

Content

03

Introduction

04

State of the Market

05

Evolving
Approaches to
Network Testing

10

China Mobile -
Sichuan NEI
Case Study

11

Survey Results
Discussion

16

Conclusion

Introduction

This White Paper examines the evolution of mobile operator requirements for measuring network quality and customer experience. As mobile networks have moved from a focus on voice, to data, and increasingly to video, the number of factors that drive network quality and customer satisfaction have continued to increase, causing mobile operators to struggle with how best to measure and assess the quality of their service delivery.

In response to this growing complexity, a variety of approaches have emerged to measure and benchmark network quality. These approaches can include:

- ✔ Drive testing, which provides feedback on actual experience for a customer progressing through the network
- ✔ Downloadable apps or embedded modules that provide direct feedback on network performance from participating customers
- ✔ Deep packet inspection (DPI) or deep flow inspection (DFI) to gather statistical information about customer usage patterns
- ✔ Network probes to provide real-time network measurement and identify chokepoints

This White Paper analyzes the advantages and disadvantages of these approaches to measuring network quality and customer experience, and the challenges to be overcome in order to make sense of data coming from 1,000s of performance indicators and 10,000s of points of data throughout a typical mobile network. The White Paper discusses the move from drive testing to crowdsourcing, and examines Huawei's Network Experience Index. The NEI features an approach that helps mobile operators make sense of this deluge of data, and provides a holistic

approach to benchmark network performance and customer satisfaction, both vs. competitors and to ensure consistent quality performance across their own networks. In addition, the NEI enables mobile operators to provide important contributions to various functions within the mobile operator, from network planning to optimization to new service introductions. The White Paper will also look at early success of one operator – China Mobile-Sichuan – deploying the Network Experience Index, based on a visit to the Chengdu Mobile Customer Experience Center. Finally, this White Paper will detail results of a global survey of mobile operators based on a GlobalData survey conducted in August 2017. We will analyze mobile operator attitudes toward network benchmarking, key priorities in determining voice, data and video quality, and assess the importance of using benchmark indexes to drive key business goals.

State of the Market

In the Beginning: Voice-Centric KPIs

As mobile networks have evolved over the past three decades, one constant has remained: Network quality remains the key to delivering customer value. Prior to the advent of 3G networks in the early 2000s, voice quality and coverage remained the highest priorities. Those indicators were vital in the early days of cellular: the ability to make calls and maintain voice quality was “table stakes” requirements for customers.

A few of the most vital criteria for mobile operators:

- ✔ Dropped Call Rate
- ✔ Voice QoS (Quality of Service)
- ✔ Mean Opinion Score (MOS)

Mobile Data: Shifting Priorities, New Measurements

As so-called “3G” networks rolled out – and particularly following the launch of the first iPhone in 2007 – customers began focusing increasingly on a whole new set of priorities around data coverage, speed, and latency. As the introduction of the iPhone and other touch screen smartphones made the Internet much easier to access on mobile devices, mobile operators found out the hard way that their networks were ill-equipped to support massive increases in Internet traffic. As a result, network

performance indicators expanded to include a much greater focus on issues that had previously been secondary factors:

- ✔ Packet Latency
- ✔ Ping Packet Success Rate
- ✔ HTTP Average Downlink Throughput

Mobile Video: Yet More Complexity

And more recently, with the popularity of high-speed mobile video, customer priorities have shifted yet again to a new focus on high-def video quality, both downloaded and uploaded. In fact, arguably, the challenges to achieving a positive customer experience in mobile video are even higher in video than in Web browsing; customers expect the same level of performance in video quality and latency as they do in accessing non-video Web content despite the higher bandwidth required to support video. Moreover, as mobile video continues to account for an ever-growing

share of mobile traffic, the challenges of maintaining strong network performance only continue to grow. Among the most relevant KPIs:

- ✔ Video stalling rate
- ✔ Video latency/start time
- ✔ Abandon rate on video download attempts

Eyeing 5G: User Expectations Continue to Rise

In the future, with the introduction of 5G, customer priorities will no doubt change again, as new services such as augmented/virtual reality, massive multiplayer gaming,

and connected car applications roll out, each with a unique set of performance requirements.

Use Case	Latency		Reliability	Throughput
	DL	UL		
Broadband Access in Dense Areas	300Mbps	50Mbps	10ms	On demand, 0 - 100km/h
Indoor Ultra-High Broadband Access	1Gbps	500Mbps	10ms	Pedestrian
50+ Mbps Everywhere	50Mbps	25Mbps	10ms	0 - 120km/h
Mobile Broadband in Cars/Trains	50Mbps	25Mbps	10ms	On demand Up to 500km/h
Ultra-Low Latency	50Mbps	25Mbps	<1ms	Pedestrian
Resilience & Traffic Surge	0.1-1 Mbps	0.1-1 Mbps	Not critical	On demand Up to 500km/h
Ultra-High Reliability & Ultra-Low Latency	50Kbps - 10Mbps	2bps - 10Mbps	1ms	On demand Up to 500km/h

Source: 5G White Paper, NGMN Alliance, February 2015

Evolving Approaches to Network Testing

Drive Testing: Tried and True?

