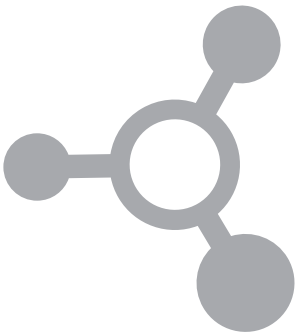
tmforum



Rakuten Mobile
NO ORDINARY TELCO

Author: Mark Newman, *Chief Analyst*

Editor: Dawn Bushaus, *Managing Editor*

June 2020

Sponsors:

allot
See. Control. Secure.

Netcracker
An NEC Company

Red Hat

tmforum

Contents

The big picture

Rakuten Group is a Japanese internet services company that has been dubbed "the Amazon of Japan". It offers a huge range of services from banking and credit cards to ecommerce, travel and video entertainment. Rakuten has 1.4 billion "members" worldwide, but the vast majority of its business is in Japan. Indeed, its efforts to replicate success in other markets have been mixed.

When Rakuten entered the mobile phone business as a mobile virtual network operator (MVNO) in 2014, it was not altogether a surprise. Many large retailers such as Tesco in the UK and France's Carrefour have been MVNOs for a decade or more. For them, mobile is another service they can offer to customers which can be bundled into loyalty programs and encourages visits to stores.

Building and operating a nationwide telecoms network is another matter entirely. Indeed, this is the first time that a "retailer" has constructed a mobile network in any major developed country. In April, Rakuten Mobile launched LTE service in Japan, becoming the nation's fourth mobile operator, but in May, the company announced that it will delay rolling out 5G until September because of the Covid-19 pandemic.

So, why did a retail giant decide to become a nationwide mobile operator? Does Rakuten see this as a genuine opportunity to run a profitable fourth mobile network in Japan? Or is diversification part of a bigger picture? For example, Rakuten Mobile could enhance the parent company's other businesses by driving more sales to its ecommerce, credit card or payments activities or by adding communications capabilities between customers and ecommerce sites.

To answer these questions, we draw on extensive interviews with Rakuten executives and the company's suppliers, along with in-depth research about the markets the company is targeting. Understanding the company's approach is important in assessing the prospects for its new mobile network business, where Rakuten Mobile fits within the larger organization and how the company will roll out 5G services.

Not a telco

Senior executives at Rakuten say they do not see the company as a telco. Rather the mobile business is part of the larger Rakuten services ecosystem. In many respects, expansion into the mobile network business can be viewed as a defensive play to counter growing competition with Amazon and SoftBank, which have eaten heavily into Rakuten's share of the ecommerce market.

In this report, we assess Rakuten as a whole, its businesses, culture and partner ecosystem, and focus on how they are impacting development of its mobile business. We also assess the prospects for a new operator entering the Japanese mobile market and the likely challenges it will face in carving out a significant market share. Finally, we examine the innovative approach Rakuten is taking to building its network and IT systems.

Read the report to understand:

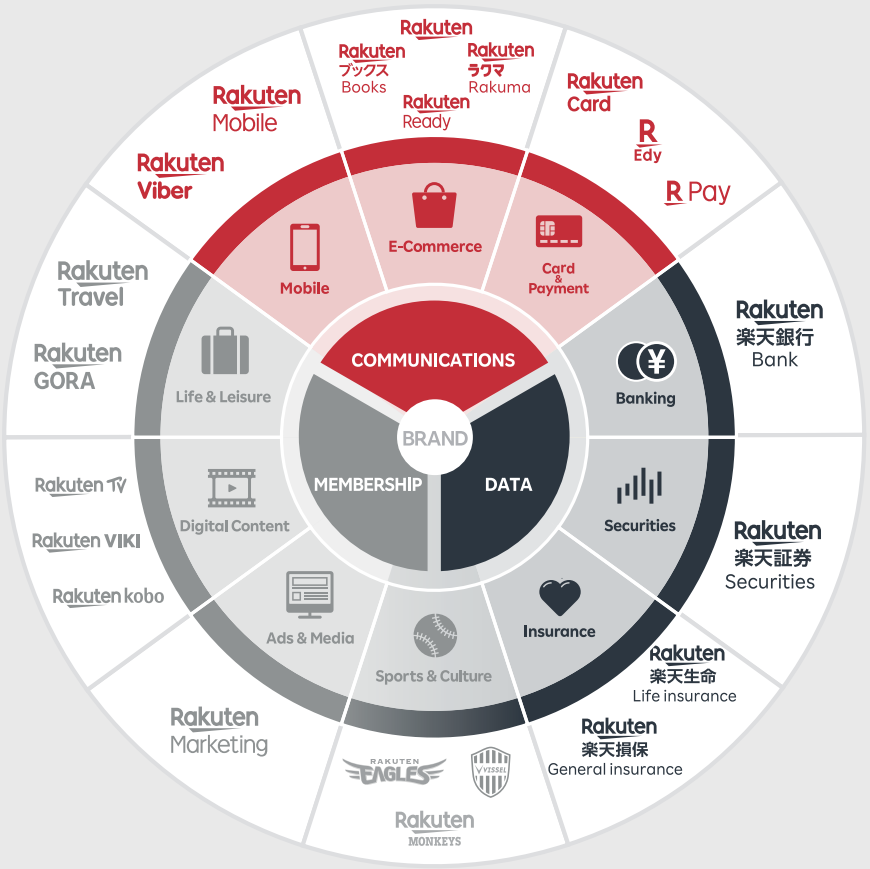
- How Rakuten is structured, how its partner ecosystem operates and the role Rakuten Mobile plays in its strategy
- The prospects for Rakuten in the mobile market with comparisons to new operators in other countries
- The unique cloud-based approach Rakuten has taken to develop its network and IT support systems
- How Rakuten is changing the relationship between CSPs and technology partners
- What other operators can learn from Rakuten's experience

Section 1

Rakuten's formula for success starts with loyalty

Rakuten Group's strategy focuses on building loyalty by treating customers as "members" and encouraging them to use multiple services that leverage a vast ecosystem of partners. When a member buys one Rakuten service, they are encouraged to join a membership program that offers discounts on future purchases. The more you use Rakuten, the more "points" you are awarded to redeem.

While many other retailers have points-based loyalty programs – including Japan's mobile operators – none have an ecosystem of partners as big as Rakuten's. Furthermore, Rakuten's presence is not limited to those merchants selling goods and services through its website. The company also has its own credit card called Rakuten Card. It is the leading credit card in Japan in terms of transaction value, and 80% of purchases are for non-Rakuten services. In addition, Rakuten Pay, the company's contactless mobile payments service, boasts 46 million users.



Rakuten's broad portfolio of services

The company operates more than 70 businesses spanning a broad range of online and offline services, from ecommerce to professional sports. By linking these diverse services through a common membership and loyalty program, the company has created a unique and robust ecosystem of partners.

TM Forum, 2020 (source: Rakuten)

Rewarding participation

Loyalty driven from Rakuten's points-based system is the main driver of customer experience, and persuading customers to use multiple Rakuten services drives creation of the Rakuten ecosystem. At the end of March 2020, 72.3% of Rakuten's customers were using two or more Rakuten services, up from 63.5% at the start of 2017.

Rakuten Membership, which gives customers the ability to get cash back on future purchases, drives them to buy multiple services. In the first quarter of 2020, Rakuten members spent ¥6.2 trillion ($58 billion) on Rakuten products and services, a 32.7% year-on-year increase.

The company has a goal of increasing members' spending (during an unspecified time) to ¥10 trillion and specifically states that the "mobile network operator business started in April is expected to contribute to the further expansion of enterprise value."

However, despite Rakuten's near ubiquity in Japan's retail landscape, its brand is not as strong as those of the country's three incumbent mobile operators: KDDI's au, NTT Docomo and SoftBank Corp. In its *Best 2020 Japan Brand Rankings*, Interbrand ranks NTT Docomo No. 6, SoftBank No. 11 and au No. 12, while Rakuten comes in at No. 19.

