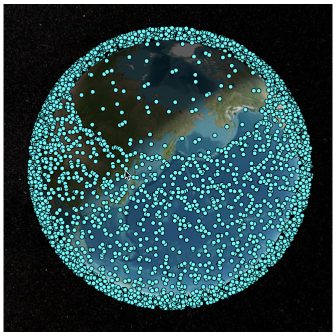
II. Related Works

Existing research efforts to evaluate the performance of the OneWeb satellite constellation have largely relied on technical details submitted to regulatory bodies such as the ITU and FCC. Various simulation studies have been conducted based on the constellation parameters as defined in these regulatory filings. del Portillo et al. [17], [18] offered technical overviews of the architectures of Starlink, OneWeb, Lightspeed and Kuiper satellite constellations, based on the configurations of each constellation as described in their FCC filings as of January 2021. They compared the orbital configurations of the constellations and estimated the total system throughput based on various simulation methodologies, including estimating the optimal number of ground stations [20], evaluating the atmospheric model, link budget model, and user demand model. According to OneWeb's FCC filings in 2021 [21], its initial deployment (Phase 1) requires 716 satellites in two sets of orbital planes, 12 planes with an inclination of 87.9° and 8 planes with an inclination of 55°, all at an altitude of 1,200 km. They estimated that this initial deployment can achieve a maximum system throughput of 1.44 Tbps. OneWeb's Phase 1 satellites do not incorporate ISL capabilities [18], [21], which significantly limits the total system throughput and necessitates the construction of abundant SNPs worldwide at strategically selected locations to satisfy the user demand model. They further simulated the potential benefit of utilizing ISLs and found that OneWeb's total system throughput could increase by up to 13% with a moderate 20 Gbps ISL configuration. This enhancement would raise the maximum system throughput from 26.9 Tbps to 30.3 Tbps and boost satellite utilization from 21.4% to 24.2% if the deployment of 6,372 satellites, including Phase 2 satellites, is completed. OneWeb completed the deployment of all Phase 1 satellites by October 2024, with the current constellation consists of 651 operational satellites positioned in 12 near-polar orbital planes with an inclination of 87.9°. Xia et al. [19] compared the satellite beam coverage models for OneWeb and Starlink. They integrated user traffic demand models with different satellite beam patterns from OneWeb and Starlink to analyze how beam coverage characteristics affect the performance of LEO satellite systems. They proposed a system method to simulate both satellite networks, characterized by metrics such as delay, throughput and access probability. Kozhaya et al. [22] analyzed the OneWeb satellite beacon signals in the Ku-band downlink using a blind beacon estimation framework. They used these beacons to identify the beams of OneWeb satellites and assess their carrier-to-noise ratio. They presented Kalman filter-based tracking methods that enabled code and carrier-phase tracking of 9 OneWeb satellites, subsequently demonstrating the potential capabilities to exclusively use OneWeb beacon signals for positioning and tracking scenarios.

Recently, researchers conducted trial tests of the OneWeb system in fall 2022 and winter 2023 in Finland, providing initial insights into the real-world performance of the OneWeb system, such as the network latency and throughput with different protocols, as well as multimedia video streaming and cloud gaming experience [23]. Their results demonstrated that the OneWeb system is capable of supporting near real-time applications, due to its relatively low network latency and jitter. For the UDP protocol, they observed the average downlink delay ranges from 55 to 65 ms, with the 90th percentile downlink delay remaining below 68 ms. In contrast, the average uplink delay ranges from 114 to 136 ms, with the 90th percentile reaching 121 ms. They also observed occasional connection breaks, with the most severe cases lasting for tens of seconds, which could cause applications to disconnect. Additionally, short but frequent periods of signal degradation occurred, leading to occasional packet losses. However, the trial tests were conducted before the full deployment of OneWeb Phase 1 satellites, and their measurements were confined to a single antenna model and a specific location in Finland, which is located at a relatively high latitude region with dense OneWeb satellite coverage.

Eutelsat OneWeb previously collaborated with Amazon Web Services (AWS) to release a Satellite Constellation Flight Dataset [24]. This dataset includes satellite altitudes, GPS and ephemeris data, Ka/Ku-band antenna metrics, magnetometer and reaction wheels measurements, on-board computer single event upset measurements, and torque rods momentum, as well as measurements collected at SNPs. However, the dataset was restricted to two days of in-orbit spacecraft data collected from August 24 – 25, 2022, during the early stages of the OneWeb satellite constellation deployment. Since then, additional satellites have been launched, and new SNPs and PoPs have been constructed and established. Consequently, the research community still lacks a comprehensive understanding of the OneWeb system, particularly regarding how different constellation designs affect UT-to-satellite handover behaviors, the impact of satellite coverage density across diverse latitudes, and global network performance variations due to SNP and PoP locations, as well as real-world performance comparisons with other LEO satellite constellations.

