

Five Things You Should Know about Low-Earth Orbit (LEO) satellite Internet services

A. What is the difference between low-earth orbit (LEO) and traditional Geostationary-Earth Orbit (GEO) satellite Internet services?

Satellite technologies play an important role in global connectivity and earth observation. Both Low Earth Orbit (LEO) and Geostationary-Earth Orbit (GEO) satellites are used to provide internet connectivity services, but they differ significantly in their characteristics and performance.

LEO Satellites (e.g., Space X Starlink satellites) orbits the earth at low altitudes of between 200 and 2000 Kilometres. Because of this, LEO systems require a large constellation (sometimes 1000s) of satellites to provide global coverage. GEO satellites on the other hand orbit the earth at 35,786 KM and require about 3 satellites for global coverage (see Figure 1). They are called GEO satellites because they rotate at the same speed as the earth and so appear stationary.

The proximity to the earth of LEO satellites offers lower latency and higher speeds compared GEO satellites translating to superior user experience. LEO satellites communicate with each other in a constellation using lasers but are also connected to terrestrial communications at selected earth station hubs. Examples of LEO satellites operators with coverage in Kenya and Africa are **Starlink** and EUTELSAT **Oneweb**. The cost of setting up and maintaining a LEO satellite system is very high due to the high number of satellites required to operate. Moreover, LEO satellites operate in much harsher environments as compared to GEO satellites that include atmospheric drag resulting in a shorter lifespan of only **about five years**. A large number of replacement satellites must be launched every year.

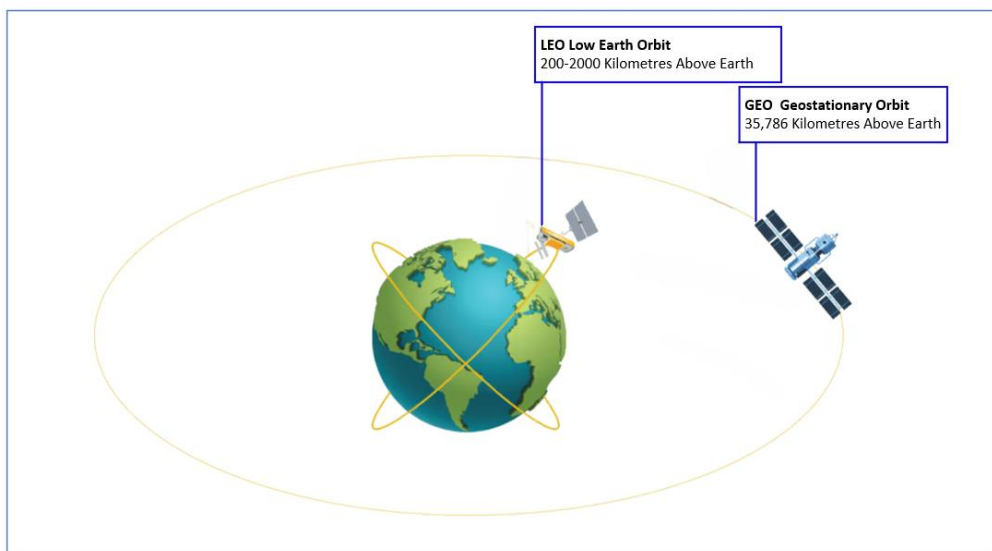


Figure 1: Contrast with the LEO and GEO satellite services

B. How are satellite services operators regulated in Kenya?

All satellite services are licensed by the Communications Authority of Kenya (<https://www.ca.go.ke>) directly or through existing Tier-1 operators (e.g. Mobile operators Safaricom, Airtel) or Tier-2 operators (e.g., KENET, Liquid Intelligent Technologies).

Direct satellite Internet services require the satellite operator to obtain a Tier-1 or Tier-2 operator license and the establishment of an Earth Station hub in Kenya. Indirect satellite Internet services on the other hand require the satellite operator to provide Internet services through partner Tier-1 or Tier-2 operators. For example, Global Starlink provides Internet services in Kenya through a subsidiary company called Starlink Internet Services Kenya Limited that is licensed in Kenya as a Tier-2 operator. Starlink equipment is also type approved in Kenya. EUTELSAT OneWeb on the other hand will work through existing Tier-1 or Tier-2 operators as a wholesale Internet services provider. For example, KENET already has a partnership agreement with EUTELSAT, the operators of OneWeb and therefore can provide Oneweb satellite Internet services. A list of all licensed services operators in Kenya can be found at <https://www.ca.go.ke/licensee-register>

Note that all these satellite services are direct to an earth station or satellite dish not a mobile telephone (e.g., 4G smartphone). Starlink or Oneweb dishes are quite small (less than 0.5m) compared to the large VSAT dishes with a radius of up to 7M for GEO satellite services operating in C-Band (*KENET initially installed two 7M dishes at Kenyatta University and Maseno in 2009 to provide GEO satellite Internet services*). Direct GEO satellite to ordinary smartphones has not yet been granted regulatory approval in most parts of the world, including Kenya.

