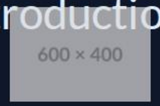
Space Communications: How Do Satellites Work?

A Simple Introduction to Satellite Technology



What is a Communications Satellite?

A satellite is essentially a "repeater" or "mirror" orbiting in space.

Its main job: to receive signals from Earth and re-broadcast them to other parts of the world.

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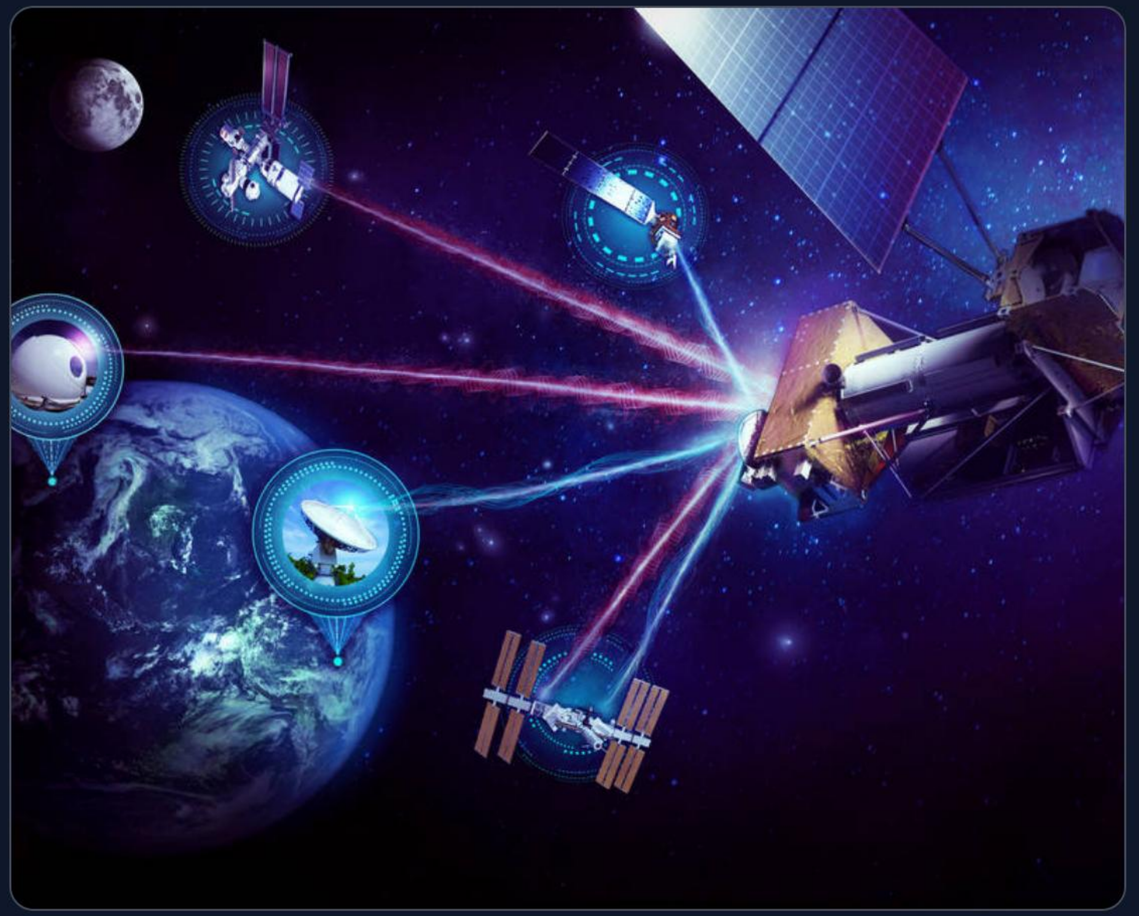

How Does it Work? (The Process)

- **Uplink:** A large ground station (earth station) transmits the signal *up* to the satellite.
- **Processing (in space):** The satellite receives the signal, amplifies it, and changes its frequency.
- **Downlink:** The satellite re-transmits the amplified signal *down* to Earth, covering a wide geographic area (the "footprint").