To the best of our knowledge, this is the first systematic measurement study to directly uncover the correlations between SINR, connected satellites, SNP handovers, and end-to-end latency characteristics for LEO satellite networks. Our


(a) Starlink

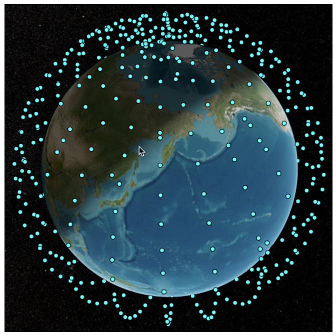

(b) OneWeb

Fig. 1: Starlink and OneWeb satellite constellations

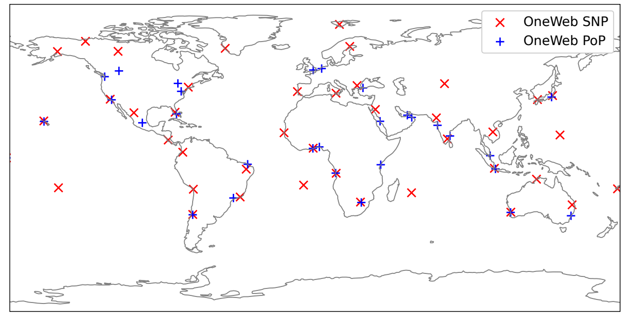


Fig. 2: OneWeb PoPs and SNPs (May 2025)

prior study [10] first proposed a systematic approach to identify connected Starlink satellites, relied on indirect inference based on obstruction maps and satellite ephemerides, as the Starlink UT does not expose connected satellite IDs or other signal metrics. Moreover, identifying landing ground stations is significantly more difficult in Starlink due to its large number of ground stations and the existence of ISLs.

III. Overview of the OneWeb Satellite Network

As the second largest commercial LEO satellite constellation in operation, OneWeb differs significantly from Starlink in several key aspects. Figure 1 provides a simulated illustration of both the Starlink and OneWeb satellite constellations with the MATLAB Satellite Communication Toolbox. As of May 2025, Starlink has over 7,000 operational satellites in various orbital shells with different inclinations. The majority of Starlink satellites are positioned in 550 km orbits with a 53° inclination, resulting in less dense satellite coverage over high latitude and polar regions. In contrast, OneWeb has 651 operational satellites in orbit, distributed across 12 near-polar orbital planes with an inclination of 87.9°. Consequently, this configuration provides the densest satellite coverage in polar regions, whereas coverage becomes more sparse near the equator.

As of May 2025, OneWeb has 29 PoPs and 40 SNPs[2] worldwide as shown in Figure 2. Note that we only consider OneWeb PoPs listed in the PeeringDB ASN800 interconnection facilities[3]. Another PoP in Almaty, Kazakhstan was reportedly established, but is not listed on PeeringDB. In North America, there are 8 PoPs, namely Ashburn, Seattle, Miami, Los Angeles and Honolulu in the United States, Calgary and Toronto in Canada, and Querétaro in Mexico. In South America, there are 3 PoPs, including Fortaleza and São Paulo in Brazil, and Santiago in Chile. There are 2 PoPs in the Europe, including Amsterdam in the Netherlands, and London in the United Kingdom. In Africa, there are 5 PoPs, namely Accra in Ghana, Luanda in Angola, Mombasa in Kenya, Lagos in Nigeria, and Johannesburg in South Africa. There are 9 PoPs in Asia, including Dubai in the United Arab Emirates, Muscat in Oman, Jeddah in Saudi Arabia, Mumbai and Chennai in India, Depok in Indonesia, Tokyo in Japan, Istanbul in Turkey, and Singapore. Finally, there are 2 PoPs in Oceania, namely Perth and Sydney in Australia.

Since the current OneWeb Phase 1 satellites do not utilize ISLs [18], [21], the strategic positioning of SNPs worldwide is crucial to achieve optimal coverage. Additionally, there are two Telemetry, Tracking and Command (TT&C) stations, located in Inuvik, Northwest Territories, Canada and Longyearbyen, Svalbard, Norway [24], which provide communications during pre-launch, orbit transfer and on-station operations for OneWeb satellites, as well as during spacecraft emergencies. Both TT&C stations also operate as SNPs. Among the existing 40 SNPs, the majority are strategically colocated near OneWeb PoPs or at major satellite teleport sites close to submarine cable landing points. Due to the lack of ISLs, additional SNPs must be constructed to cover remote service regions, such as in French Polynesia, Fiji, Mauritius, and Saint Helena. The list of 40 OneWeb SNPs is included in the Appendix.

OneWeb relies on industry partners and hardware vendors to design and manufacture compatible UTs for different usage scenarios, such as the flat panel UT (HL1120W) by Hughes [25], mobility-first flat panel UTs (Hawk and Osprey) by Kymeta [26], dual-parabolic antenna UT (OW70L) by Intellian [27], etc. From the perspective of network traffic, once transmitted from the UT to a connected satellite, an SNP is selected to land the network traffic based on the satellite's beam coverage. The packets must be routed from the landing SNP to the user's associated "home-PoP" via terrestrial fiber infrastructure before they can exit to the Internet through Internet exchange points (IXPs). Similar to other satellite network providers, OneWeb relies on terrestrial and submarine fiber cable carriers for the underlying connectivity of the ground segment.

