

Business-driven Network Metrics

Best practices for improving business performance through customer experience metrics

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Summary

In brief

Leading digital service providers (DSPs) are increasingly using network experience indicators (NEI) and network performance indicators (NPIs) derived from analytics, virtualized networks, and digitallyminded business strategies, to understand how well digital service networks are meeting customer needs. But more needs to be done to link NEIs and NPIs fully to business strategy. DSPs that both invest in such systems, and collaborate with an ecosystem to further develop them, will be more successful in executing their strategies.

Ovum view

DSPs globally are investing strategic and capital resources to build a clearer view of customer experience, to design better operational and market strategies. By working to improve service quality metrics and network performance metrics, including network coverage, and call and data access quality levels, DSPs are seeing clear impact on improving network experience. Some are even analyzing correlations between network experience measures (e.g., call quality, download speeds, customer care response times) and the influential brand equity metric net promoter score (NPS). Virtualization efforts are further aiding in both increasing the volume of experience data, and analyzing it in relation to operational performance. In so doing, DSPs are getting close to building business performance management systems to create further network efficiency, as well as a future performance management system to correlate customer experience with business activities.

Key messages

- Focus on efficiency paves the way toward network business value. Business pressures and shareholder expectations have forced DSPs to monitor and manage the network efficiency ever more closely, relying on performance measurement instruments which allow decisionmakers to monitor and improve how network assets are utilized.
- Tacking toward optimal customer experience. EBITDA, asset utilization, or return on investment (ROI) may not yet immediately yield insight on how customer experience is being improved, but they do provide two important strategic levers for DSPs. Financial metrics provide a common frame of reference, which focuses the attention of decision-makers and stakeholders on shared business objectives. Measures of asset utilization efficiency are compelling DSPs to invest in next-generation networks and digital transformation business platforms.
- Building on physical asset performance measures is creating the network business value system. Analysis tools are emerging which can take both quantitative measures of experience – voice call quality or latency – with qualitative inputs from customers, increasingly provided by customers directly through contact centers or social media. Building more efficient, virtualized network capabilities lets DSPs provision on-demand services in real time, and increases their ability to draw business-actionable conclusions.
- Network business indicators (NBIs) include the Network Experience Index (NEI) and network performance indicators (NPI). NEI is a comprehensive measure of how end users experience

the network, composed of such key categories as voice call experience, web browsing experience, and video experience. NPI is composed of various metrics designed to capture the specific network performance or service levels such as accessibility, integrity, mobility, and retainability. The aim is to use data science to correlate NBI with network experience and network performance metrics, which will provide DSPs with data analytics to guide network service and capability improvement, advanced insights to prioritize their business decisions, and improve the overall efficiency and effectiveness of their investments.

Network business value

Senior technology decision-makers at successful DSPs are increasingly conscious of the need to link their business strategy to the network parameters they monitor to maintain technical performance excellence. How do leading DSPs enhance their business performance, and develop strategies for network performance and operational management to support new and enhanced service portfolios?

DSPs are slowly getting closer to unifying their operational and business performance strategies, and leading carriers globally realize that achieving this is crucial to their long-term success.

Using insights from discussions with financially successful DSPs globally, this report examines the ways they prioritize operational metrics such as network experience and network performance, and use them to inform their overall business strategy. Through research and discussions with carriers, this report examines the ways DSPs currently:

- Map technical measures of the network's operations to business performance indicators.
- Create and refine network performance and customer-viewpoint experience metrics as they undergo digital transformation, to improve operational efficiency.

This report argues that DSPs are aggressively building the formal processes and analytic capabilities to link their business performance to their network operations, and the increase in strategic direction to transcend operational efficiency is quickly laying the groundwork for the creation of a network business value methodology. At the same time, this is creating an initial platform for DSPs to view their network assets through the lens of business value.

DSPs can thus use this platform to take steps to close the gap between network performance, experience, and business value. Advances in network deployment strategies, particularly those that look to virtualize both network capacity resources, and the BSS and OSS which govern them, are turning customer experience indications into more strategically actionable data.