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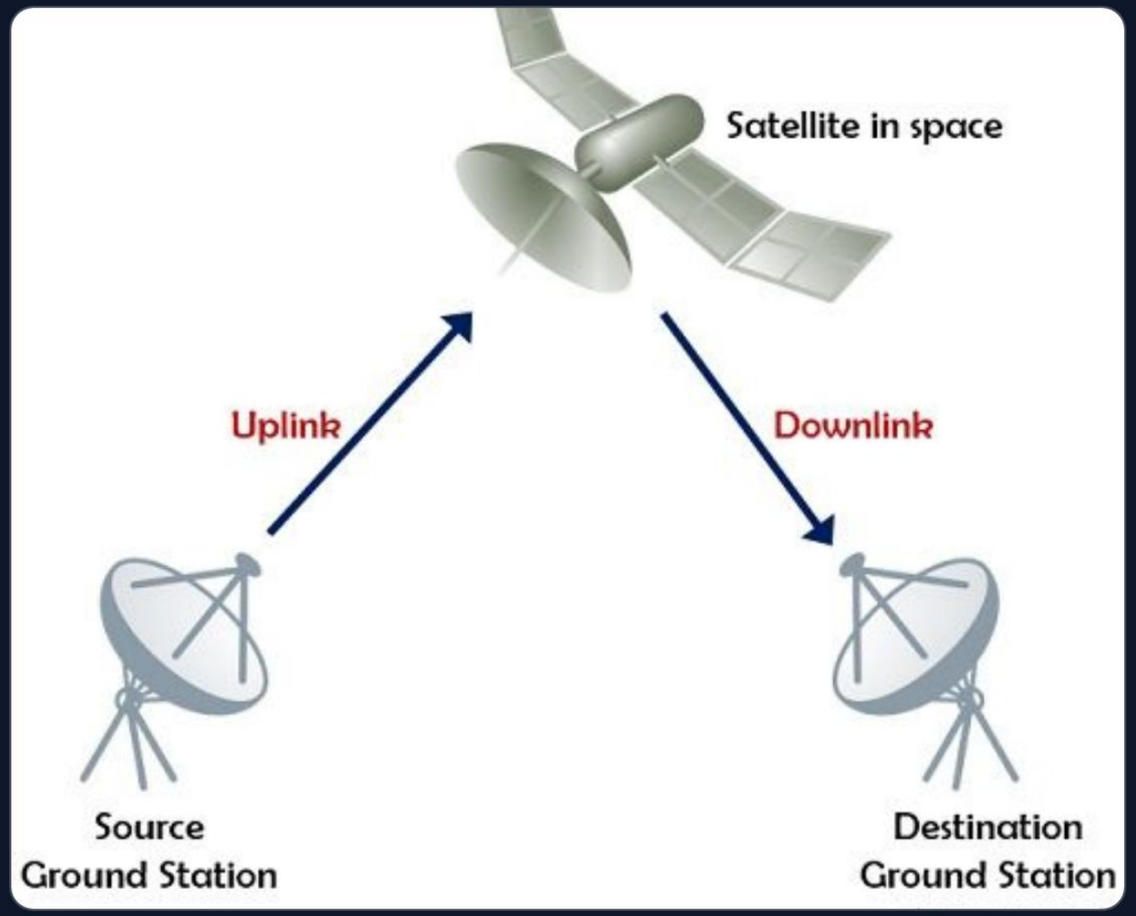

Common Applications

- **Television Broadcasting** (e.g., Satellite TV channels).
- **Internet & Phone Calls** in remote areas (deserts, oceans, airplanes).
- **Navigation:** The Global Positioning System (GPS) is entirely satellite-based.
- **Private Business Networks:** Connecting global bank branches or company HQs.