IV. "Inside-out" Measurements

A. Overview

We utilized the ARA Wireless Living Lab platform [28] with a OneWeb UT installed at the Iowa State University in Ames, Iowa, USA to conduct active "inside-out" network measurements. It is associated with the OneWeb PoP in Ashburn, Virginia, which is located near the east coast of

[2]The locations of the SNPs are compiled from the AWS OneWeb Satellite Constellation Flight Dataset [24], as well as various sources from regulatory bodies across different countries.

[3]https://www.peeringdb.com/asn/800

the USA. The OneWeb UT is the Hughes HL1120W model, provisioned with the 100/20 Mbps throughput SLA. In 2024, we briefly had access to OneWeb UTs (Hughes HL1120W) in Alaska, associated with the Seattle PoP. In Section VI, we provide a brief discussion of the measurement results obtained in Alaska. However, our primary focus in this section will be on the ARA OneWeb UT in the Midwestern USA.

The OneWeb compatible UTs manufactured by different vendors might have varying hardware capabilities, such as differences in antenna design, transmission power, and maximum network throughput. Regarding the access network topology in the local area network (LAN), once installed, the UT is typically accessible at the IP address 192.168.100.1. A web interface for UT management is available at HTTP ports 80 and 443. Different vendors retain discretion over how much diagnostic information is disclosed to customers via UT management dashboards. Certain vendors might also offer a built-in web interface for user router management, enabling basic router configuration and management such as DHCP and DNS, as well as its wireless access points, if the user router has built-in wireless capabilities. When a user device is connected to the user router via Ethernet or Wi-Fi, it is assigned a LAN IP address, either through DHCP or static IP allocation. The configuration such as the user router gateway, VLAN management or network address translation (NAT) may vary based on the specific network planning scheme employed.

Each OneWeb compatible UT is equipped with a Global Navigation Satellite System (GNSS) module for accurate positioning and timing. The GNSS module helps the UT to establish satellite connections using the OneWeb satellite ephemeris. Additionally, each UT features a built-in modem compatible with the OneWeb system, which includes two Access Point Names (APNs). APN0 has a Carrier-Grade NAT (CGNAT) subnet, where each UT is assigned with a unique management IP address 100.x.y.z. This subnet is used by OneWeb to facilitate UT access to configuration and firmware updates internally. APN1 is used for customer's Wide Area Network (WAN) connection to the OneWeb satellite network. Each UT measures and records relevant runtime metrics in AIM tracking logs, including the antenna SINR, the azimuth and elevation angles of connected OneWeb satellites and other diagnostic data. Such information can be accessed via the UT's REST APIs at 192.168.100.1. On UTs manufactured by certain vendors, such as Hughes, the AIM tracking logs contain records of connected OneWeb satellites IDs. However, some vendors, such as Kymeta, prevent the direct retrieval of connected OneWeb satellite IDs by encrypting certain AIM tracking logs. Nevertheless, information such as the azimuth and elevation angles of connected satellites remains available through the REST APIs.

B. Latency Measurement and the Impact of Handover Events

Existing research and OneWeb's FCC filings [21]–[23] illustrated its Ku-band downlink signal allocation pattern. Each OneWeb satellite is equipped with 16 nominally identical, non-steerable highly-elliptical user beam in the Ku-band, and two identical steerable gateway beam antennas in Ka-band towards SNPs. The downlink frequency band is divided into eight contiguous channels of 250 MHz. Different users in the same service cell can receive downlink data from a single OneWeb satellite simultaneously, while being multiplexed in frequency and spatial division. As the satellites traverse their near-polar orbits, a UT will be progressively handed over from beam to beam belonging to a single OneWeb satellite, to subsequent satellites in the same orbital plane, or to satellites in adjacent orbital planes.

Figure 3 illustrates a snapshot of four timeslots of average SINR, network latency, and inter-beam and inter-satellite handover events. The average SINR and connected satellite IDs are obtained from the Hughes UT AIM tracking logs through the `/aim/api/log/all_logs` API endpoint. The average SINR value is calculated at runtime by the UT, with the actual sampling occurring at a higher frequency, depending on different UT models. We measure the network latency performance with the round-trip time (RTT) from a client connected to the UT to the associated OneWeb PoP using the ICMP `ping` command on Linux. We set the ICMP echo request interval to 10 ms, although the actual packet interval may vary due to the operating system's workload and scheduling policy. As observed in Figure 3, inter-beam handover events occur for the UT-satellite association, indicated by the periodic SINR fluctuations, while the UT remains connected to the same satellite. Latency fluctuations are minimal when the UT remains connected to the same beam, except when link quality deteriorates, such as during the third beam of `ONEWEB-0359`, around `20:12:18`. Brief latency spikes may occur during inter-beam or inter-satellite handover events. In rare cases, the UT might frequently switch between multiple satellites in different orbital planes due to the deteriorated signal quality. Frequent handover events can then lead to degraded performance, as later discussed in Figure 8.

