

The packet round trip time (RTT) from California to the Netherlands remains relatively unchanged from 2000, 2010, and 2020 due to the fundamental limitations imposed by the speed of light and the distance that data must travel. Here are some key factors:

Speed of Light in Fiber Optics

Fundamental Limit: The speed of light in a vacuum is about 300,000 km/s, but in fiber optics, it's around 200,000 km/s due to the refractive index of the glass.

Distance: The physical distance between California and the Netherlands is approximately 8,700 kilometers. Given the speed of light in fiber optics, the minimum theoretical round trip time is about 87 ms (one-way distance of 8,700 km / 200,000 km/s * 2 for round trip).

Other Contributing Factors

Network Hops and Routing: Data packets often travel through multiple intermediate nodes and routing points, adding latency at each hop.

Network Congestion and Queuing: Congestion and queuing delays at routers and switches contribute to additional latency.

Transmission Delays: While transmission technologies have improved, the distance-induced delays dominate over improvements in router and switch processing times.

Technological Advances

Improvements in Bandwidth: There have been significant increases in bandwidth capacity and reductions in jitter and packet loss.

Better Routing Protocols: More efficient routing protocols and algorithms have been developed, optimizing paths and reducing unnecessary delays.

Improved Infrastructure: Enhanced physical infrastructure, such as undersea cables and terrestrial networks, has reduced some delays, but the distance factor still plays a major role.

Conclusion

The RTT for a packet from California to the Netherlands hasn't changed dramatically over the years because the speed of light in fiber optics sets a lower bound on latency. Technological advancements have improved overall network performance and reliability, but they can't significantly reduce the RTT for such long-distance communication due to these physical constraints.