Through network virtualization, software-defined network elements, and increased use of cloud-based analytics, DSPs are moving to more discretely measure customer information and network performance metrics, and correlate them with financial performance measures which inform the common language that carriers speak to their constituents – shareholders, partners, and employees.

As will be revealed in case studies of leading DSPs, digital transformation is creating the capability to translate customer experience in terms of digital network performance, and analytics will further enable carriers to correlate gains in improved experience – both technical indications of quality connections, and increasingly crowd-sourced expressions of satisfaction directly from customers themselves – to their business decisions.

Report methodology

This research report is based on Ovum's ongoing analysis on service provider strategies and financial performance, coupled with in-depth interviews with senior executives responsible for network performance management and with visibility into the strategic planning process.

This information and insight was compiled to develop qualitative case studies of how financially successful carriers develop their strategy based on the relationship between network experience and business value.

Defining business value in the digital business world

There are explicit and implicit connections between a carrier's metrics of business value, and its network performance and experience measures. And while decision-makers within service providers find it difficult to align detailed network indicators to business KPIs (often because a direct cause and effect cannot be immediately identified) there is a fast-growing trend to leverage digital platforms – and digital modes of work – to identify causality between the two. The use of performance analytic platforms and business information systems can increasingly synthesize customer requirements and feedback about how those requirements are being met, in effect tethering network experience to business activity through network performance monitoring.

Back to basics

The related business KPIs of carriers are typically those defined by what are arguably basic indications of successful business performance in terms of acquiring customers, and the costs and revenues associated with that activity: ARPU, churn, and customer service cost reduction. Carriers similarly associate basic network performance indicators with the ability to successfully achieve those business goals in a straightforward calculus: Expanding mobile network coverage, capacity, and quality increases addressable market, subscriber base, and average revenue per user (ARPU) and, by extension, improves the carrier's service reputation.

It is becoming easier for carriers to gather more, and more precise, network performance data, as will be revealed in the case studies below. It is also, thanks to investments in virtual OSS and BSS, increasingly possible to take customer experience-linked measurement of performance indicators and view experience measures such as latency and throughput through the performance lens. That said, linking these increasingly precise measurements of specific technical feature to their impact on business goals is challenging, even for the most sophisticated and financially successful global carriers.

While digital transformation is providing DSPs with tools and insight to better correlate network performance with business outcomes, it also creates additional challenges for selecting and managing appropriate metrics. Digital transformation will see more virtualization of network functions, and as network managers convert capabilities from physical to virtual network elements, organizations will also change. This is creating tremendous pressure on incentive structures and management culture; the CIO of an Asian mobile operator observes, "When we managed our own (physical) equipment, each element was managed, bottom to top, by one person, but the cloud means splitting up management by service line – and thus the overall organizational chart changes." Management and

incentive structures will change as a result; DSPs must align performance incentives against an increasingly precise set of metrics.

Business planning and management information flow

Reviewing the strategies of financially successful DSPs reveals aggressive attempts to formalize the processes by which business performance information is communicated throughout the organization. This is increasingly being done through investments in improving information visibility, which is a key to making the shift in management culture alongside DSP's technology evolution. Tools and processes for making performance data open and accessible are also emerging best practices; for example, some carriers such as Proximus (see case study below) have designed business systems specifically to monitor the efficacy of their capital expenditure.

Network performance indicators

Leading DSPs are becoming more systematic in the use of key network performance indicators as tools to focus network investments and enhance market reputation.

Comprehensive service coverage and quality continue to be important metrics leading carriers are using to both signal their commitment to the market and bolster reputation. DSPs see network coverage and quality as a crucial link to both their customer experience and their brand reputation. This can apply to everything from data network speeds and latency to more traditional services; voice quality, for instance, is a critical brand equity influencer in many markets worldwide (see the MTN case study below). Coverage, while not a competitive differentiator in some markets, continues to be front and center in others, particularly larger markets such as the US.

