Optimizing data center placement and network design to strengthen cloud computing

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Telecommunication experts estimate the amount of data stored "in the cloud" or in remote data centers around the world, will quintuple in the next five years. Whether it's streaming video or business' database content drawn from distant servers, all of this data is—and will continue in the foreseeable future to be - accessed and transmitted by lasers sending pulses of light along long bundles of flexible optical fibers.

Traditionally, the rate information is transmitted does not consider the distance that data must travel, despite the fact that shorter distances can support higher rates. Yet as the traffic grows in volume and uses increasingly more of the available bandwidth, or capacity to transfer bits of data, researchers have become increasingly aware of some of the limitations of this mode of transmission.

New research from Nokia Bell Labs in Murray Hill, New Jersey may offer a way to capitalize on this notion and offer improved data transfer rates for cloud computing based traffic. The results of this work will be presented at the Optical Fiber Communications Conference and Exhibition (OFC), held 19-23 March in Los Angeles, California, USA.

"The challenge for legacy systems that rely on fixed-rate transmission is that they lack flexibility," said Dr. Kyle Guan, a research scientist at Nokia Bell Labs. "At shorter distances, it is possible to transmit data at much higher rates, but fixed-rate systems lack the capability to take advantage of that opportunity."

Guan worked with a newly emerged transmission technology called "distance-adaptive transmission," where the equipment that receives and transmits these light signals can change the rate of transmission depending on how far the data must travel. With this, he set about building a mathematical model to determine the optimal lay-out of network infrastructure for data transfer.

"The question that I wanted to answer was how to design a network that would allow for the most efficient flow of data traffic," said Guan. "Specifically, in a continent-wide system, what would be the most effective [set of] locations for data centers and how should bandwidth be apportioned? It quickly became apparent that my model would have to reflect not just the flow of traffic between data centers and end users, but also the flow of traffic between data centers."

External industry research suggests that this second type of traffic, between the data centers, represents about one-third of total cloud traffic. It includes activities such as data backup and load balancing, whereby tasks are completed by multiple servers to maximize application performance.

After accounting for these factors, Guan ran simulations with his model of how data traffic would flow most effectively in a network.

"My preliminary results showed that in a continental-scale network with optimized data center placement and bandwidth allocation, distance-adaptive transmission can use 50 percent less wavelength resources or light transmission, and reception equipment, compared to fixed-rate rate transmission," said Guan. "On a functional level, this could allow cloud service providers to significantly increase the volume of traffic supported on the existing fiber-optic network with the same wavelength resources."

Guan recognizes other important issues related to data center placement. "Other important factors that have to be considered include the proximity of data centers to renewable sources of energy that can power them, and latency—the interval of time that passes from when an end user or data center initiates an action and when they receive a response," he said.

Guan's future research will involve integrating these types of factors into his model so that he can run simulations that even more closely mirror the complexity of real-world conditions.

Provided by Optical Society of America

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