Mobile operators have long relied on drive testing as the primary means for gauging network experience based on actual field observations. This approach, which was originally applied to test voice quality and coverage, expanded to include data testing as smartphone usage proliferated. Drive testing uses vehicle-mounted smartphones or modules to gauge network quality in large cities, suburbs, and major roadways. Sometimes, drive testing data is augmented by walking tests in busy downtown areas. Drive test providers typically rank mobile operators based on an arbitrarily weighted set of criteria that reflect network quality for both voice and data services, and often these companies provide a public benchmark report that is used by mobile operators to tout their own network quality. For example, P3 provides public benchmarks and offers “Best In Test” certificates that mobile operators are frequently anxious to use in advertising campaigns.

However, P3 and other drive testing providers are limited in a number of ways.

- ✔ Network measurements are limited to samples collected during active testing and limited to the roadways, hotspot locations (and occasionally railways) tested. This methodology frequently ignores significant portions of the network, and especially in more rural locations.
- ✔ Testing usually occurs in outdoor settings, a serious limitation considering that most mobile handset usage happens indoors in homes and offices. Indoor locations are the most challenging areas for mobile operators to maintain network quality, which will typically not be measured by traditional drive testing methodologies.

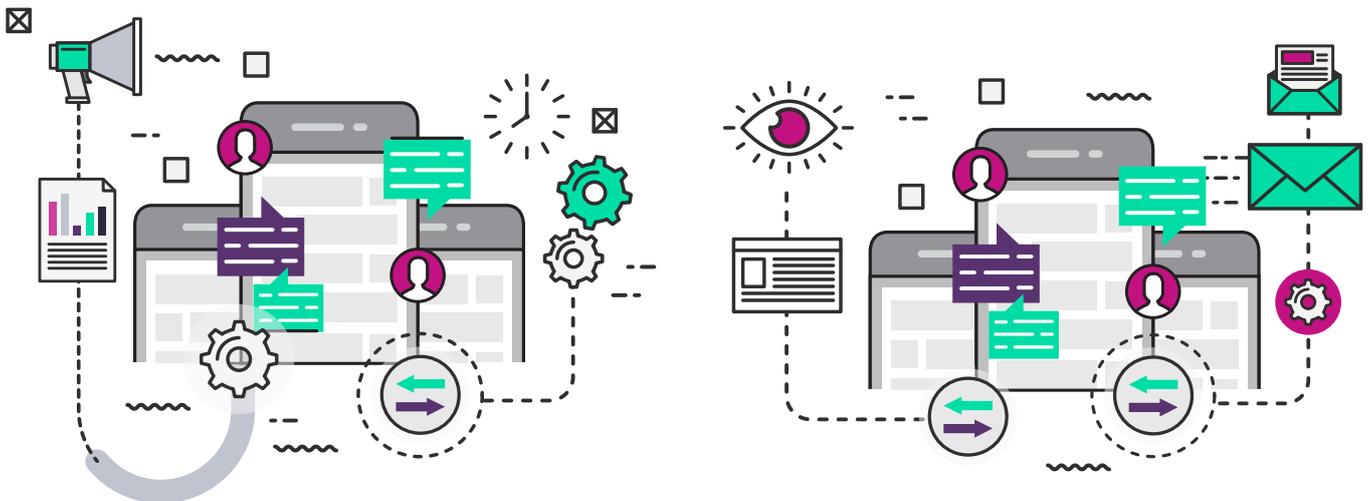
- ✔ Drive testing typically measures network performance on just a handful of the most popular smartphones. Considering that network performance can vary significantly depending on the terminal, limiting collection to a select few devices leads to an incomplete assessment of network performance.

Complicating matters, given that all drive testing companies use a different set of weighting criteria, network scores can vary significantly. Varying sampling techniques, combined with the shortcomings described above, mean that drive testing methodologies provide an incomplete view of network-wide user experience across a full portfolio of user devices.

Crowdsourcing: Leveraging the Power of the Internet

As mobile operators look to remedy the shortcomings of drive testing – including a limited sample of testing devices, limited number of locations tested, the focus has evolved to take advantage of the inherent power of the Internet. Namely, a number of firms have begun offering downloadable apps available to anyone with a smartphone. Once downloaded, these apps draw little power and consume a small amount of data, while performing hundreds of individual tests. By measuring network quality continuously, the app-based approach provides a truer view of actual user-experienced network performance, across the entire network. This includes collection of smartphone performance both in outdoor locations, and significantly, indoor locations where many users tend to have the most difficulties getting a strong, reliable signal. In addition to being able to assess network quality more broadly across the complete indoor and outdoor network, the app-based approach also provides better insights into traffic patterns throughout the day, to identify usage patterns and better predict usage on a 24/7 basis and not just during times that network drive testing is being conducted.