Note that the latency in Figure 3 exhibits a bimodal pattern, featuring two distinct levels of minimum RTT at 50 ms and 100 ms across different timeslots. By examining the relative locations of the UT, OneWeb satellites, SNPs and the PoP, we identified that this pattern was caused by SNP handover events. Figure 4 illustrates the relative positions of the OneWeb UT in the Midwestern USA, OneWeb satellites, SNPs and the associated PoP. We utilized the historical Two-Line Element (TLE) data for OneWeb satellites at the time of measurements in Figure 3 and the MATLAB Satellite Communication Toolbox for the illustration. In Figure 4, the satellites were on the ascending pass of their near-polar orbits, moving northward along their trajectories. There are 4 SNPs in the continental USA, including Santa Paula (CA), Clewiston (FL), Southbury (CT), and Talkeetna (AK). We omit the Talkeetna (AK) SNP from Figure 4 because it lies outside the line-of-sight (LOS) for OneWeb satellites that provide connectivity to our UT. Due to the strategic location of the OneWeb UT in the Midwestern USA, it is situated roughly in the middle between the Santa Paula SNP in the west and the Southbury SNP in the east. We estimate the RTT of network latency over the ground fiber

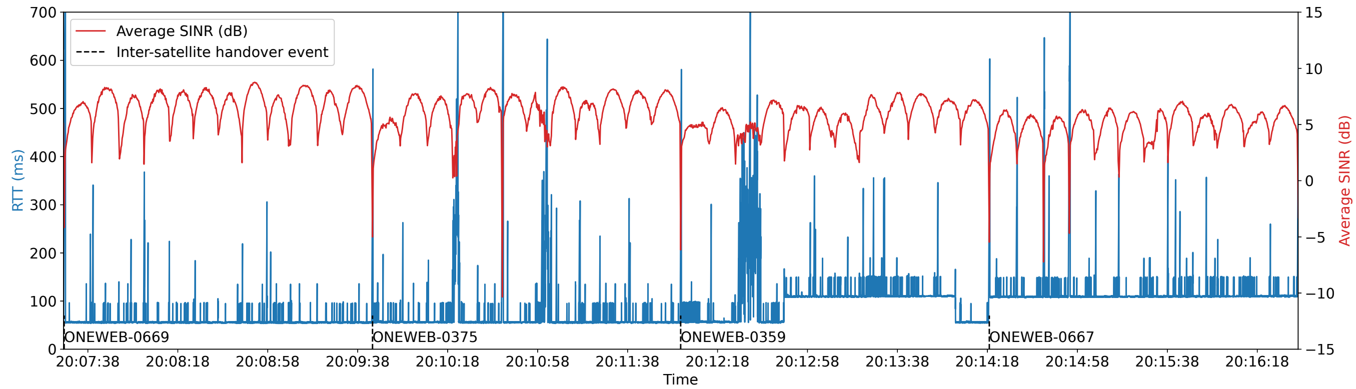


Fig. 3: Average SINR, handover events and latency performance for the UT in the Midwestern USA

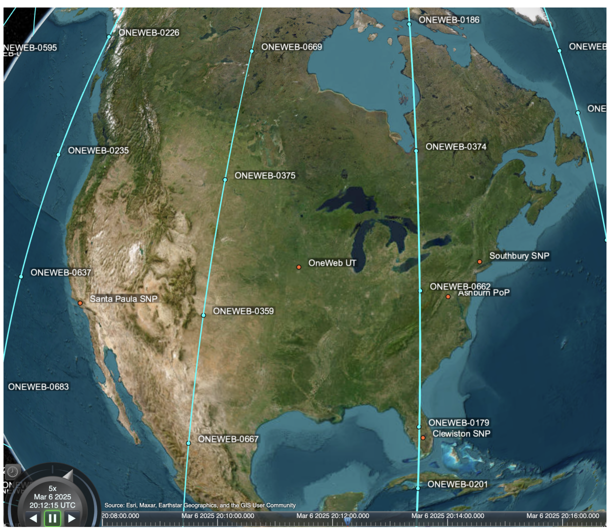
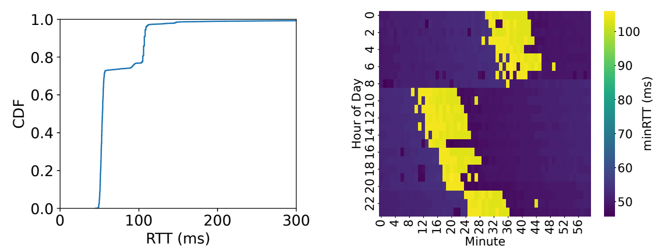