Network experience indicators

Once a 'fuzzy' indicator of performance, measures of customer experience are becoming not only more precise, but new digital technologies and digital business practices are allowing those measures to be more thoroughly understood across the customer journey. Moreover, and more importantly, tools and processes are providing capabilities to align experience metrics related to speed and call quality to more benchmarkable business performance measures – specifically NPS.

Increasingly, that data is analyzed in ways that take NPS from a rough measure of customer satisfaction to a metric with strong correlation to network performance. One senior strategy executive interviewed in an Asia-based global carrier notes, "NPS – gathered through social media, customer touchpoint interactions, and customer surveys – remains the most valuable measure of brand health. Virtualized service environments allow us to see this in greater granularity, tracking customer journeys end-to-end, and in real time." The executive points out that regression analysis has allowed them to equate NPS to call and connection experience metrics such as standard call quality and mobile webpage loading time, cross-referenced by call plans and customer care experiences.

Case studies

Leading DSPs are both driving business strategy from their network performance measures, as well as building the capability to gather and interpret customer experience data quicker and more accurately.

Ovum has examined the network development and business execution strategies of several financially successful carriers across the globe. While there is variance in the metrics used by each, there is also overwhelming evidence that these carriers are engaged in a common objective: To use increasingly available network experience data to inform and refine business strategy, to make faster, more impactful decisions on network investments, new service creation, and customer-defined parameters of service experience. Importantly, these efforts are part of each carrier's digital transformation efforts: Investing in next-generation technology platforms built more on software than hardware, provides more real-time insight into customer experience, network performance, and business value, and the relationships between them.

Telstra

From telco to tech-co, driven by customer experience performance measurement

For Telstra, improving visibility into its customer experience, and linking efforts to improve that experience through more precise business performance metrics, is an integral part of its overall network transformation strategy. Virtualizing network capability is for Australia's largest integrated service provider, at the heart of the company's strategy, in the words of Telstra International CIO Sundi Balu, "to evolve from a telco to a tech-co." Telstra's Network of the Future vision, including its rollout of a 5G and IoT platform, has implications for how its core network, as well as its product and services, are changing.

This evolving redesign of the way Telstra links its strategic objectives to its performance measures: Nimbler network capabilities allows for the creation of more customer-defined services. This, in turn, means Telstra will be able to drive business decisions from a precise view of customer experience, because the underlying technology platform will also carry back real-time feedback and analysis of how well that customer-defined service has been delivered.

Telstra is seeing immediate impact on its network performance management metrics and how the carrier manages business performance. Virtual network environments are not only seen as a move to back-end efficiency, but are now being translated into client-facing offers. A primary example of this was launched last year in its enterprise services: The Telstra Programmable Network is a self-service virtual managed service offering, allowing enterprise clients to build their own IT and connectivity capabilities – virtual firewalls, throttle bandwidth on a metro and WAN basis, connecting and managing data centers – on their own, using their own SLAs and performance measures. By migrating its network architecture to software-defined capabilities, Telstra is replacing a time-consuming client provisioning process with portals and APIs; and, significantly for performance management, with "commercial implications" for performance defined by clients themselves.

Historically, network performance at Telstra, was viewed through a technology lens at the Network Management Center. "Now, we are uplifting all our metrics to be defined by customer experience." While again this is largely being down at the enterprise level – "if a client has a globally dispersed managed SAP platform with a 30-second latency SLAs selected, can we demonstrate that as a dashboard?" This customer-defined service experience will eventually come to Telstra's consumer offering as the underlying infrastructure changes. This is being accelerated by Telstra's work on its self-labelled Next Generation OSS, which will be able to allow business line managers to abstract performance data from the service inventory, delivering insight to the relationship between service provisioning and revenue performance.