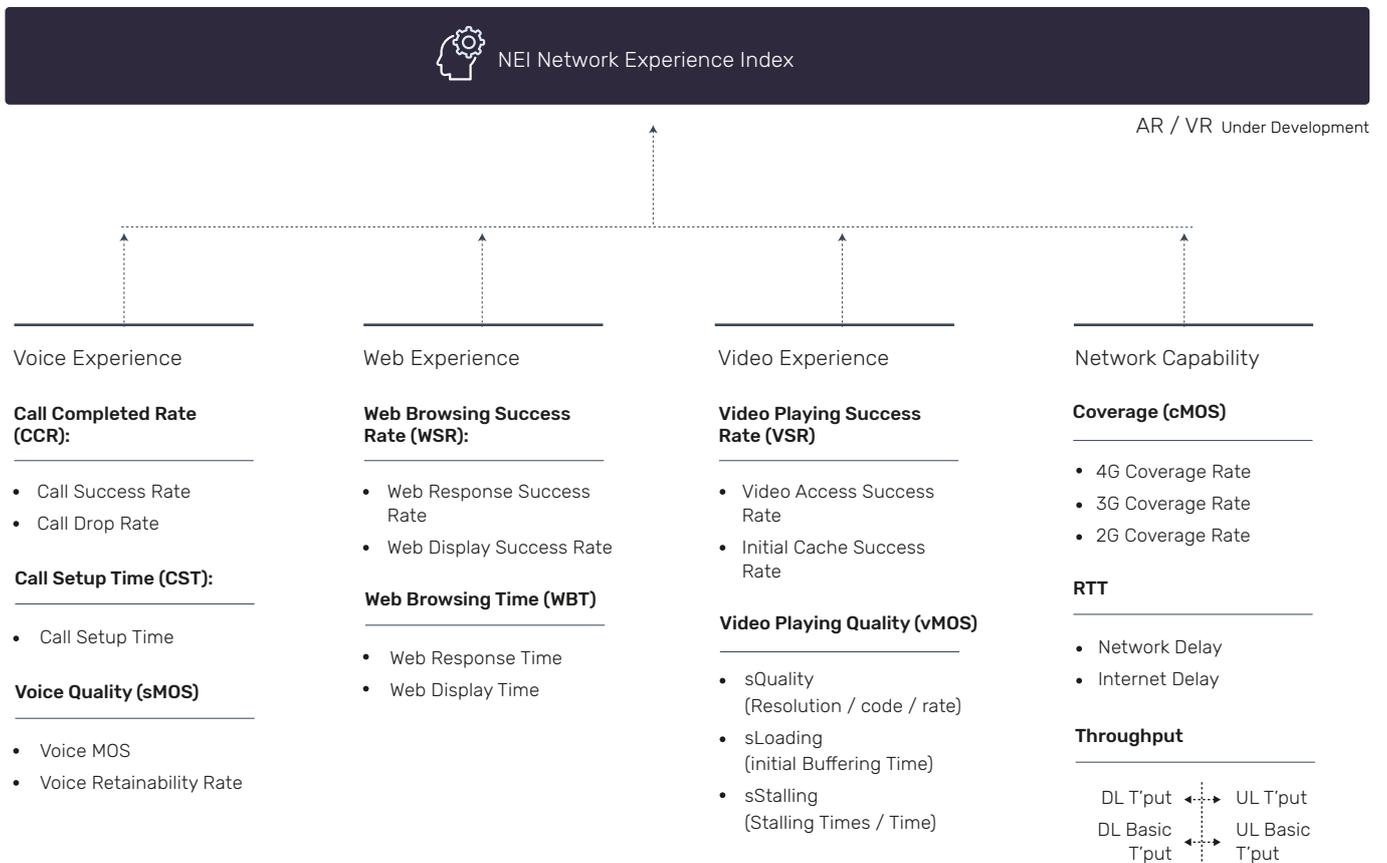
And in addition to providing a more holistic view of current network performance, collecting and analyzing terabytes of data on network performance provides mobile operators with the opportunity to begin to predict future network performance, identify areas of the network most vulnerable to diminished performance, and make the appropriate steps to avoid network chokepoints before they occur. Crowdsourcing has increasingly been adopted by mobile operators to both ensure network quality and use favorable results as a marketing tool to differentiate from competitors. For example, Ookla-owned Speedtest provides an app-based “Speed Score” that measures user download and upload speeds, and then collects results from millions of users to determine the “Fastest Mobile Network” per country and city. However, while Speedtest and other crowdsourced approaches provide an easy way to test raw upload and download speeds, the number of measurements used to gauge end user satisfaction is often limited. The end goal is also limited: the goal with most public benchmarks is to achieve a “best network” ranking to tout in advertising campaigns.