C. Why is KENET Deploying LEO satellite Internet services?

KENET has connected 15 campuses to Starlink Internet for period of three to seven months since January 2024. KENET also plans deploy Oneweb LEO satellite Internet services in the next six months when it is available in Kenya. The reasons have been varied and include the following:

1. **Lack of an affordable terrestrial Internet solution with required capacity.** For example, when an affordable leased line solution with required capacity is not available to connect rural educational institutions campuses or research stations. KENET has connected such campuses in different rural areas of Kenya with limited fixed Internet coverage (e.g., Taveta and Shimoni areas).
2. **Provision of immediate Internet services during the development of a terrestrial connectivity solution.** In general, it takes KENET four to six weeks to connect a new educational institution campus or research station to KENET backbone and Internet from the date a member signs the Service Order Form. Starlink has made it possible to start providing Internet services within a week temporarily while developing the terrestrial fiber

or radio last mile connection. This has been used even for campuses in Nairobi and environs.

3. **Provision of short-term upgrade requests by relatively small campuses of educational institutions (i.e., 500 students).** For example, in July 2024, the 14 TTCs on the KENET network all requested for “bursting” or temporary increase of capacity from average of 50 Mb/s to 150 Mb/s to support online KNEC examinations. In cases where the leased line providers did not have the necessary upgrade capacity, Starlink provided a temporary upgrade solution.
4. **Low-cost temporary backup Internet services for small rural campuses, research stations or hospitals.** This has been the case for small educational institutions campuses in Wajir and Mandera that did not have an affordable backup solution. KENET NOC has also been able to deploy Starlink Internet in cases of extended faults for campuses without backup (*KENET does not provide FREE backup solution for small campuses with subscription capacity of less than 100 Mb/s*).

We note that KENET has so far used Starlink Internet as a temporary solution and was still collecting perceived quality of Internet services by the users and technical performance in different weather conditions.

D. Are LEO satellite Internet services cheaper than equivalent terrestrial Internet services?

LEO satellite services require that users purchase an earth station kit (non-recurrent cost or NRC) and pay a monthly fee based on data consumption. The kits must be type-approved by CA. In the case of Starlink, the kits can be ordered online directly from Starlink portal or purchased from Naivas supermarkets in Kenya. The NRC is much lower than a P2P radio link or the cost of extending fiber to a campus.

However, the monthly cost for Starlink Internet services depends on the data bundle plan selected (we have not yet tested Onweb LEO satellite services). The Standard service has a data bundle cap of just 50 GB and is not appropriate for educational institutions. KENET has been using priority bundle service that has guaranteed quality of service. KENET selected 1TB, 2TB or 6TB priority data bundle plans for different campuses based on data consumption. Once a campus exhausts a data bundle, it is possible to purchase additional priority data or revert to standard rate without priority as part of fair-use policy.

The Starlink service is therefore similar to the Home Fiber solutions that often a data bundle cap with fair use policies at low speeds. KENET fixed Internet services have unlimited data usage and KENET does not enforce any fair-use policy that throttles capacity.

The cost of 2TB priority data bundle is Kes 13,572. This is affordable for research stations or small hospital clinics with less than 10 users. However, an educational campus with about 500 users consumes about 10TB per month that would cost up to Kes 162,182 per month for priority data. KENET tertiary connectivity package is priced at only Kes 37,500 per month for a 50 Mb/s link.

Starlink Internet costs are therefore much higher than equivalent terrestrial Internet solutions even for small educational institutions.

E. Are LEO satellite services likely to disrupt KENET in its role as an academic network (i.e., NREN)?

KENET has already been deploying Starlink LEO satellite services at some of our campuses. KENET also has an existing partnership with EUTELSAT for provision of both GEO and LEO satellite Internet services when necessary or appropriate.

However, it is possible for some of our members with small campuses to procure Starlink services directly. There are also other operators such as Karibu Connect that are connecting TVCs, TTCs and TTI using Starlink.

The high cost of bundles for educational institutions with over 200 students means that Starlink services are unlikely to disrupt high-speed Internet service with unlimited data transfers that are provided by KENET. A campus with a subscription of 50 Mb/s requires about 10TB of monthly data bundle and the cost is much higher than Kes 37,500.

LEO satellite Internet services are unlikely to disrupt KENET Internet services. Instead, LEO satellite services shall allow KENET to provide Internet backup services or connect rural and remote campuses where terrestrial solutions are not available or affordable. LEO satellite services shall also remain viable solutions for researcher or research stations in rural and isolated areas. It might also be a viable home Internet solution for faculty and researchers in areas without home fiber coverage or adequate 4G/5G coverage.