Fig. 4: Positions of the UT, satellites, SNPs and the PoP



(a) CDF of RTT

(b) Daily latency heatmap

Fig. 5: CDF of RTT and daily latency heatmap

infrastructure from the west coast to the Ashburn PoP to be approximately 50-60 ms, using public Internet probes on the RIPE Atlas platform. Each OneWeb satellite's user beam has limited coverage, approximately 1600 km in longitude and 65 km in latitude [23]. The satellites must switch to another SNP if its gateway beam can no longer reach the connected SNP or if it is below the SNP's minimal elevation angle. For our OneWeb UT, when the associated SNP is switched from the Southbury SNP to the Santa Paula SNP, user traffic must then traverse from the west coast to the Ashburn PoP, thus significantly increasing the latency from around 50 ms to around 100 ms. As observed in Figure 3, SNP handovers may occur through inter-beam handovers, evident in different beams during the third timeslot, or through inter-satellite handovers, as demonstrated by the switch from `ONEWEB-0359` to `ONEWEB-0667`. Prior to the inter-satellite handover to `ONEWEB-0667`, latency briefly decreased to approximately 50 ms, because of the reassociation with the Southbury SNP in the east. This is likely due to the satellite trajectories and shifts in the relative positions of the satellites and SNPs.

The impact of SNP handover events is further illustrated through continuous measurements with extended duration. In Figure 5, we illustrate the CDF and heatmap of daily latency performance. Approximately 76% of daily latency measurements fall within the lower range, with a minimum RTT of 45.1 ms, while the remaining 24% exceed 100 ms. The daily latency heatmap, which features the minimum RTT resampled every minute as shown in Figure 5b, reveals a significant and periodic pattern attributable to the movement of satellite trajectories and orbital planes.

C. Throughput Measurement

While Starlink offers priority plans for business customers over regular residential or roaming users, it relies on user contention and does not provide a specific throughput SLA to its customers. In contrast, each OneWeb UT is provisioned with a specific throughput SLA, with the most common plans offering either 50/10 Mbps or 100/20 Mbps for downlink and uplink, respectively. These plans may also be subject to a monthly data allowance. Our OneWeb UT at the Iowa State University is provisioned with the 100/20 Mbps throughput SLA and a monthly data allowance of 100 GB, after which the throughput is throttled to 1 Mbps, preventing us from conducting prolonged and continuous throughput measurements in a meaningful way. To investigate the throughput performance of the OneWeb network, we utilized iPerf3 for UDP and TCP throughput measurement. We provisioned a virtual machine in the Google Cloud Platform (GCP) `us-east4-a` availability