The Huawei Network Experience Index: Crowdsourcing + Experience

Like Speedtest, Huawei's NEI takes an app-based approach, relying on the power of the crowd to collect network performance data across all types of handsets and across the entire network. By contrast to drive testing methodologies, NEI is able to provide continuous measurement of network quality, not limited to specific testing periods. Huawei's NEI also addresses some of the shortcomings in other public benchmarking approaches by going deeper, combining app-based data with a variety of other data sources. For instance, while other public benchmarks focus primarily on downlink and uplink throughput, Huawei utilizes significantly more data points to build a more complete picture of user experience. Huawei collects network performance data from over

10,000 counters and 1,000s of performance indicators and has whittled this data down to establish over 100 Key Performance Indicators (KPIs) and over 70 Key Quality Indicators (KQIs). In addition, the NEI is able to move beyond app-based testing, factoring in direct measurements from network elements to develop a more holistic view of network operations. Finally, taking into account feedback from both mobile operators and a deep understanding of what factors are most determinative of user satisfaction, Huawei developed a comprehensive Network Experience Index (NEI), using a holistic approach that distills thousands of data points into a clear view of network quality and user experience.





Huawei is also well-positioned to help mobile operators use the NEI benchmark results to address a variety of priorities. During the network construction phase, NEI benchmarking can provide vital benchmarking to help operators build out and optimize networking assets. Once networks are operational, network engineers can rely on NEI data to help ensure a more consistent and personalized experience across the network, as well as enhance their move toward proactive and preventive maintenance. Marketers can use the NEI to showcase a superior network experience against market competitors and boost market campaign efficiency.

The CFO can use the NEI to help establish the ROI for network investments. And the CEO can claim credit for all of it!

Huawei reports early traction with the NEI, beginning in China but extending into other countries as well. The company reports the NEI testing has extended to 42 major cities in China, as well as 8 high-speed railways. Globally, NEI testing and scoring has been conducted in over 350 networks.

