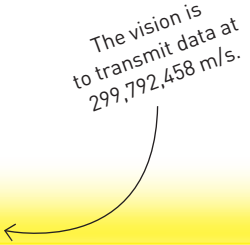
Computer science

Light-speed Internet

Ankit Singla wants to add radio antennas and satellites to the Internet. That could make it many times faster, allowing us to transfer data almost at the speed of light.



The Internet is getting faster and faster. All over the world, companies are busy laying new fibre optic cables and speeding up data transmission by boosting bandwidth. But the Internet still isn't fast enough for Ankit Singla, an Assistant Professor at ETH Zurich's Department of Computer Science since 2016. "If we could communicate with each other with nearly zero delay, then we could achieve true telepresence." By that Singla means that we could be sitting on our sofa at home and using virtual reality glasses and sensors to visit friends holidaying on a beach in Tenerife, interacting with them virtually and merging fiction and reality in the process. But to make that kind of experience immersive and authentic, you need to cut the time it takes a signal to traverse the Internet from point A to point B – what we call latency – to less than 20 milliseconds. Right now, that figure is often many times higher, depending on the distance and connection in each case. That makes certain things impossible – for example professional musicians in different parts of the world rehearsing with each other online.

Inspired by high-frequency traders

Singla is from Chandigarh in northern India. The 32-year-old studied engineering in Mumbai before completing his doctorate in computer science at the University of Illinois. It was there that he and his colleagues composed a manifesto for a faster Internet in 2014. Their vision was to transfer data at the speed of light (299,792,458 m/s), the maximum speed that is physically possible. "Today's Internet is, on average, 37 times slower than what is theoretically possible, and often up to a hundred times slower," says Singla. "And that's not because of issues such as available bandwidth." He explains that this high latency has three causes: the geographical distance between communicating parties, the protocols that govern data transmission, and the physical infrastructure of the Internet – in other words cables, servers and routers. "The first factor remaining fixed, we can optimise the other two," he says. "My research focuses on the infrastructure – and my goal is to reduce latency."

Singla's research is in part inspired by high-frequency trading on the New York, Chicago, London and Frankfurt stock exchanges. Traders can win or lose millions in a matter of microseconds, which is why they came up with the idea of building their very own, optimised "Internet". This involves installing radio antennas on high buildings such as skyscrapers and towers located at intervals of 70 to 100 kilometres and using them to transmit data from point to point in the form of

microwaves. With this approach, latencies within 5 percent of the minimum possible – at the speed of light in va- cuum along the shortest path – are achievable.

"We want to make this kind of system available to everyone," Singla says. To achieve that goal, he is collaborating not just with computer scientists, but also with two physicists from Yale University and the University of California, both of whom also consult for the high-frequency trading industry. In one of their most recent publications, the researchers pooled their efforts to simulate the infrastructure required to provide 85 percent of the US population with Internet speeds very close to that of light. Their results showed that all it would take would be a network of radio antennas installed on 2,526 existing towers, each of which is situated within 70 kilometres of its closest neighbour. They put the price tag at 253 million dollars for installation and 96 million dollars a year in running costs. "That's relatively affordable compared to the cost of laying the new underwater Internet cable from London to Tokyo across the Arctic Circle, for example, which is earmarked at 850 million dollars." But how does Singla intend to connect continents across the world's oceans with a system that relies on high towers to transmit data? His idea is to use a network of satellites to extend light-speed Internet overseas. "SpaceX is looking to put around 2,000 new satellites into operation by 2024. We could use those satellites to transmit the signal, because most of them will be in low-Earth orbit."

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Benefits for interactive applications

Singla envisages light-speed Internet supplementing the existing fibre optic network rather than replacing it, in part because the data transfer bandwidth of microwave links is up to a thousand times lower than that of fibre optic cables. "That's why it wouldn't make sense to use radio transmission for video streaming and file sharing, which make up over 70 percent of data traffic in the US at peak times." He sees the biggest benefits in interactive applications such as telepresence, multiplayer games and musicians playing together online. Industry has also expressed a keen interest in this type of high-speed Internet: Amazon has calculated that 100 milliseconds of additional latency lead to a one percent drop in sales on its online platform, while Google sees search volumes drop by 0.74 percent when latency increases by 400 milliseconds. That's why Singla believes that private companies will get the ball rolling by building small-scale microwave networks. It's also one of the reasons motivating his collaboration with a researcher from Akamai, an American cloud service provider that could benefit from these types of networks for its own services.

Up to now, Singla's work on light-speed Internet has been theoretical. But over the next few months, he is planning to work with his partners in the US to carry out preliminary experiments over an existing microwave network used by high-frequency traders – for instance the one that covers the 1,200 kilometres between New York and Chicago. "We want to find out which applications work best over this kind of network and what needs to be modified to connect it to the existing Internet." In practice, seamless integration will also require new protocols that can handle the consequences of expanding the system, such as faster and more frequent changes in data transmission paths. Singla hopes to lay the foundations for that with a combination of experiments, analytics and simulations. — Samuel Schlaefli

Ankit Singla's latest publication on light-speed Internet:
→ arxiv.org/pdf/1809.10897.pdf