How many undersea and underground



There are approximately **500 to 550** active and planned undersea cable systems around the Earth, with the total length of these submarine cables stretching over about **1.3 to 1.4 million kilometers**. These cables carry the vast majority of internet and telephone data worldwide.

Underground cables, which connect these submarine cables to cities or between cities on land, are much more numerous and harder to quantify precisely due to their extensive and varied deployment. However, these terrestrial cables form an intricate network that spans continents, connecting data centers, cities, and ultimately, individual users to the global internet infrastructure.

- **Submarine Cables:** The exact number can fluctuate with new cables being laid and some older ones being decommissioned, but the figures mentioned are commonly cited in recent analyses.
- **Terrestrial Cables:** There isn't a definitive count because of the ongoing and vast nature of network expansion by numerous companies worldwide. These cables are essential for distributing the data from undersea cable landing points to various locations inland.

Both undersea and terrestrial cables are critical for global communication, ensuring the high-speed, high-capacity data transfer that supports modern digital life.

How many satellites are in orbit above earth?

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As of the latest updates, there are approximately **10,000 known active satellites** in orbit around Earth. This number can change frequently due to new launches and the decommissioning or failure of existing satellites. Here's a breakdown based on recent data:

- **Starlink Constellation:** A significant portion of these, around 4,733, belong to SpaceX's Starlink project, aimed at providing global broadband internet coverage.
- **Other Satellite Operators:** Besides Starlink, there are many other satellites operated by various nations and corporations for purposes like communication, navigation (e.g., GPS), weather monitoring, Earth observation, scientific research, and more.
- **Inactive Satellites and Space Debris:** Additionally, there are thousands of inactive satellites, rocket bodies, and other forms of space debris in orbit. The total number of objects being tracked by space agencies is significantly higher when including these.

Keep in mind that satellite counts are dynamic due to ongoing launches, the end of satellite lifespans, and the inevitable creation of debris through collisions or satellite failures. For the most current figure, one would need to refer to real-time satellite tracking databases or reports from organizations like the Union of Concerned Scientists or industry-specific trackers.

Given so many satellites in orbit, why do we depend on cables for the "vast majority" of our communications and internet services?

Answer

Despite the increasing number of satellites in orbit, the vast majority of global internet and communication services still rely on undersea and terrestrial fiber optic cables for several reasons:

1. **Bandwidth Capacity:**
   - **Fiber Optic Cables:** They offer extremely high bandwidth capabilities, with capacities reaching into the terabits per second. A single fiber optic cable can carry far more data than multiple satellite connections combined.
   - **Satellites:** While satellite technology has advanced significantly, especially with constellations like Starlink, each satellite link still has limitations in bandwidth compared to fiber optic cables. The total bandwidth provided by satellites, even with constellations, doesn't yet match the sheer data-carrying capacity of the global fiber network.
2. **Latency:**
   - **Fiber Optic Cables:** They provide much lower latency compared to satellite communications. Data traveling through fiber optic cables moves at about two-thirds the speed of light in a vacuum, providing very quick information transfer times for the distances involved.
   - **Satellites:** Even low earth orbit (LEO) satellites, which aim to reduce latency compared to geostationary (GEO) satellites, still introduce more delay because signals must travel to space and back, which inherently adds more time to the transmission.
3. **Reliability and Stability:**
   - **Cables:** Once laid, fiber optic cables are generally very reliable, with the main risks being physical damage from human activity, natural disasters, or equipment failure. Repairs, while costly, can be managed.
   - **Satellites:** Are subject to the harsh environment of space, including radiation, space debris, and the risk of satellite failure. Constellations like Starlink mitigate this by having many satellites, but any single satellite can still fail, and the overall system's reliability depends on having enough operational satellites.
4. **Cost:**
   - **Initial Investment:** While the initial cost of laying undersea cables is high, the cost per bit of data over time is much lower due to the high capacity and longevity of the cables.
   - **Satellites:** Launching and maintaining satellites is expensive. Each satellite has a limited lifespan due to fuel depletion or component failure, requiring regular launches of new satellites to maintain service.
5. **Geographical Coverage and Accessibility:**
   - **Cables:** They are excellent for high-density, high-demand areas where the population and data centers are concentrated, which is where most internet traffic occurs.
   - **Satellites:** Excel in providing coverage to remote, rural, or underdeveloped areas where laying cables is impractical or too expensive. They bring connectivity where it's otherwise unavailable but can't compete with the capacity of terrestrial networks in high-traffic zones.
6. **Security and Privacy:**
   - **Cables:** Generally provide a more secure transmission environment. While they can be tapped, doing so is more difficult and usually involves physical access.
   - **Satellites:** Signals can be intercepted more easily, although encryption helps mitigate this risk.
7. **Infrastructure Growth:**

- The existing infrastructure for fiber optic cables worldwide is vast and continues to expand. This infrastructure has been built up over decades, with continuous upgrades in bandwidth and capacity.