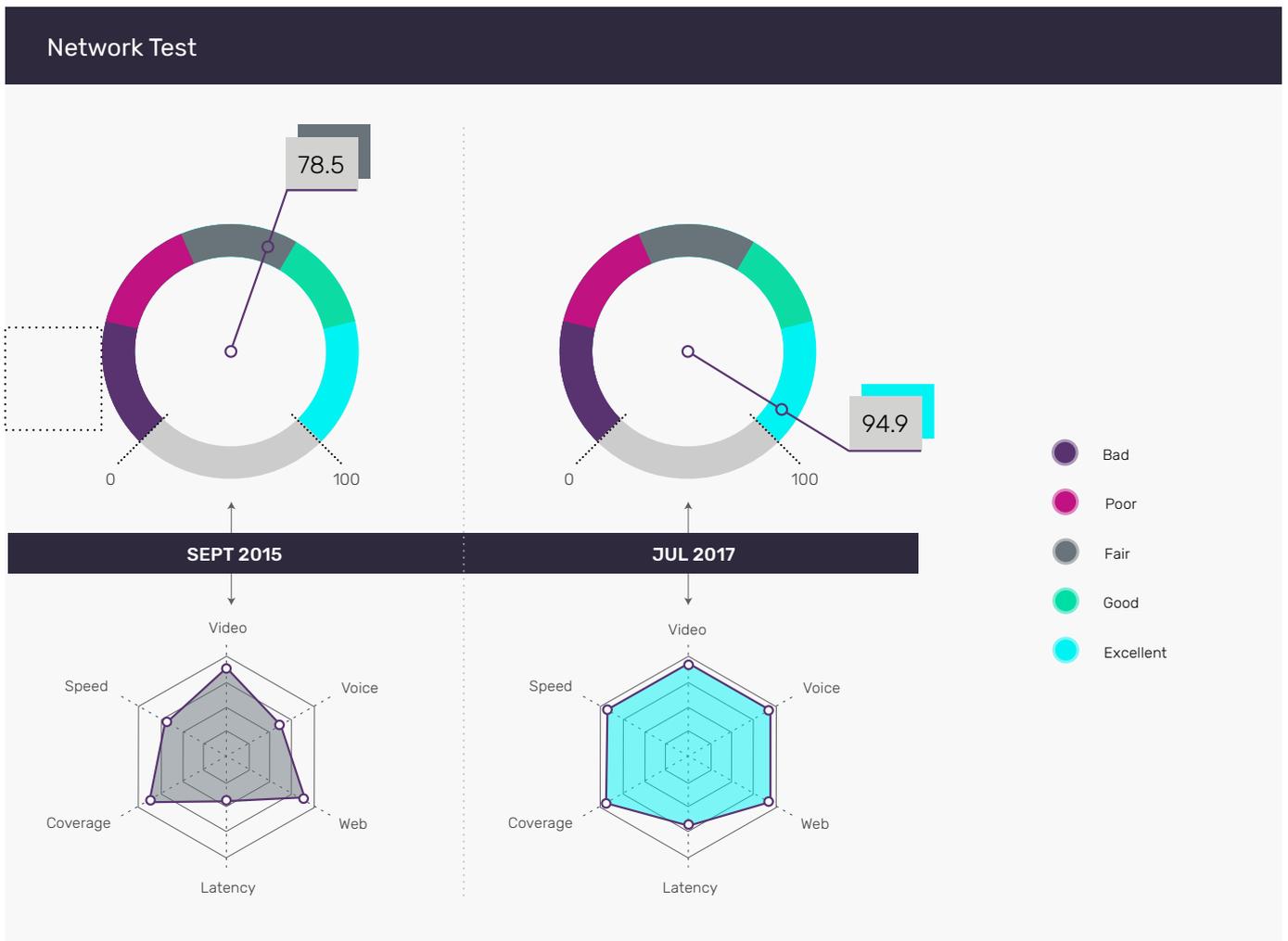


China Mobile-Sichuan: NEI Case Study

One mobile operator already seeing the benefits of deploying Huawei's Network Experience Index is Chengdu, China-based China Mobile-Sichuan, the largest mobile operator in western China. In an effort to better benchmark itself – both from city to city within its own network, and to compare itself to its market competitors – China Mobile-Sichuan implemented Huawei's Network Experience.

And the results have been dramatic. Specifically, in the first year since putting the NEI into the field in Chengdu, China Mobile-Sichuan improved its user performance

significantly, improving benchmark index performance across all of the major index criteria, including voice, Web and video performance as well as on coverage and speed. The NEI also revealed a widening gap between China Mobile-Sichuan and its competitors on VoLTE quality, Web browsing delay, and video user experience. Notably, the NEI does more than just report the "good news." For example, for China Mobile-Sichuan, the results showed that while user experience improved significantly in nearly all areas, latency continues to be a challenge. As a result, China Mobile-Sichuan is now able to devote additional focus and investment to address this challenge.



Source: Huawei

Survey Results Confirm NEI Direction

In August 2017, GlobalData conducted a survey of 20 mobile operators globally to gauge their current and future benchmark testing plans and identify key reasons for using benchmark testing. The survey results confirm the importance of benchmarking, and confirm that benchmarking indexes are being used to drive a number of key business goals.

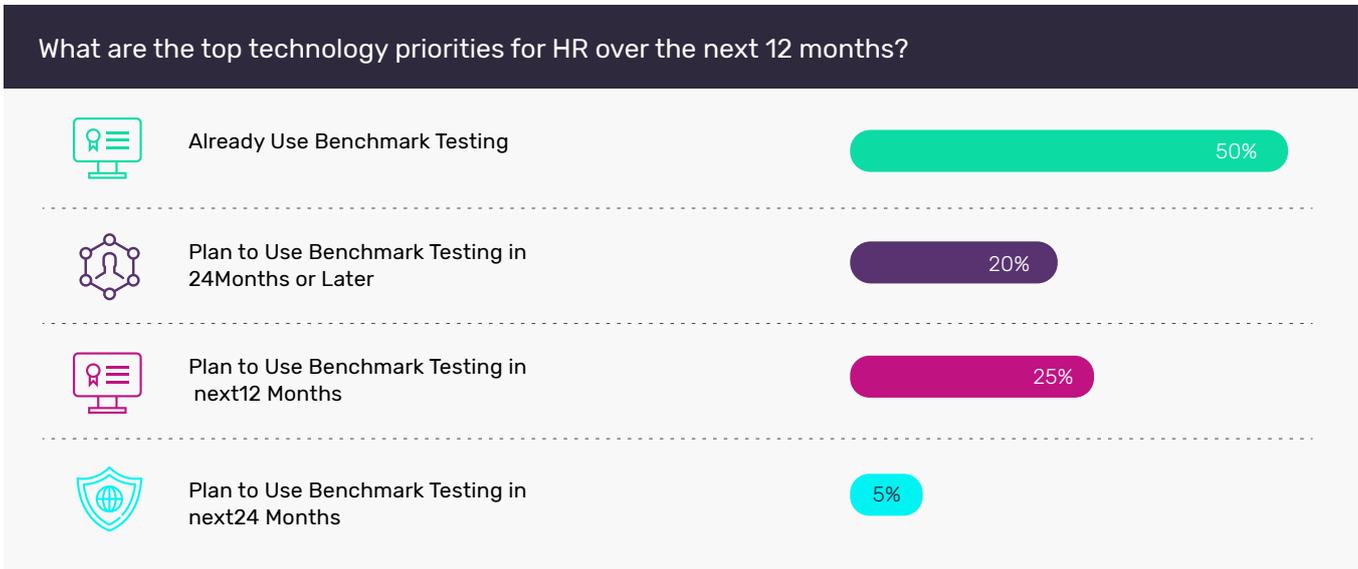
benchmark testing: half of respondents reported having already begun using benchmark testing, while another 30% plan to begin using benchmark testing in the next 24 months. When asked "How important is it to have an overall view of the customer experience represented by a single index that takes into account different network KPIs/KQIs," 75% responded "Very Important" or "Important."