While Telstra's core network capacity is still managed at the enablement level, and these core performance metrics are still defined by technical performance indications such as latency, lag, or uptime, Telstra's goal is to convert all performance views to a customer experience-monitored view. Balu observes, "it was hard to correlate technology-driven performance metrics to customer experience when every capability was in a vertical slice; now, we are going to horizontal, and we will be able to correlate" technical performance with experience metrics.

Balu feels that this will gradually give way to an ultimate correlation to business objectives, "but this is a five-to-seven-year journey," in which he expects to see Telstra's revenue mix change substantially, "as we shift to digital-native services and away from connectivity, then we will be able to see the impact of performance against experience expectations to revenue and EBITDA."

T-Mobile US

Un-carrier strategy, network investment drive subscription boom, and financial turnaround

T-Mobile US has become one of the most successful mobile operators in the US, due to its innovative Un-carrier strategy which has included network, service, price, and other initiatives launched over the last four years. "Listening to customers and solving their pain points is what the Un-carrier movement is all about," says Neville Ray, chief technology officer of T-Mobile US.

The Un-carrier strategy has been guided by performance data in two interdependent ways: T-Mobile has carefully managed its financial performance to achieve efficiency in its network investments, while leveraging new technologies to generate actionable customer experience data. "For the network, listening to customers means monitoring our network performance obsessively every minute of every day," Ray says. "That is why we built a massive big data platform to collect as much network data as possible. This listening data tells us which improvements to prioritize and where to focus them."

One of the major network improvements has been network coverage. T-Mobile launched 4G LTE services in March 2013, more than two years after rival Verizon; but it achieved population coverage of 100 million by mid-2013 and more than tripled that to 322 million, nearly the entire US population, by end-2017. "The LTE coverage gap between T-Mobile and Verizon is a thing of history," Ray says.

T-Mobile US has used this much-improved coverage, as one of many initiatives rolled in its Un-carrier strategy, to dramatically improve financial results. Revenues increased 52% from \$24.4bn in 2013 to \$37.2bn in 2016, and EBITDA increased from \$4.9bn to \$10.4bn over the same period. This gain has

been achieved in an efficient manner: T-Mobile's capex saw only modest rises, from \$4bn in 2013 to \$54.7bn in 2016. As a result, operating free cash flow (FCF) margin, one of the key measures of a company's financial performance, more than tripled from 4% in 2013 to 15% in 2016.

Customer experience and results

T-Mobile's Un-carrier strategy and investment in LTE coverage have helped its mobile subscriptions more than double from 33 million at the end of 2012, to 71 million at the end of 2016. This led T-Mobile to pass Sprint in 2015 to become the third-largest mobile operator in the US by subscriptions.

T-Mobile US relies on third parties that measure and promote aspects of customer experience and satisfaction. One metric it cites is network download speeds; Speedtest.net shows T-Mobile's network has offered faster download speeds than Verizon and AT&T since 3Q15, with that its advantage has increased since Verizon and AT&T launched unlimited data plans in early 2017.

T-Mobile also cites data from OpenSignal, which publishes research based on nearly 6 billion tests from US mobile customers using its OpenSignal App. In January 2018, OpenSignal said T-Mobile won six of the seven categories it tracks for network experience – 4G download speed, 3G download speed, overall download speed, 3G latency, and 4G availability. AT&T won the other category – 4G latency.

T-Mobile US cites an independent customer satisfaction study by HarrisX Mobile Insights, based on a survey of more than 360,000 US mobile phone customers, where the carrier is ranked first, well ahead of Verizon and AT&T, and fourth-placed Sprint. "The secret for having the happiest customers isn't a secret at all," says John Legere, president and CEO of T-Mobile. "Listen to customers, fix their pain points, and give them a great deal and awesome coverage."