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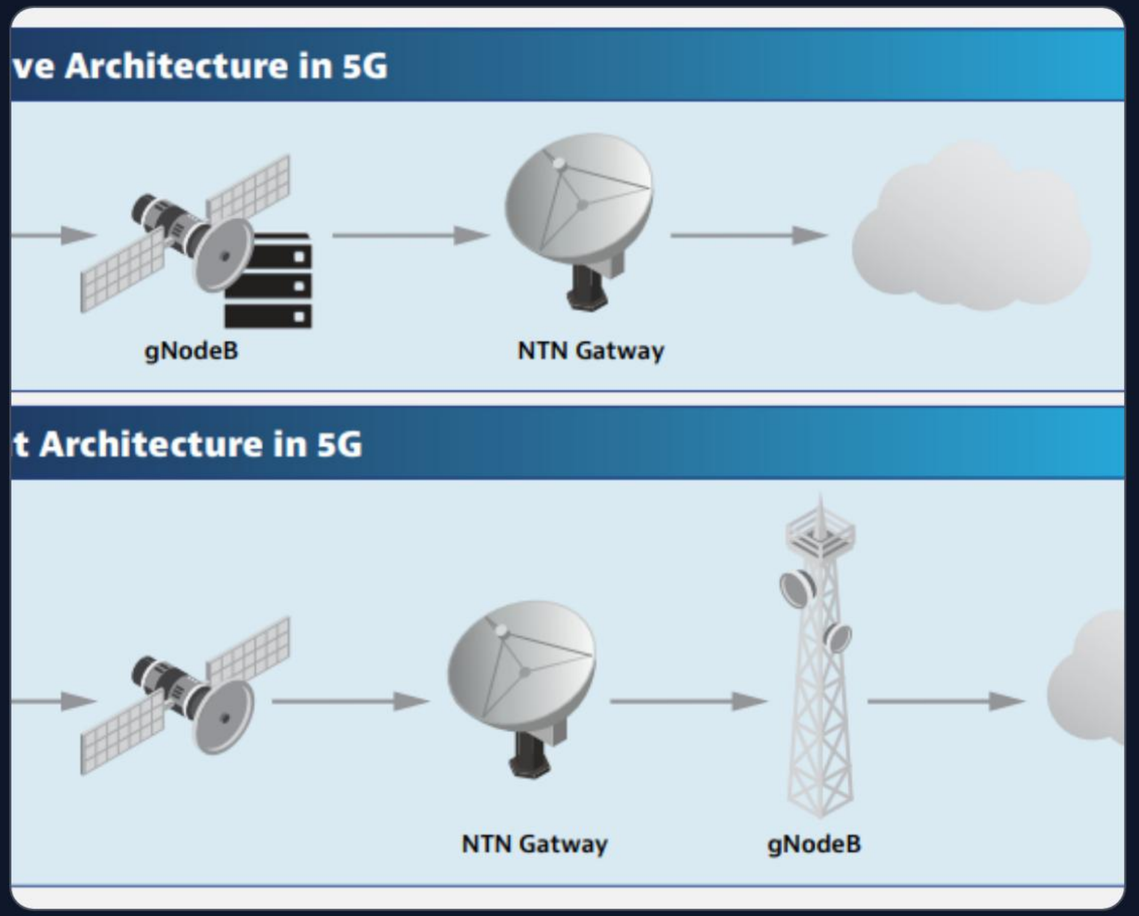

Signal Challenges

- **Free Space Loss:** The signal gets very weak because it travels thousands of kilometers and spreads out.
- **Atmospheric Attenuation:** The signal loses energy passing through the atmosphere (rain, fog, and oxygen).
- **Propagation Delay:** The long distance causes a noticeable time lag, or delay, in the signal.

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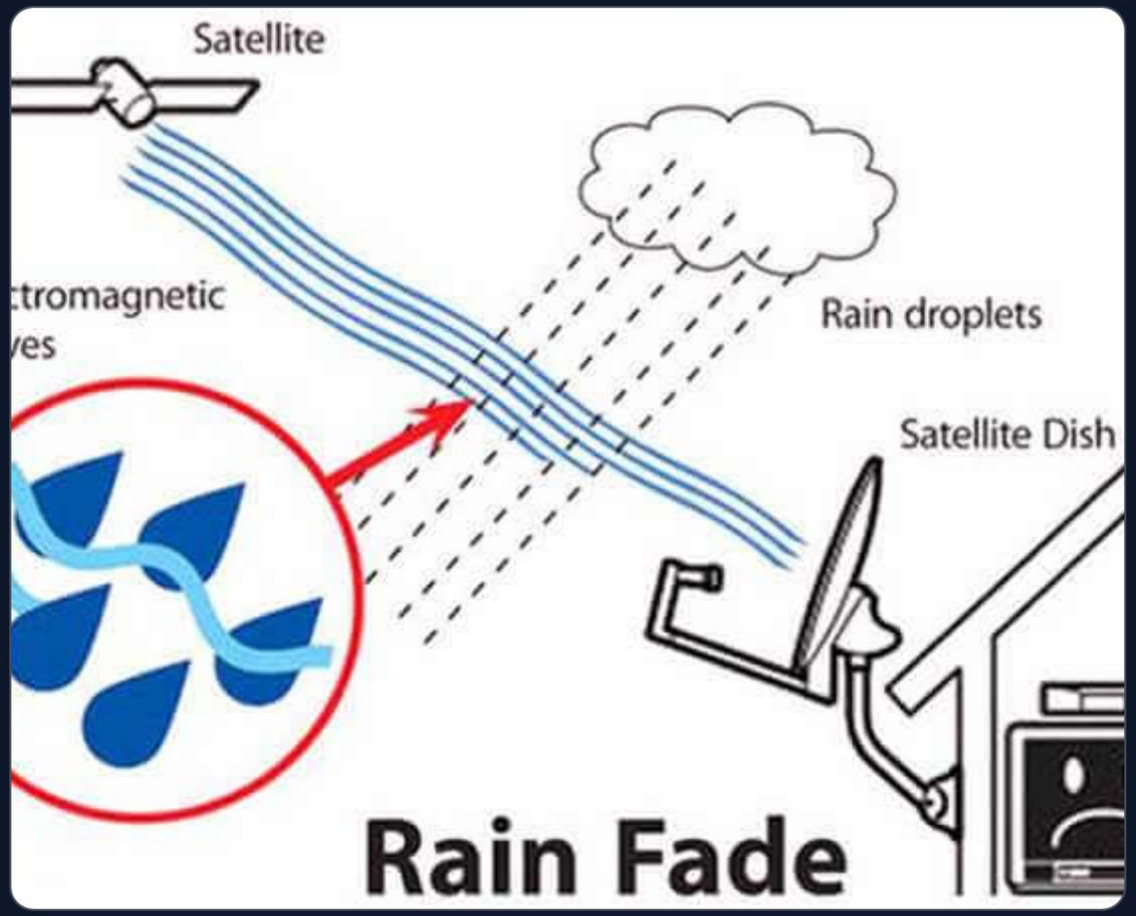