Our survey showed a clear and growing desire for

Clear Demand for Benchmark Testing

Our survey showed a clear and growing desire for benchmark testing: half of respondents reported having already begun using benchmark testing, while another 30% plan to begin using benchmark testing in the next 24

months. When asked "How important is it to have an overall view of the customer experience represented by a single index that takes into account different network KPIs/KQIs," 75% responded "Very Important" or "Important."



Source: GlobalData Mobile Operator Survey, August 2017.

Nearly Half Report Shortcomings with Network-Quality Related Data Collection

While a slight majority of survey respondents indicated they were happy with the amount of KPI/KQI data and visibility, nearly half were not satisfied. While a few mobile operators reported having trouble making sense of the KPI/KQI data collected, the primary issue for most dissatisfied respondents was that they don't collect enough KPI or KQI data to be able to have a holistic view of actual custo-

mer quality of experience. Moreover, despite the fact that over half of respondents felt they had the right amount of network data, the advent of new network challenges created by 5G, network slicing, and new services like IoT could find even these operators in need of more rigorous benchmarking over time.



Source: GlobalData Mobile Operator Survey, August 2017.

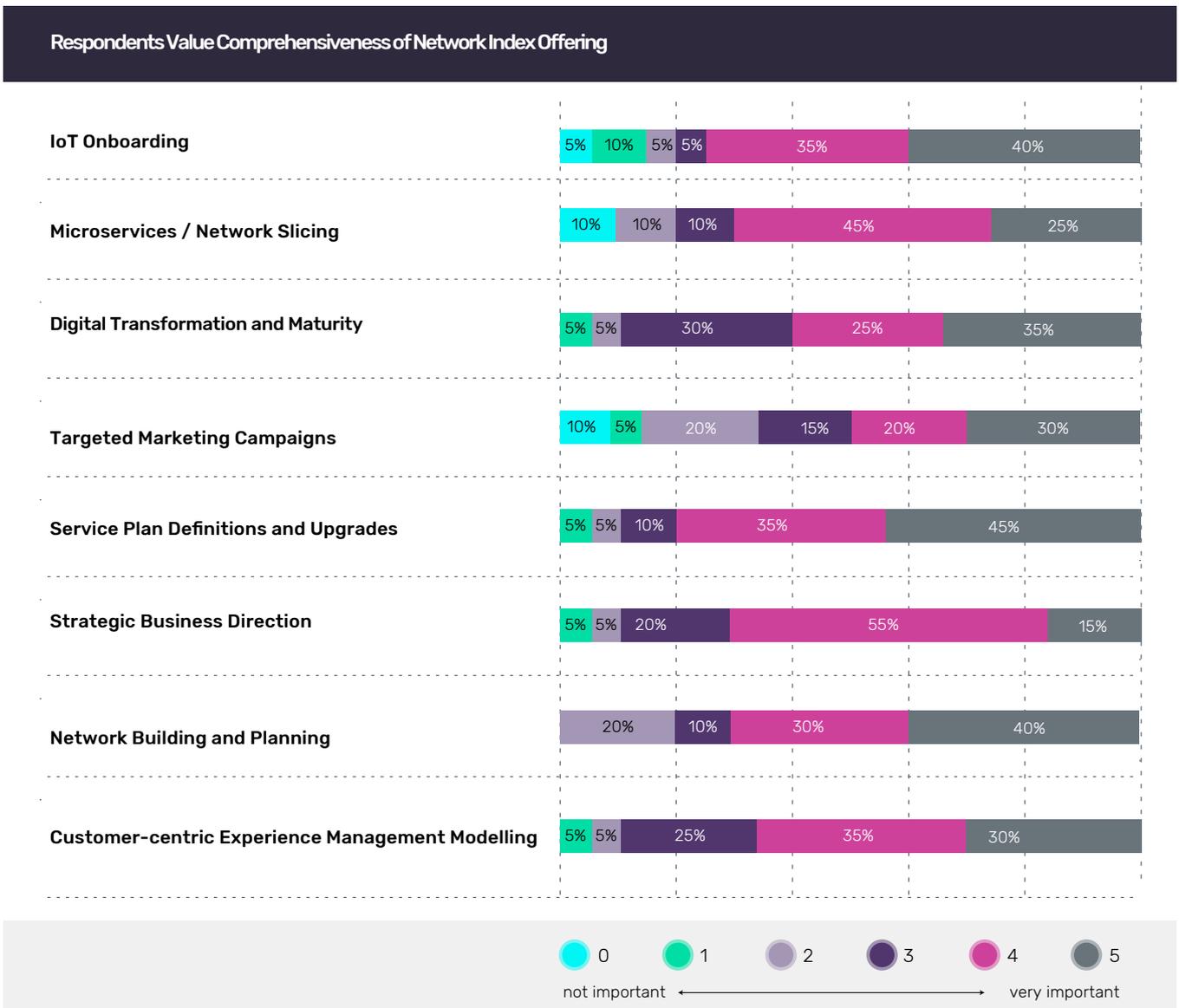
Over half of survey respondents stressed the importance a third-party benchmarking index in order for results to be objective, ranking this as "Important" or "Very Important."