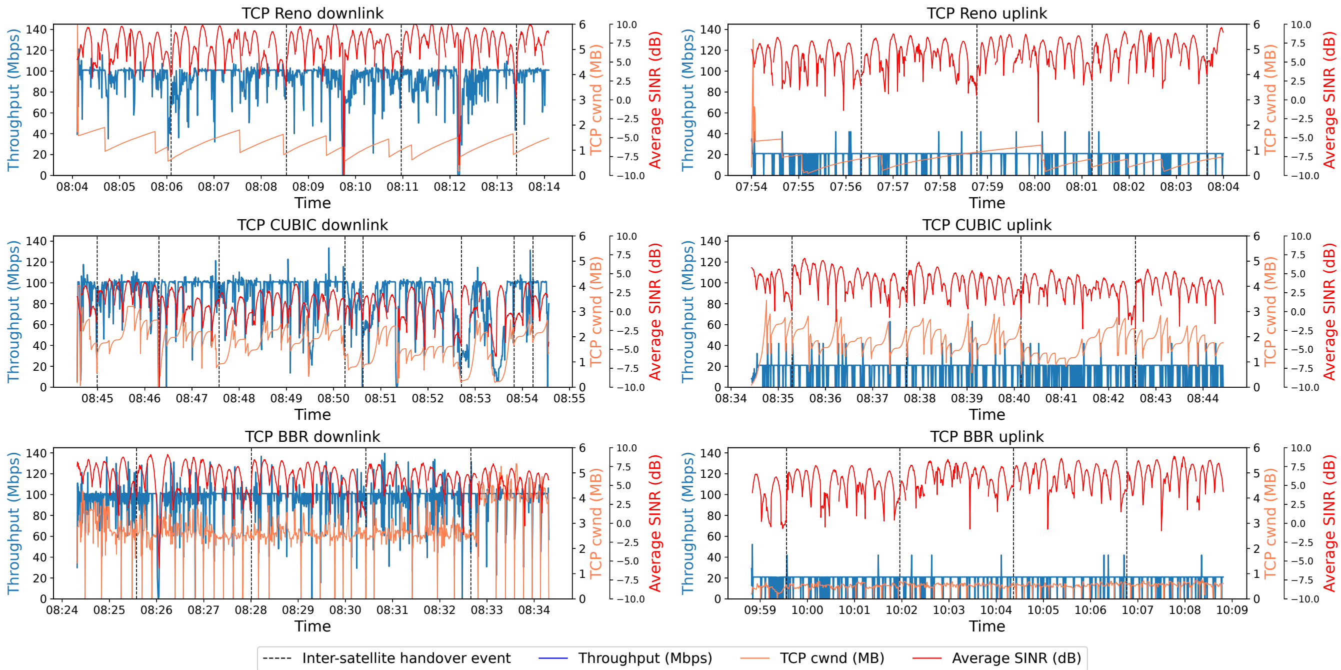


Fig. 6: TCP throughput with different congestion control algorithms

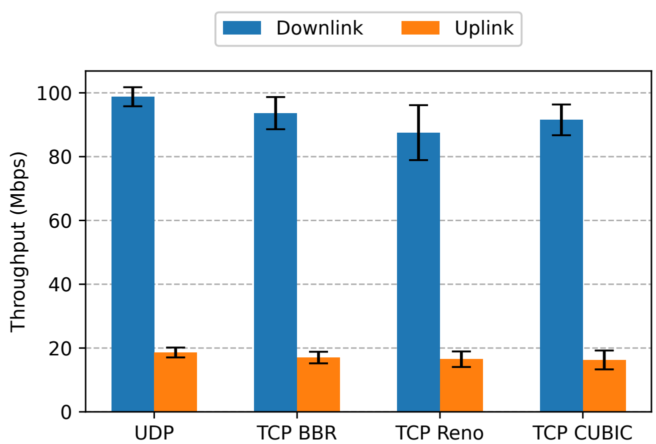
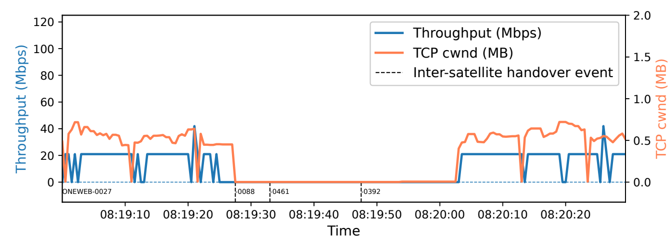
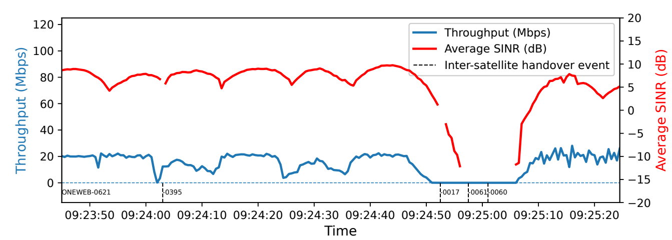


Fig. 7: Throughput performance of UDP and TCP



(a) TCP BBR uplink throughput and cwnd



(b) UDP uplink throughput and SINR

Fig. 8: TCP BBR and UDP uplink throughput during short periods of frequent handover events

zone, located in Ashburn, to host the iPerf3 server daemon. This availability zone is selected due to its ideal peering with the OneWeb Ashburn PoP. To establish the baseline for the throughput measurement, we utilize iPerf3 in UDP mode with a target bitrate of 100/20 Mbps for downlink and uplink respectively, eliminating the impact of congestion control algorithms. To evaluate the performance of different TCP congestion control algorithms, we record the throughput and TCP congestion window (cwnd) variation, and correlate the throughput performance with antenna SINR and inter-satellite handover events as shown in Figure 6. Each iPerf3 test session in Figure 6 has a duration of 10 minutes, illustrating the relationship between throughput performance and inter-satellite handover events across multiple timeslots. To ensure the generalizability of our throughput measurements while adhering to our monthly data allowance, we repeat each session with a 60-second duration at 3-hour intervals across a five-day period. The session duration and repeat interval are selected as a balance between data diversity and the limited monthly data allowance.

Figure 7 illustrates the average throughput of UDP and TCP with different congestion control algorithms. The error bars are calculated based on the standard deviation of the collected results. The results demonstrate that OneWeb generally fulfills its throughput SLA, while the practical performance is affected by different congestion control algorithms, with BBR showing the best result among others. In Figure 8, we illustrate the occasional “outages” and abnormally frequent inter-satellite handover events triggered by signal deterioration. When inter-satellite handover events happen, in rare instances, the UT switches among multiple satellites in adjacent orbital planes to find the best candidate due to the deteriorating signal quality. This can lead to connection disruptions and degraded application performance.

Additionally, we utilized the example file transfer programs available in the Cloudflare `Quiche` library to transfer a fixed 1 GB file with different congestion control algorithms to assess QUIC performance over OneWeb. Our results show that QUIC exhibits comparable throughput performance to TCP over OneWeb. However, the performance difference is also subject to varying implementation optimizations between user-space programs and in-kernel TCP optimizations.