T-Mobile US identifies three fundamental drivers of its financial turnaround and success in delivering what it describes as "America's best unlimited network":

- To go faster, move faster: "Every meaningful network innovation in the last three years has come to Un-carrier customers first," Ray says. "All that new tech translates into lots of customer benefits increased voice quality, higher reliability, lower latency, better experience as well as increased speed." This strategic mandate has led the company to maintain and increase network quality, speeds, and features while offering unlimited data plans, and has supported a dramatic increase in subscriptions and improvement in financial results.
- Plan ahead: T-Mobile US says one advantage of being relatively late to market with LTE was it was able to plan ahead for future network upgrades by deploying the latest software-upgradeable network equipment. "We weren't the first with LTE, so we know we had to be the best," Ray says. It is doing the same with its current deployment of LTE in the 600MHz band, in that it will be software-upgradeable to 5G, which T-Mobile US plans to deploy in 2019.
- Listen: T-Mobile US says listening to customers has been the key driver of its hugely successful Un-carrier strategy. While one aspect of that is listening to customer directly via social media and other channels, T-Mobile also continually monitors customer experiences on its network to identify and fix problems. T-Mobile says it has built a big data platform to collect as much network data as possible, and then analyze that data to understand which network improvements will deliver the most value for customers, which in turn will translate into financial value for T-Mobile.

T-Mobile also uses crowdsourced data which is based on actual end-user experiences as part of its network monitoring and management. Sources include OpenSignal and Speedtest.net cited above. The carrier says that developing systems to assemble, analyze, and act on a huge volume of data generated by real end-user network experiences is key to developing competitive advantage from investments in its mobile network.

"Crowd data is essential because it tells us what real people are experiencing on the network in real situations with their devices in near real time," Ray says. "When you're obsessed with delivering the best customer experience, like we are, that's what really matters."

Proximus

Becoming a more efficient, customer-centric carrier through Smart Capex and analytics

Proximus is embarking on an initiative to determine how quickly its capex investments are monetized. Data analytics has proven key to maximizing the value they capture and the return the company is able to get from the investments.

Proximus is one of the leading integrated service providers in Belgium with a market share of 47% in fixed broadband, 37% in TV, and 43% in postpaid mobile in 3Q17 based on subscriptions. In 3Q17, Proximus Group EBITDA declined 2% year on year to €464m (\$579.3m) on revenues down 3.2% to €1.44bn (\$1.80bn).

Smart Capex is part of a broader push at Proximus to use a host of digital tools – including data, analytics, and applications – to generate more value from existing services. Another example is the group has updated its My Proximus application to report in real time customer mobile data consumption in the month, and to offer upgrades to larger data packages based on the latest usage data. The focus is "new ways to make sure we are monetizing data consumption," says Guillaume Boutin, chief consumer market officer at Proximus.

Network strategy and investment

Proximus partnered with Real Impact Analytics, a specialist in data analysis, to develop the software for Smart Capex, a data-driven, network-planning tool that features a broad suite of apps and is designed to work with any access technology. Proximus has already used Smart Capex to plan FTTH network rollout under its Fiber for Belgium initiative, a 10-year, €3bn (\$3.75bn) investment program through which Proximus aims to deliver FTTH coverage to up to 50% of the country. Now Proximus is planning to use Smart Capex in the expansion of its mobile network.

Smart Capex is designed to provide Proximus's management with strategic guidance on where to invest in order to maintain a sustainable and profitable business, and generate long-term value. The Smart Capex project works in a multi-technology environment, clearly maximizing the profitability of Proximus' fiber investment and legacy technologies such as copper. On the mobile side, Proximus plans to apply data analytics at a very local level.

Although a good ROI is the primary goal, Proximus is also linking its investment strategy to improved customer experience, by building more granular customer information: Knowing who customers are;

what they consume, where they consume; and how they consume. This customer information can be used to plan network development. Analytics is the key to improving both network investment and customer experience.

Smarter business logic

Smart Capex enables smarter business decisions linked to Proximus' long-term strategy, drawing data from 50 different sources, from which end users can validate the results every six-to-eight weeks.

Proximus expects that this will help it to achieve the following goals:

- Prioritize investment locations at the most granular level.
- Provide ROI measurements at each location.
- Build feedback and measurement systems on performance which link them to strategic objectives.
- Use Smart Capex as a competitive advantage.