In terms of Net Promoter Score (NPS), Rakuten claims that its score increased by 5.1% in the period November 2018 to May 2019 and maintains that its NPS remains ahead of its two (unnamed) closest competitors.

Partners for mobile

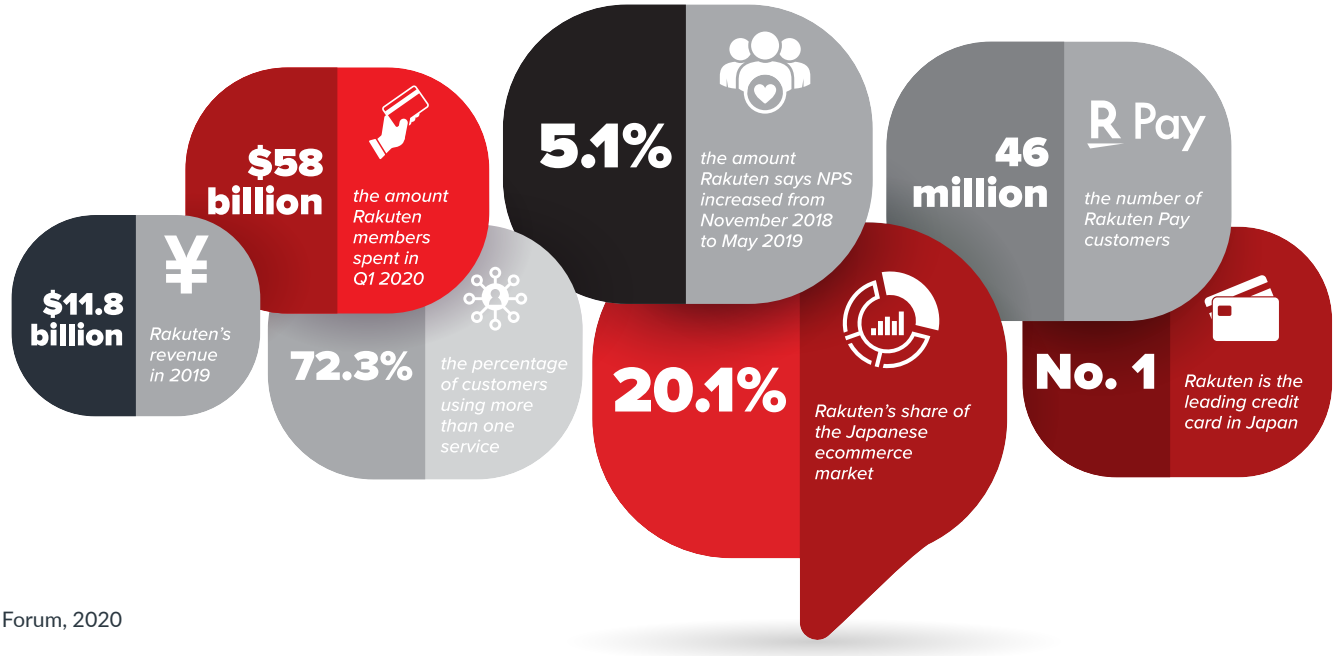
At first glance, most observers likely would characterize Rakuten as a B2C company, but this is not how the company sees itself. Its website states: "We support individuals, businesses and societies to realize their dreams."

Rakuten is often compared to Amazon. In 2018, Japan's External Trade Organization assessed that Amazon and Rakuten owned nearly exactly the same percentage of the country's ecommerce market (20.2% and 20.1%, respectively), but their relationship with brands that use their platforms are quite different.

Rakuten's approach is to have brands sell on its platform in a way that looks more like a partnership. Merchants can manage aspects of the ecommerce ecosystem such as inventory, logistics and customer service. By contrast, Amazon manages all these aspects on behalf of a partner selling in the marketplace.

> In short, Rakuten affords partners a level of control and personalization that Amazon does not. While Amazon is more like a "vending machine" experience, Rakuten feels more like a shopping mall where shoppers can visit a variety of stores.