The Future: GEO vs. LEO

GEO (Geostationary)

Traditional satellites. Very far (36,000 km). Appear "fixed" in the sky. Suffer from high delay (latency).

LEO (Low Earth Orbit)

Modern "mega-constellations" (like Starlink). Very close (~550 km). Move very fast. Offer extremely low delay, similar to fiber optics.

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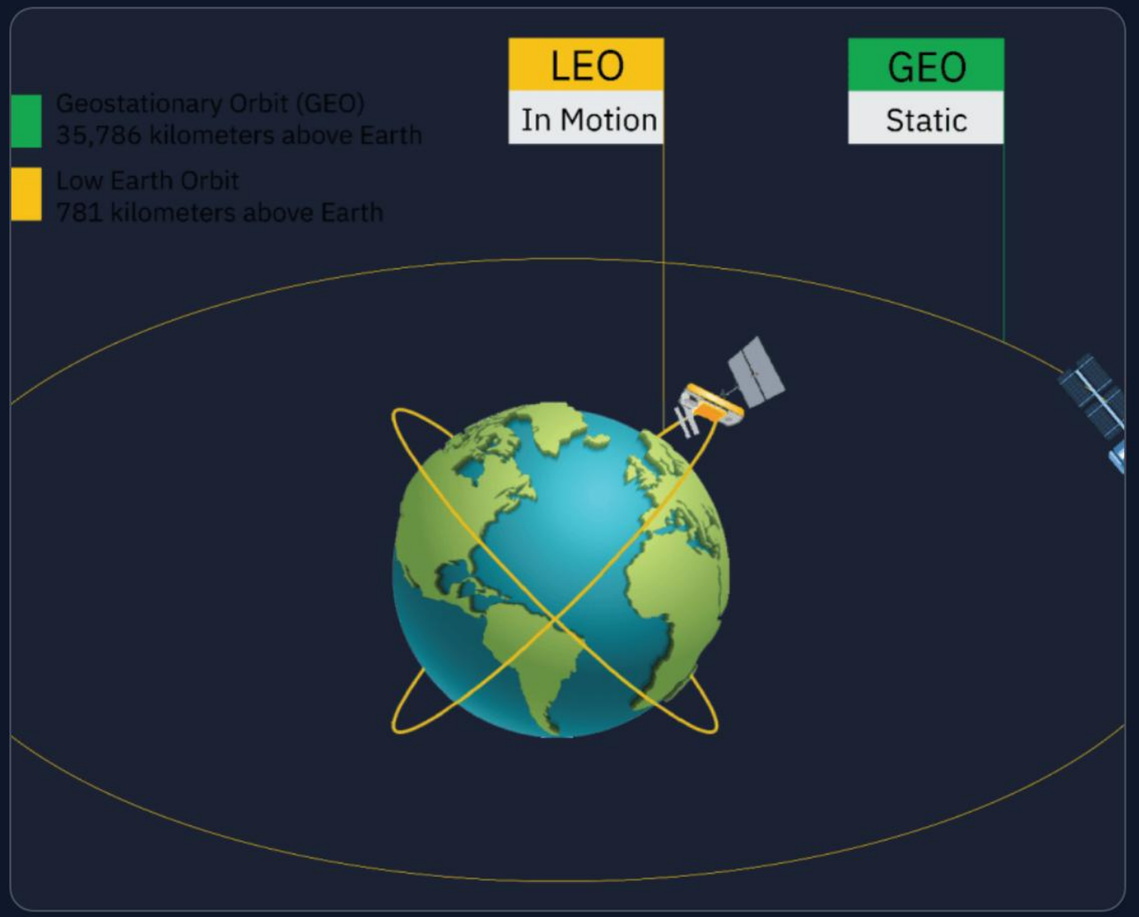

Thank You

Satellites have turned space into a critical part of our global communications network.

Questions?

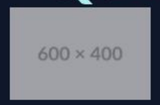

Image Sources

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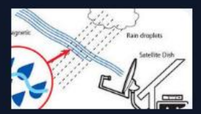

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