V. “Outside-in” Measurements

A. Overview

Other satellite ISPs, such as Starlink, publish customer IP allocation and GeoIP assignment[4]. Starlink customer IP addresses are generally advertised under ASN14593, except for ASN45700 in Indonesia, due to local regulations. Previous research has employed “outside-in” approaches to probe Starlink’s public IPv4 and IPv6 addresses, aiming to assess its global latency performance [13], [29]. In contrast, OneWeb’s enterprise and government customers have the option to bring their own IP addresses (BYOIP) and advertise them under their own enterprise ASNs. Furthermore, while OneWeb advertises many IP prefixes under ASN800[5], IP addresses within this ASN are not necessarily served by OneWeb’s satellite network. Lastly, most of OneWeb’s enterprise and government customers implement firewall and access control policies that restrict access to their OneWeb UT management dashboards from the public Internet. However, the factory firmware of OneWeb UTs from certain vendors comes with the firewall disabled by default during the testing mode in the initial deployment and testing phase. As a result, if a OneWeb UT is configured with a public IP address without NAT, its management dashboard may be exposed to the public Internet. We used the Censys platform [30] to scan for publicly accessible hosts with HTTP ports 80 and 443 open, filtering for those whose HTTPS certificate Common Name (CN) matched the default name used by OneWeb UT firmwares. We discovered some publicly accessible UT management dashboards of different antenna models in geographical regions at various latitudes, including Europe, North Africa and East Asia. It is important to note that most of these UTs were detected during

[4]https://geoip.starlinkisp.net
[5]https://bgp.he.net/AS800

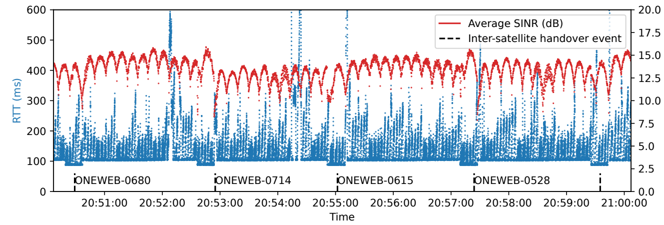


Fig. 9: Average SINR, handover events and latency performance for `UT-EUR`

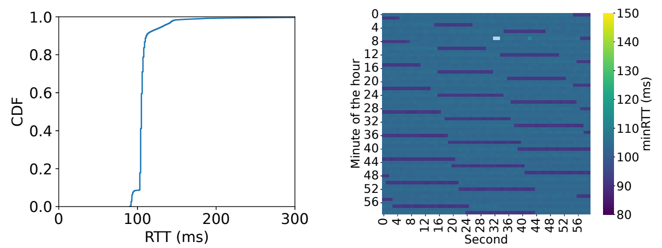
their initial deployment and testing phases. Over time, many of them become unreachable from the Internet, likely due to the implementation of proper external firewall settings, which is a common practice among enterprise and government users. Because OneWeb UT management dashboards disclose GPS coordinates of the installations, we refrain from publishing the IP addresses and the exact UT locations in this paper for privacy and ethical considerations. In this section, we examine a OneWeb UT (referred to as `UT-EUR`) in Northern Europe, at a latitude higher than 70°N within the Arctic Circle, which is the Intellian OW70L-Dac model with the dual-parabolic antennas[6].

B. Latency Measurement and the Impact of Handover Events

To identify the associated OneWeb PoP for `UT-EUR`, we initiated latency measurements using `mtr` from data centers close to different OneWeb PoPs to the target IP address, examining the latency fluctuations along different hops in the path. Specifically, we initiated latency measurements from Akamai Linode data centers in London and Amsterdam to `UT-EUR`, and discovered that `UT-EUR` is associated with the OneWeb PoP in London. The Intellian UT model does not directly export the connected OneWeb satellite IDs in its AIM tracking logs. However, it has corresponding APIs to retrieve the azimuth and elevation angles of connected satellites. By utilizing the TLE data of OneWeb satellites and the SGP4 [31] algorithm, we can accurately infer the connected satellite IDs at this location.

Figure 9 illustrates the average SINR, handover events, and the latency performance of the OneWeb UT within the Arctic Circle, with latency measurements initiated from the Akamai Linode data center in London. The minimum RTT generally remains around 100 ms, but it periodically drops to about 90 ms for a short duration. The two closest SNPs in the region are the OneWeb SNPs in Longyearbyen, Svalbard and Piteå, Sweden. When the Svalbard SNP is selected by connected satellites, network packets need to be transmitted to the continental Europe through the Svalbardfiberen submarine cable, before they can reach the OneWeb PoP in London. With a length of 2,714 km, the submarine cable can introduce an additional 20 ms latency. Additionally, Figure 10 shows the CDF of RTT and the hourly latency heatmap for `UT-EUR`. We can conclude that `UT-EUR` is associated with the Svalbard

[6]The `UT-EUR` became unreachable since late March 2025, due to routing updates affecting “outside-in” traffic.



(a) CDF of RTT (b) Hourly latency heatmap

Fig. 10: CDF of RTT and hourly latency heatmap for `UT-EUR`

SNP for nearly 90% of the time, and periodically associated with the Sweden SNP depending on the LOS of connected OneWeb satellites. Notably, the SNP handover intervals for `UT-EUR` are significantly shorter compared to those of the OneWeb UT in the Midwestern USA. This difference is due to the distinct SNP locations and satellite orbit trajectories. For the OneWeb UT in the Midwestern USA, SNP handovers primarily result from transitions between satellites in different near-polar orbital planes. Conversely, for `UT-EUR`, the SNP handover behaviors involve SNPs aligned in a north-south direction along the near-polar orbits of each satellite.