Beyond financial metrics

Net present value is an extremely important metric; the operator needs to make financially sound decisions taking several drivers from different domains into consideration. Data sources such as customer profiles (customers rated according to their spend or status as influencers); customer experience metrics including network performance criteria, call quality, throughput, and handover; and sociodemographic information correlated to geolocation data are all integrated in an algorithm to increase the accountability and transparency of business investments.

MTN South Africa

Back to basics and forward to the future with analytics

MTN is combining a current pragmatic focus on network basics – coverage and call quality – to boost its market reputation, with a future-looking digital business sensibility which uses analytics of customer-generated data to guide its network investments in ways which enhance customer experience. Its new Ignite transformation initiative will use data analytics to improve decision-making relating to customers and networks. It also focuses on its NPS score, and particularly its network NPS, a brand equity measure based specifically on customer experience of network performance.

MTN South Africa is part of the MTN Group, which is the largest operating group in the Middle East and Africa, with operations in 22 countries across the region. MTN South Africa accounts for more than 31% of the group's revenue, and is the country's second-largest mobile operator, with 30.91 million mobile subscriptions – nearly a third of the country's total – at the end of September 2017.

Network strategy and investment

In 2016, MTN's management made a number of changes following what the company described as a period of underperformance in South Africa. This turnaround plan increases network investment in South Africa and other key markets, to enable further growth in data revenue. MTN increased its capex in South Africa to ZAR11.09bn (\$956.1m) in 2016, up a modest 1.3% on 2015, but almost double the figure of ZAR5.68bn (\$489.9mn) in 2014.

MTN also carried out what it described as an "aggressive" rollout of 3G and 4G sites in 2016, adding 1,134 3G sites and 1,538 4G sites during the year. MTN's data revenue in South Africa grew by 11.4% in 2016, which the company attributed to the improvements it had made in the quality and capacity of its 3G and LTE networks.

MTN continued to expand its mobile broadband network in 2017. In its results for 1H17, the company said that its South African unit had delivered an encouraging performance, with subscriptions up by 1.5% year on year, service revenue up 5.2%, data revenue up 18.5%, and digital revenue up 37.6%. EBITDA at MTN South Africa was up by 13.1% in 1H17.

MTN's strategy of expanding its mobile broadband network in South Africa has led to improvements in network quality and to a better commercial performance, and the latter is reflected in the rise in data revenue, said MTN Group CEO Rob Shuter in MTN's 1H17 results presentation.

In 2017, MTN unveiled a new strategy, BRIGHT, comprised of six "pillars" around which MTN plans to develop its business: Best customer experience; Returns and efficiency; Ignite commercial performance; Growth through data and digital; Hearts and minds; and Technology excellence. The choice of pillars shows that MTN is linking network and customer-related priorities in its overall strategy.

Customer experience and results

MTN was the second-ranked operator in South Africa in terms of NPS score at end-1H17, but it aims to become the highest-ranked operator through its new strategy, BRIGHT. MTN has made recent advances with its NPS score, as the company said that its NPS score in South Africa increased significantly in the 4Q16, rising by eight percentage points compared to the end-2015 figure, an increase at least partly due to improvements in network quality and capacity.

MTN also regards network NPS as an important metric. At end-1H17, MTN was the second-ranked operator in South Africa in terms of its network NPS score; but it aims to become number one on this measure too. Customers' experience of using data networks to download emails, browse the web, and watch videos increasingly determines their perception of network quality, and MTN says that it aims to provide its customers with what it describes as "quality data sessions," or a good overall data experience.

Shuter said MTN was "very focused on voice quality" in the company's 1H17 results presentation. Despite the growing importance of data networks, the quality of voice calling continues to play a big part in perceptions of network quality, and has pointed to a significant drop in 2G and 3G dropped call ratio fall in 1H17 to show that its voice quality is improving. Shuter has stated that technical processes in billing and customer support also contribute to perceptions of network quality, so the carrier continues to focus improvement efforts in its customer-facing processes.