And nearly half of respondents indicated they expect to increase their budget for benchmarking testing over the next year.

Mobile Operators Need for Benchmarking Goes Well Beyond PR Campaigns

Based on survey responses it is abundantly clear that mobile operators are looking to benchmark indexes to drive a variety of business goals. In fact, the traditional marketing and PR angle that accompany typical benchmarking turns out to be the least important business goal. In contrast, benchmark indexes are increasingly being tied

into emerging priorities like the introduction of microservices and network slicing, IoT onboarding, and the ability to creating more personalized rate plans to improve retention of high-value customers. Mobile operators are also relying on benchmark indexes to assist in network building and planning.

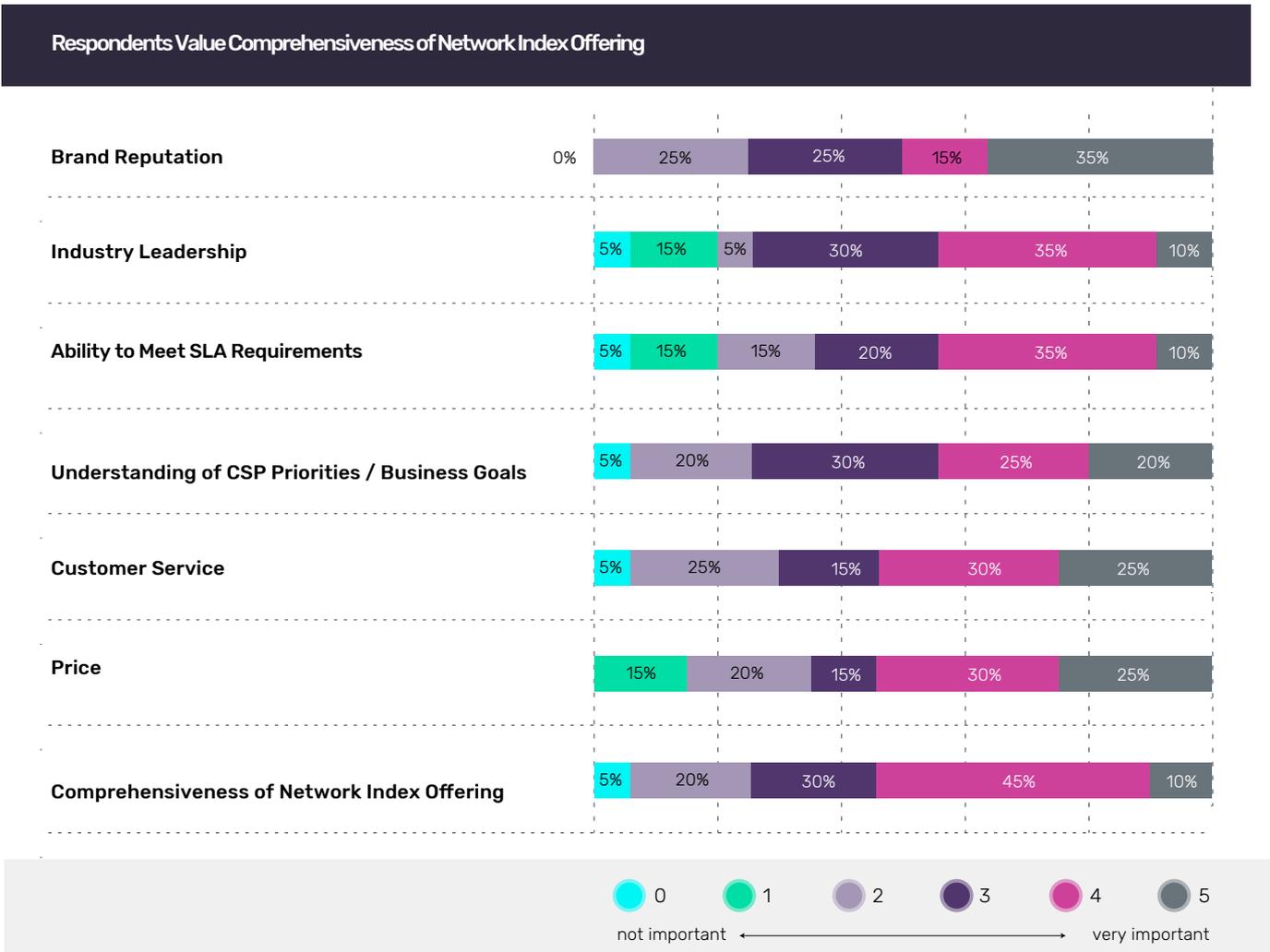


Source: GlobalData Mobile Operator Survey, August 2017.

