China Telecom
takes the drive out of testing in Hangzhou

When it comes to network optimization, China Telecom Hangzhou (Hangzhou Telecom) has moved beyond the usual game of drive tests and KPIs. Through call record analysis, the operator has significantly enhanced its ability to sniff out latent issues and elusive flaws in its network coverage, leading to a troubleshooting process that is far less troublesome.

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The old way doesn’t cut it anymore

The traditional network optimization process is a tedious ordeal where highly-skilled, highly-paid engineers spend their time analyzing dry key performance indicators (KPIs), riding around in vans for hours on end, and scouring the nooks & crannies of buildings and tunnels for network bugs, as if they were high-tech exterminators. The situation was no different at China Telecom Hangzhou (Hangzhou Telecom), a branch of the Chinese incumbent located in Zhejiang’s provincial capital. The operator found that the majority of its O&M man hours and resources were being expended on routine optimization tasks, with O&M engineers optimizing based on the usual KPIs such as dropped call rates and other forms of traffic analysis, as well as user complaints.

KPI analysis for network elements (NEs) is usually based on their signaling point statistics, which neglect QoE and QoS management. If 200 out of 100,000 users experience a call drop, the call drop rate is 0.2%. If you are an optimization engineer, this might be cause for a bonus, but if you are one of those unlucky users, this might be cause for a complaint, and it may not prove terribly helpful anyway unless you have an uncommon knack for precisely remembering time, place, and circumstance.

Assuming enough complaints come in, as opposed to the mere silence of a lapsed subscription, a drive test (DT) may follow, but such methods are anecdotal. They also can’t simulate the conditions that occurred at the time a call failed (the signaling storm generated by a rock concert can’t be recreated at 10:00 a.m. on a Tuesday). What’s worse, more time is wasted if an engineer has to leave the van to scan for an indoor fault, which may or may not be detected thanks to IP network opacity and traffic dynamism.

One particular Hangzhou Telecom user filed a complaint regarding poor signaling and frequent call drops at a certain housing development. During the initial DT, the project team could not contact the user and therefore could not get access to the fault site itself. Not surprisingly, the problem was not found. Therefore, the team had to make a second trip to the user’s front door. After complicated entry formalities, the team got into the user’s residence and found the problem to be coverage overlap coupled with some missing neighbors on site. The team therefore adjusted the antenna and optimized the neighboring cells – problem solved.

However, not every single-point optimization is consequence-free. To strengthen coverage for Road X near West Lake, a famous local tourist attraction, Hangzhou Telecom adjusted one sector’s azimuth for a nearby base station (BTS) and got good DT results for Road X, but this led to complaints of call drops on Road Y.

Both of these examples illustrate how time and resources can be wasted during network optimization, and what’s worse, the typical gear that a field engineer will have with him cannot anticipate ripple effects of the sort seen in the West Lake example. A network simulator could be used, but Hangzhou Telecom wouldn’t have been able to get its hands on one at the time this story began (2010). Even today, one would be bulky, expensive, and possibly inconvenient if it is not from the same vendor that provides your field tools.

In December 2010, Hangzhou Telecom decided to add a little more scientific rigor to the optimization process. The operator joined forces with Huawei to analyze its reams of call data and lump its fault incidents into certain categories, which were then modeled and incorporated into its optimization equipment.
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The devil is in the details

For certain areas, call drop rates can be very high, with the worst offenders even reaching 100%. For such dead zones, a large number of fault records will accumulate, especially when you multiply them by the sheer number of base stations needed to cover a city of eight million such as Hangzhou.

The data in question stems from call detail records (CDRs), which contain a wealth of information to be sure, but finding the exact data that you want for a certain BTS is real “needle in a haystack” territory, and even if you do find it, you still need to know how to sew.

In light of the characteristics of CDMA networking, Hangzhou Telecom’s project team opted to use time difference of arrival (TDOA) coupled with user behavior analysis as its methods for CDR-based fault location, with the latter being utilized because user responses to faults do show certain patterns – after a call is dropped, users will normally redial, and CDRs before or after a dropped call can in fact be used to help pin down a fault location.

For Hangzhou Telecom, a certain user complained about a call drop inside an office building. CDR analysis before and after the drop indicated that the redial connected to indoor cells that were different from the outdoor cells that had carried the original call. It seemed that the outdoor cells did not recognize the indoor cells as neighbors, a problem that is easily remedied across Hangzhou’s numerous towers and high-rises.

As the numbers of successful diagnoses increased, certain models were formulated for such problems (missing neighbors, coverage overlap, pilot pollution, etc.) over the course of three months. This involved network optimization experts pooling records from different CDR levels (BSC, cell, and user) and categorizing call drop patterns accordingly. This data was mapped out so that engineers could get a clear picture of what measures to take for optimization of both neighbor and coverage cells.

These models eventually became algorithms that could effectively label each dropped call with reasonable accuracy (improving the experience). They were eventually incorporated into Hangzhou’s Telecom’s network optimization gear, with KPIs improving soon after.

Statistical significance

With its customized optimization equipment in place, Hangzhou Telecom’s troubleshooting efficiency and efficacy have both improved. And what’s more, faults that were once stealthy can now be detected. Thanks to the aforementioned map, which presents all call drops at a certain site, engineers can figure out the proportion of each type of call drop, find out the root causes, and resolve them comprehensively & effectively. For example, these methods can guide antenna feeder adjustment based on overall coverage status for a
Hangzhou Telecom’s overall call drop rate has declined from 0.24% to 0.17%, raising the operator’s overall ranking from the No. 10 to No. 3 among China Telecom Zhejiang subsidiaries.