Rakuten in numbers



TM Forum, 2020

A matter of logistics

To fulfill the goods purchased from the Rakuten shopping mall, the company operates its own logistics companies, Rakuten Super Logistics and Rakuten Express. In the past, consumers had to pay for shipping separately and became frustrated by the lack of total price visibility, so Rakuten responded by moving to all-inclusive pricing.

Rakuten also works with numerous merchants to help them implement points programs, payment options and ways to integrate data. This helps players such as regional supermarkets, bookstores, electronics shops and fashion shops deliver a better experience for their customers. As Rakuten CEO Hiroshi Mikitani explains in a LinkedIn blog post:

> “We can digitize their physical retail experience in ways that make physical retail a more convenient and pleasant experience for shoppers. We can even look ahead to options such as personalized pricing for customers or dynamic pricing that allows a convenience store to charge higher prices after midnight, to support the higher cost of keeping the store open at that hour. There are many ways that we as a data owner can support the work physical stores do every day.”

Is Rakuten overstretched?

Despite comparisons with Amazon, Rakuten is a fraction of the size. It is also much smaller than KDDI, NTT Docomo and SoftBank. This means it will be challenging for Rakuten to build a competitive mobile business, especially given the inevitable drag on the company’s profitability as it constructs the network.

Ranging from ¥926 to ¥937 (about $8.70) in mid-June, the price for shares of Rakuten stock, which are traded on the Tokyo Stock Exchange, sat at half their 2015 peak and have been trading at the same level (+/- 30%) for the last two years. However, despite the dip in share price revenues have risen 16.9% and 13.8% year-on-year during the last two quarters ending March 31 (the most recent of which was impacted by the Covid-19 pandemic). During these quarters, operating income rose by 19.1% and 3.1%.

There is no single reason why Rakuten shares have stagnated over the last couple of years. Some shareholders and observers have expressed concern that the company may be overstretching. For example, a huge effort has been made to take the company global: In addition to the takeover of existing ecommerce businesses in many countries, Rakuten spent $220 million on a sponsorship deal with Barcelona Football Club and $60 million sponsoring US basketball team Golden State Warriors.

The company also is sometimes criticized for a lack of focus. The umbrella company owns more than 70 businesses including its core ecommerce, credit card and insurance businesses. Rakuten is also an investor in several early stage internet, fintech, healthcare and ride-sharing companies (see below). As such, and given its expansion into the mobile network business in recent years, Rakuten shares some similarities with SoftBank.

How does Rakuten’s revenue and profit stack up to competitors?

	2017		2018		2019	
	Revenue	Profit	Revenue	Profit	Revenue	Profit
amazon	177.87	3.03	232.89	10.07	280.52	11.59
Rakuten	8.83	1.39	10.30	1.59	11.82	0.67
docomo*	44.54	7.40	45.27	6.21	43.49	5.53
KDDI KDDI Research	44.40	8.54	47.14	9.01	47.50	9.47
SoftBank	85.65	9.36	56.98	13.61	57.84	7.49

Figures are in US$ billions
*Profit attributable to NTT Docomo shareholders

TM Forum, 2020

Rakuten's Investment Business portfolio

Internet

Pinterest (IPO Exit)
SHOPBACK
OneSignal
carousell
from scratch
epic!

Ride sharing

careem
gojek
Lyft * (Affiliated Company)
Glovo
cabify

Fintech

BlueVine
Upstart
acorns
simplesurance
Currencycloud
folio
TORANOTEC

Healthcare

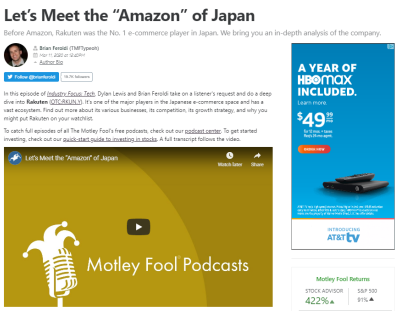
Rakuten Medical * (Affiliated Company)
airweave
Genesis Healthcare

* Lyft and Rakuten Medial were transferred from Investment Business in April and September 2019, respectively and changed from pure investments to strategic investments

In terms of the contribution of its various lines of business, the internet services segment represents a little more than half of total revenue and is growing at about 17%, while financial services represent about 35% of revenue, growing at 15%. Like Alphabet and its subsidiary Google, Rakuten is taking the profits from its core businesses and plowing them into other businesses to grow them as rapidly as possible.

