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Multihop wireless networks allow for more versatile and dynamic deployments of wireless devices, such as sensors, but can be undermined by an overuse of network-coding algorithms.

Wireless networks

Delays undermine multihop Wi-Fi

Modelling shows that delays caused by a network-coding algorithm are a drain on the performance of multihop wireless networks

Wireless networking is nearly ubiquitous in our daily lives, but the technology is more than a mere convenience. For scientific applications — such as industrial and environmental sensor networks — wireless connectivity has made it possible to connect and network devices in previously unimaginable locations while retaining the ability to view data remotely in real-time.

To maintain wireless connectivity, the wireless device needs to be in 'talking' distance to a base station — typically, in near line-of-sight and within a few tens of metres. Where these requirements are difficult to meet, such as around the summit of a volcano or within the labyrinthine heart of an industrial complex, the devices themselves can be used to capture and retransmit data from nearby devices so that the data eventually finds its way to a wireless endpoint — and from there to a wide area network like the Internet. This type of 'multihop' wireless network has become popular, but as the networks become larger and carry more data, there is a need for greater throughput and improved network performance.

Shoji Kasahara from Japan's Nara Institute of Science and Technology, with colleagues from Kyoto University, has now shown that the performance increases obtained from a promising throughput-enhancing scheme called 'network-coding' are actually limited by the additional processing time incurred in the encoding process[1]. Network-coding is a data transmission algorithm that takes two or more received packets of data and encodes them into a single packet for broadcast to neighbouring multihop nodes. This offers a theoretical boost to throughput, but as the algorithm is currently implemented as a network process rather than in hardware, the encoding step requires computation, which can add milliseconds to each packet transmission.

Kasahara and colleagues found through mathematical analysis of a generalized three-node multihop network that throughput is only increased above that of a network without network coding if the computational delay is less than 1,500 microseconds. Moreover, the performance benefits achieved at shorter computational delays are significantly undermined by this 'coding overhead'. "The main achievement of this work is that the result was obtained in a general setting, which makes the finding applicable to any transmission situation," explains Kasahara.

Since most multihop networks are implemented on low-power remotely deployable sensor devices, network coding may not be as attractive as might first appear. In order to realize the true potential of this promising wireless transmission scheme, hardware-based network coding – with negligible coding overhead – is essential.

Reference

1. Yazane, T., Masuyama, H., Kasahara, S. & Takahashi, Y. Effect of network-coding overhead on end-to-end throughput for multihop wireless networks. *Performance Evaluation* **70,** 14–27 (2013).

More information about the group's research can be found at the Large-Scale Systems Management Laboratory webpage:
http://isw3.naist.jp/Contents/Research/ai-03-en.html