

Quantum Optimization Fuels Greater Mobile Network Performance

CASE STORY

Maintaining steady connections on a mobile network entails a lot of behind-the-scenes effort. Recent work done by Japanese telecommunications company NTT DOCOMO demonstrated that quantum computing can help mitigate potential performance issues on mobile networks during periods of heavy use.

Mobile phones maintain constant contact with various base stations, communicating with each other via paging signals. These paging signals help establish a device's location when calls or messages are received or as the device holder moves from one part of the mobile network to another.

Although conceptually straightforward, the paging signal system can become complicated very quickly. Today's networks are experiencing an unprecedented level of activity. In addition to the smartphones that most people carry around everywhere, base stations must also track the activity of ever-growing numbers of smart watches and other networked devices. This is an especially important challenge for [NTT DOCOMO](#), Japan's largest mobile carrier with more than 90 million subscribers.

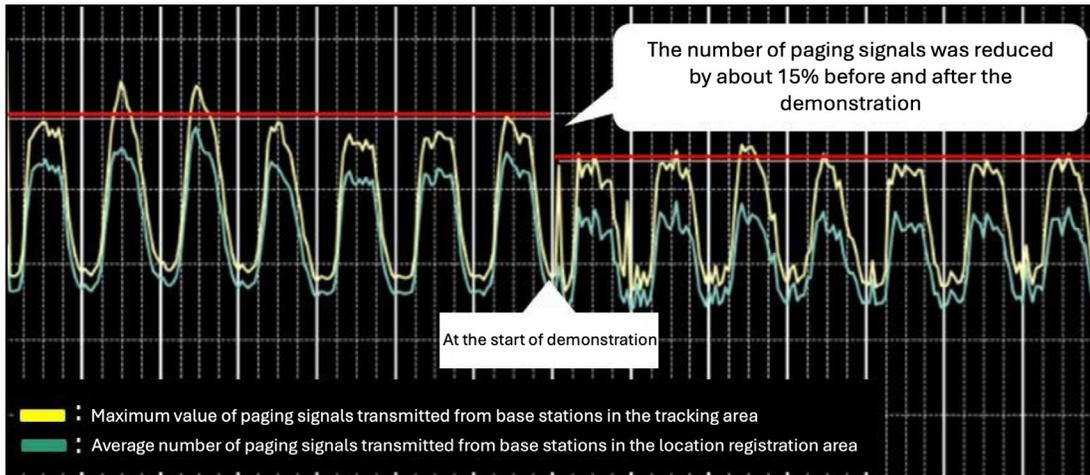
Furthermore, maintaining contact with mobile devices can be something of a trial-and-error process. Whenever a phone moves to a new coverage area, small groups of base stations transmit paging signals to locate the device. But if this outreach is unsuccessful, signals must be sent from larger numbers of stations, creating even more network activity and thus increasing the data-processing burden borne by the network.

Given the size and complexity of the mobile network, optimizing the flow of these paging signals poses a major challenge. Fortunately, D-Wave's quantum technology offers an ideal tool for addressing such problems, and DOCOMO recently conducted a demonstration study to determine whether D-Wave's constrained quadratic model (CQM) hybrid solver could help reduce unnecessary paging signal traffic.

To do so, the carrier focused on identifying groups of base stations that allow the network to locate active mobile devices more efficiently. The DOCOMO team began by collecting mobile traffic data from three regions in Japan. They then developed a mathematical model that allowed them to predict the number of paging signals that would be produced by different groups of base stations under those traffic conditions. Finally, they applied the CQM solver to identify grouping strategies for base stations that minimize paging signal traffic based on that mathematical model.

The scale of this optimization problem was substantial, involving the configuration of 270 base stations from the three demonstration regions into 21 different tracking area groups. With a classical computing approach, it took well over a day of analysis to arrive at a solution. And critically, this is only for a small subset of the total DOCOMO network, which encompasses more 250,000 base stations across Japan—far too many variables to manage effectively with traditional methods.

D-Wave's quantum computing platform delivered an optimized solution for this subset of three demonstration regions in just 40 seconds. And when DOCOMO implemented the grouping strategy proposed by the CQM solver, they were able to reduce the number of paging signals by roughly 15% during periods of peak network activity. The carrier estimates that this reduced signal traffic would allow the network to accommodate a 20% increase in the number of active devices while still delivering stable and reliable service.



Number of paging signals reduced in the demonstration experiment

VERTICAL AXIS: Number of paging signals

HORIZONTAL AXIS: Date (one week before and after the demonstration experiment)

DOCOMO is now in the process of applying optimization solutions identified via quantum computing to its base stations. This is just the beginning. The company plans to explore many opportunities to streamline other aspects of their operations with help from quantum computing—for example, coordinating the deployment of workers and equipment for construction projects or optimizing retail operations.

In a recent press release, Takatoshi Okagawa, director of research and development strategy at

DOCOMO, expressed enthusiasm about how quantum computing might further empower his company in the future:

“With D-Wave’s hybrid quantum technology,” he said, “we aim to set a new standard in the telecommunications industry for operational performance.”

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