VI. Discussion

For the OneWeb network, the absence of ISL capabilities not only constrains the total system throughput simulated by previous research [17], [18], requiring OneWeb to establish more SNPs to increase the coverage, particularly in remote regions, it also significantly affects the latency performance in different geographical regions, leading to SNP handovers with substantial latency variations. For instance, a OneWeb UT located in Alaska at latitude 61.1°N shows a minimum RTT of approximately 70 ms. There is no bimodal pattern because the Talkeetna (AK) SNP is the sole SNP within the LOS of the connected OneWeb satellites. In East Asia, a OneWeb UT could be associated with SNPs in Thailand, Guam or Japan, leading to increased latency variations during handover events. Additionally, the latitude of OneWeb UTs can influence the duration of inter-satellite handover intervals. In high latitude regions, the handover interval may be shorter, and the UT might skip the immediately adjacent satellite, switching instead to a satellite further along within the same orbital plane.

Existing LEO satellite networks still heavily depend on terrestrial infrastructure, particularly submarine fiber cables. In practice, despite the existence of ISLs, Starlink lands user traffic at nearby ground stations as soon as possible, using terrestrial fiber networks to then route traffic toward customers' "home-PoPs" and final destinations. Consequently, long-haul links, such as transatlantic and transpacific routes, continue to depend heavily on submarine fiber cables instead of ISLs. For LEO constellations without ISL capabilities, such as OneWeb, the reliance on terrestrial infrastructure is more pronounced, threatening network resilience if fiber cables are disrupted by natural disasters or man-made events. Additionally, unlike cellular networks, existing LEO satellite networks operate as isolated systems, lacking interoperability across different vendors. While digital sovereignty and secure connectivity are paramount for future constellations such as IRIS^2 [32], commercial constellations may benefit from collaboration among vendors and standards organizations to develop an interoperable standard, enhancing satellite network resilience in a manner akin to cellular networks. Lastly, given the challenges of conducting "outside-in" measurements on the OneWeb network, future network measurement research on OneWeb is likely to rely on "inside-out" measurements as the most feasible approach, potentially through collaborations to extend geo-diversity. We also encourage OneWeb customers to host RIPE Atlas probes (currently none), enabling the research community to gain a better understanding of the network's performance.

VII. Conclusion and Future Work

In this paper, we conducted a comprehensive measurement study of the OneWeb satellite network using both the "inside-out" approach for controlled OneWeb UTs, as well as the "outside-in" approach for publicly accessible UTs on the Internet. We provided detailed insights into the latency performance of the OneWeb system at different geographical locations, affected by its inter-beam and inter-satellite handover events, as well as SNP handover events caused by the strategic positioning of OneWeb SNPs worldwide. We verified OneWeb fulfills its throughput SLA most of the time, while the exact performance is still largely affected by different transport layer protocols and congestion control algorithms. Future work includes expanding the "inside-out" measurement coverage to diverse geographical regions to offer deeper insights into the SNP handover pattern and the impact of satellite density at varying latitudes. Additionally, future studies should further compare the performance of QUIC and TCP, alongside LEO-aware congestion control algorithms and explore how different handover events affect DASH adaptive video streaming and real-time applications such as WebRTC. Finally, it is of community interest to compare the practical performance among different LEO satellite constellations, such as OneWeb and Starlink, across diverse geographical regions.

Ethical Considerations

We anonymized the "outside-in" measurements by removing the IP addresses and GPS coordinates that could otherwise be used to associate latency measurements with individual UTs. Other measurements such as the "inside-out" methodology from controlled UTs do not impose ethical concerns.

Acknowledgment

This work has been partially supported by NSERC, CFI and BCKDF, and ARA is funded in part by NSF (award 2130889), NIFA (2021-67021-33775) and PAWR Industry Consortium. We would like to thank Mark for early access to OneWeb UTs in Alaska and Reddit users for sharing insights, and we are grateful to the anonymous reviewers and shepherd for their valuable comments.

Appendix

OneWeb SNPs (May 2025)

Continent	Country or territory	Location
North America	Canada	Inuvik
		Yellowknife
	Costa Rica	Cañas
	Mexico	Toluca
	United States	Clewiston
		Paumalu
		Santa Paula
		Southbury
		Talkeetna
		Yona
South America	Brazil	Maricá
		Petrolina
	Chile	Arica
		Santiago
	Colombia	Cali
Europe	Bulgaria	Stara Zagora
	Greenland	Nuuk
	Italy	Palermo
	Norway	Svalbard
	Portugal	Sintra
	Sweden	Piteå
Africa	Angola	Luanda
	Ghana	Accra
	Mauritius	Union Vale
	Saint Helena	Horse Point
	Senegal	Sebikotane
	South Africa	Hartebeesthoek
Asia	India	Tejpura
		Thoothukudi
	Indonesia	Serang
	Japan	Ibaraki
		Yamaguchi
	Kazakhstan	Almaty
	Saudi Arabia	Tabuk
	Thailand	Sirindhorn
Oceania	Australia	Charlton
		Darwin
		Perth
	Fiji	Suva
	French Polynesia	Papenoo

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