Respondents Value Comprehensiveness of Network Index Offering

With the number of public benchmarking “brands” in the market, including P3 and Speedtest, it should not come as a surprise that mobile operators identified “brand reputation” as an important factor in how they value vendors providing network benchmarking services. However, what is clear from survey results is that mobile operators value

benchmarking indexes on a number of criteria that go well beyond brand recognition. Specifically, more than half of survey respondents identified “Customer service,” “Price” and “Comprehensiveness of network index offering” as “Very Important” or “Important” in assessing vendors providing network benchmarking.



Source: GlobalData Mobile Operator Survey, August 2017.

Conclusion

One of the interesting paradoxes for mobile operators today is that no matter how much network quality improves, user expectations seem to increase even more quickly. The “gee whiz” factor of being able to download a video onto a mobile device is very quickly followed by the aggravation that accompanies latency, poor video quality or interruptions in service. Looking forward these concerns will only be heightened as new services like IoT, AR/VR and connected car applications proliferate. Thus, the need for network experience benchmarking will continue to grow. And it’s clear from the results from GlobalData’s survey

that mobile operators are looking for benchmarking data to provide input into multiple functions, including network planning, optimization, customer retention initiatives and the introduction of new services. Huawei’s Network Experience Index provides a unique benchmarking tool that combines a comprehensive approach, including data from both end users and mobile networks. Early positive results from China Mobile-Sichuan Mobile, and Huawei’s rapid progress extending the NEI to mobile operators globally, help confirm the NEI comprehensive approach and compelling value proposition.

Basingstoke

4th Floor, Northern Cross
Basing View, Basingstoke,
Hampshire, RG21 4EB,
UK

+44 (0) 1256 394224

Beijing

Room 2301 Building 4
Wanda Plaza, No 93 Jianguo Road
Chaoyang District
Beijing 100026, PR China

+86 10 6581 1794
+86 10 5820 4077

Boston

179 South St, Suite 200,
Boston, MA 02111
USA

+1 617 747 4100

Buenos Aires

Basavibaso 1328, 2nd Floor
Off 206, Buenos Aires, 1006
Argentina

+54 11 4311 5874

Dubai

Dubai Media City
Building 7, Floor 3, Office 308
PO Box 502635
Dubai

United Arab Emirates
+971 (0) 4391 3049

Hong Kong

1008 Shalin Galleria
18-24 Shan Mei Street
Fo Tan, New Territories
Hong Kong S.A.R

+852 2690 5200
+852 2690 5230

Hull

GlobalData PLC
Shirethorn House
37-43 Prospect Street
Hull

HU2 8PX

Hyderabad

2nd Floor, NSL Centrum,
Plot No-S1, Phase 1 & 2
KPHB Colony, Near: BSNL Office
Hyderabad-500072

Andhra Pradesh
+91-40-30706700

London

John Carpenter House
7 Carmelite Street
London
EC4Y 0BS
+44 (0) 207 936 6400

Madrid

C/Jesusa Lara, 29 - Atico J,
28250 Torrelodones Madrid,
Spain

+34 91 859 4886

Melbourne

Suite 1608
Exchange Tower
Business Centre
530 Little Collins Street
Melbourne

3000, Victoria, Australia
+61 (0)3 9909 7757
+61 (0)3 9909 7759

New York

441 Lexington Avenue,
New York, NY 10017
USA

+1 646 395 5460

San Francisco

Progressive Digital Media Inc
425 California Street
Suite 1300
San Francisco
CA
94104

Seoul

Global Intelligence & Media Korea Limited
11th Floor, West Wing,
POSCO Center Building,
892, Daechi-4Dong,
Gangnam-Gu, Seoul 135-777
Republic Of Korea (South)

+82 2 559 0635
+82 2 559 0637

Shanghai

Room 408, Jing'an China
Tower No: 1701,
West Beijing Road
Jing'an District, 200040,
Shanghai, PR China

+86 (0)21 5157 2275(6)

Singapore

1 Finlayson Green
#09-10
049246
Singapore

+65 6383 4688
+65 6383 5433USA

Sydney

45 Clarence St
Sydney
NSW 2000
Australia
+61 (0)2 8076 8800

Tokyo

Global Intelligence & Media Japan Tokoyo
Level 3,
Sanno Park Tower,
2-11-1 Nagata-cho, Chiyoda-ku,
Tokyo, 100-6162
Japan

+81 3 6205 3511
+81-3-6205-3521

Toronto

229 Yonge Street
Suite 400
Toronto
Ontario
M5B 1N9
Canada

Washington

21335 Signal Hill Plaza,
Suite 200, Sterling,
VA, 20164
+1 703 404 9200
877 787 8947 (Toll Free)