In January 2018, MTN was rated as the best mobile network in South Africa by local publication *MyBroadband*, based on mobile network speed tests conducted across South Africa between October and December 2017. On a network quality score based on latency, upload, and download speeds, MTN scored 9.98 out of 10, followed by Vodacom with 9.38, Telkom with 6.72, and Cell C with 6.41.

Better customer experience through analytics

At the end of 2016, MTN introduced a new program, called Ignite, through which it aims to improve operational and financial performance. As part of Ignite, which was launched in MTN's units in South

Africa and Nigeria ahead of other operations, MTN aims to use data analytics to improve decisionmaking relating to customers and network deployment.

Vivo Brasil

Consistent investment in the network pays off in the long run

Vivo, part of the Spanish group Telefónica, is a converged operator and a longtime leader in the Brazilian wireless market, which has managed to retain its leadership in a heavily contested market.

Vivo has historically placed network quality at the center of its strategy, and has consistently promoted its network as the best in the country. This strategy has served Vivo well: It has never lost a market-leading position, managing to transfer its 2G and 3G leadership to Brazil's 4G market.

Financial results

Vivo reported revenues of €9.1bn (\$11.36bn) in the first nine months of 2017, a 14% improvement on 2016, when Vivo's financial performance was adversely affected by Brazil's macroeconomic problems which negatively impacted telecom service demand – from 2014 to 2017, for instance, the country's mobile market declined by 43 million subscriptions.

Despite the recent difficulties, Brazil remains one of Telefónica's most important markets: Vivo accounts for nearly 30% of Telefónica Group's total fixed, mobile, and pay-TV subscriptions. Furthermore, Vivo makes an important contribution to Telefónica's finances, and accounted for 23% of the Group's total revenues in 9M17, and 26% of EBITDA. Vivo also boasts an EBITDA margin of 35%, 3% higher than the Group's average. Telefónica makes substantial investments in Vivo's capex: €1.5bn (\$1.9bn) in 9M17, roughly 25% of Telefónica Group's total capex. While financial performance is a priority, projects are also assessed on their impact in customer experience.

Network strategy and investment

Over the past four years, Vivo's network spending has averaged €2.1bn (\$2.6bn) annually, much of which was spent expanding LTE and fiber networks coverage and capacity. Vivo is also undertaking a digital transformation project, to simplify and upgrade its IT systems. Telefónica operates with a three-year strategic planning process which links network investment initiatives to the company's overall strategic plan. Projects must be both financially sustainable, as well as enable superior customer experience.

The digital transformation project at Vivo is part of a broader program being carried out across the Telefónica Group. End-to-end digitalization is well underway, notably via Full Stack programs across six Latin American markets including Brazil. Telefónica has migrated 59% of customers in these markets to a single online charging system.

Telefónica has also created UNICA, an NFV model to virtualize network functions across its subsidiaries, in core network elements as well as to vRAN. Telefónica looks to UNICA to not only support an agile and cost-efficient infrastructure, but to prepare the company for the arrival of 5G.

A key objective of Telefónica's digitalization project is to improve customer satisfaction by investing in self-service tools and automation in sales, provisioning, and installation, payments and top-ups, technical support, and post-sales and care. The company expects this project to:

- increase the number of unique app users
- increase the interactions in digital channels
- reduce calls to call centers
- reduce orders with manual intervention and incidents.

Network business value outlook

During the 2017 edition of Mobile World Congress, the mobile industry's annual gathering in Barcelona, Spain, Telefónica unveiled what it calls its fourth platform, cognitive intelligence. Through cognitive intelligence, which is based on the application of analytics and big data, Telefónica aims to use the flow of data created by the company and its customers, to cut costs, improve customer experience, and develop new services. Telefónica says the new platform rests on the building blocks created by its first three platforms: Networks infrastructure as the first platform, IT systems as the second platform, and digital services as the third platform.