8. **Redundancy and Resilience:**
    - The global cable network often has multiple redundant paths for data traffic, providing resilience against failures in any single cable. This redundancy is harder to achieve on the same scale with satellite networks.

In summary, fiber optic cables are favored for the bulk of global communications due to their capacity, speed, reliability, and cost-effectiveness over long distances. Satellites play a crucial role in providing connectivity where cables can't reach, for mobile communications, and increasingly for global internet coverage, but they complement rather than replace the terrestrial and submarine cable network for the vast majority of internet traffic. The two technologies serve different needs and are often used together in hybrid networks to provide comprehensive coverage and service.



Why bother with placing these satellites in orbit if cables are far more useful, and what do the 10,000 satellites actually do?

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Despite the advantages of fiber optic cables for high-capacity, low-latency communication, there are compelling reasons to utilize satellites in orbit:

Why Use Satellites?

1. **Global Coverage:**
    - **Remote Areas:** Satellites can provide internet and communication services to regions where laying cables is impractical or prohibitively expensive due to geography or low population density. This is crucial for connecting remote, rural, or developing areas.
2. **Mobility:**
    - **Mobile and Maritime Communications:** Satellites enable communication for users on the move, like ships at sea, airplanes, vehicles in remote areas, or individuals in disaster zones where terrestrial infrastructure is compromised.
3. **Redundancy and Backup:**
    - **Disaster Recovery:** In the case of natural disasters or terrorist attacks damaging terrestrial networks, satellite links can serve as a backup to maintain communication lines.
4. **Specialized Applications:**
    - **Broadcasting:** Satellites are ideal for broadcasting TV signals, radio, and other media to wide areas simultaneously.
    - **Navigation:** GPS and similar satellite navigation systems provide global positioning services, which are critical for numerous applications beyond just navigation, including time synchronization for financial transactions, scientific research, and emergency services.
5. **Scientific and Environmental Monitoring:**
    - **Earth Observation:** Satellites monitor weather patterns, climate change, natural resources, and environmental changes, providing data essential for scientific research and policy-making.
6. **Military and Security:**
    - **Intelligence, Surveillance, Reconnaissance (ISR):** Satellites are used for national security purposes, monitoring military activities, and providing tactical intelligence.

7. **Emerging Technologies:**
    - **Direct-to-Device Communication:** Initiatives like Direct to Cell by Starlink aim to allow satellites to connect directly with standard mobile phones, potentially eliminating 'dead zones' for mobile coverage.

What Do the 10,000 Satellites Do?

- **Communication:**
    - A significant portion, particularly Starlink satellites, are designed to provide internet services globally, aiming to bring high-speed internet to underserved areas and improve connectivity for users worldwide.
- **Navigation:**
    - Satellites like those in the GPS, GLONASS, Galileo, and BeiDou constellations offer positioning, navigation, and timing services.
- **Earth Observation:**
    - Satellites capture images of Earth for purposes like weather forecasting, agriculture, urban planning, and environmental monitoring.
- **Scientific Research:**
    - Many satellites are dedicated to scientific missions studying everything from climate change to cosmic phenomena. For instance, the International Space Station (ISS) orbits Earth but isn't included in the typical count of communication satellites.
- **Military and Security:**
    - Military satellites handle communications, reconnaissance, and early warning systems for national security.
- **Broadcasting:**
    - Geostationary satellites in particular are used for TV and radio broadcasting due to their ability to remain in a fixed position relative to the Earth's surface.
- **Space Exploration:**
    - Some satellites serve as communication relays for deep space missions, like those around Mars.
- **Technology Demonstrations:**
    - New technologies are often tested in space via satellites, which can lead to improvements in both satellite technology and applications on Earth.

The deployment of satellites, particularly in large constellations like Starlink, is driven by the goal to enhance global connectivity, especially in areas where traditional internet infrastructure is lacking. While cables are indeed more efficient for high-volume, low-latency data transfer, satellites fill critical gaps by providing access, mobility, and services that are either impractical or impossible to achieve with terrestrial infrastructure alone. The coexistence of both systems allows for a more resilient and comprehensive global communication network.