One example of Telefónica's use of cognitive intelligence is Aura, a virtual assistant developed in collaboration with Microsoft's AI team. Aura allows Telefónica to enable customers to manage their digital lives holistically, and have control over the data generated when using Telefónica's products and services. Aura will be available through multiple channels and its features will include making recommendations to customers based on their behavior.

Vivo is also applying big data and analytics to network management via three focus areas – network deployment optimization, network capacity planning, and end-to-end service quality management – to improve network management, reduce opex and capex, and allow faster deployments.

Vivo still uses traditional network performance indicators as metrics to understand its operations. The carrier's goal, however, is to increase the level of automation to handle these KPIs, given the volume of network data. The company also analyses KPIs with the highest impact in customer experience, concluding that downlink throughput when downloading files is the most important, followed by throughput in the uplink, followed by latency, and finally coverage.

The company also utilizes its own applications that simulate user behavior in the network, monitoring the performance of the most-used apps such as YouTube. Also, the call center has a back-office dedicated to resolve issues that are not solved in the first line of support, this data is also used by the engineering team to identify issues in the network. The focus on network quality impacts all aspects of the operation, including culture; for example, Vivo uses its values to screen candidates in its recruitment.

Toward network business value

Analytics links performance, experience, and value

The creation of a network business value ecosystem will enable DSPs to collaborate to improve their network and customer experience. This is supported by insights derived from advanced data science that allow DSPs to organize the sequence of importance of their own NEI/NPI.

Leading DSPs have nearly all the pieces in place to utilize their network experience data to undertake more effective network planning and commercial marketing strategies. Moreover, market conditions

are accelerating a sense of urgency, as customers' expectations of service levels grow exponentially, along with their ability to communicate their satisfaction (or dissatisfaction). There is still work to be done to create systems which integrates the insight gained from customer experience with a carrier's business performance processes – but this too is happening at speed.

A team of data scientists at Yale University, in collaboration with several leading universities in China, has been working with Huawei Technologies to develop a new analytical framework, using advanced network analysis techniques to identify the interconnections among various network experience and network performance measures. The main goal is to determine which metrics correlate to, and therefore can be influential on, carrier business decision-making. This analysis will deliver analytic hub nodes which can assist in prioritizing NEI/NPI measures.

These efforts have produced a two-layer network model to comprehensively describe the NBI-NEI/NPI relationship, using network per service per user data. In an experiment with more than 1,500 customer records supplied by China Mobile, the preliminary analysis reveals that network experience factors appear to influence more than 40% of customer interaction, with call completion ratio and comprehensive network coverage being the most significant factors. This model is one of an increasing number of quantitative approaches of connecting technical KPIs to customer satisfaction, to understand the network drivers of network business value realization, and create a framework for DSPs to prioritize operational and investment decisions to improve experience.

The state of play and the road to network business value transformation

There are explicit and implicit connections between a carrier's metrics of business value, and its network performance and experience measures. That said, most decision-makers within service providers have traditionally found it difficult to align detailed network indicators to business KPIs. This is changing, however, and quickly, as more effective tools to measure experience are developing and are being applied to business investment activities.

Carrier business KPIs are often aimed at increasing efficiency, ROI, and customer service cost reduction. This has swiftly shifted, as efficiency gains are now hard-coded in DSP operational strategy, and carriers are looking to achieve competitive advantage by improving customer experience. These too, however, are still linked to fundamental network performance; coverage, capacity and call quality are still such important metrics.

The availability of more granular customer data, and use of analytics to get more out of that data, allows DSPs to drive their business decisions through customer journey-defined metrics, and understand how this contributes to their brand equity. NPS thus continues to be an important driver.

It takes an ecosystem: Collaboration and network business value

While precisely quantifying how each specific technical or experience measure impacts business goals remains challenging, the future is clear: Modeling will begin to drive those linkages ever closer. Carriers cannot do this in isolation, however, and must avail themselves of a growing ecosystem to leverage best practices in the formulation of metrics and their use.

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