With this snapshot of Rakuten's strategy as background, we'll take a look at the Japanese mobile market in the next section.

Listen to The Motley Fool's podcast about Rakuten's strategy:



Section 2

Japan: A mobile market of contradictions

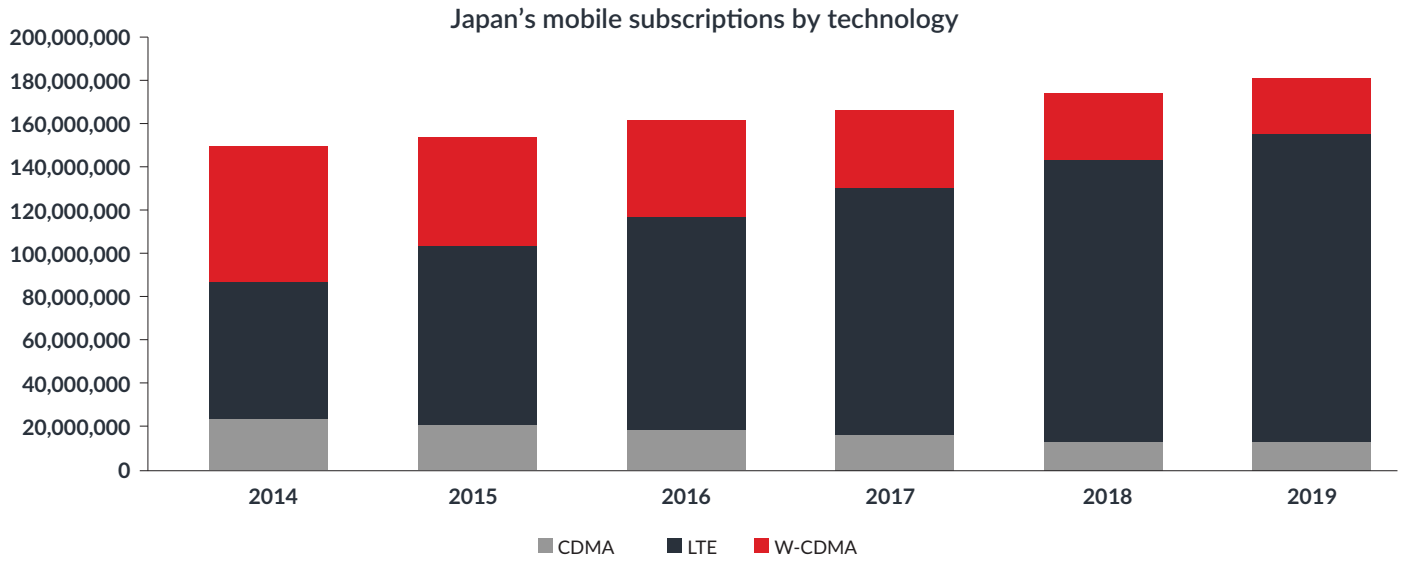
The Japanese mobile market is mature, with 144% penetration at the end of 2019. Given that SIM-swapping and multi-SIM devices are extremely uncommon, the high penetration rate largely results from people owning more than one device, typically one for work and one for personal communication. Three fourths of connections are LTE, and strong growth in 5G is expected through 2023 as Japanese mobile operators seek to move heavy data users onto new networks.

Until Rakuten's launch in April, the country had three mobile operators: NTT Docomo, KDDI's au and SoftBank Mobile. NTT Docomo dominated the market for many years, enjoying a share well in excess of 50%, and although the company's share has now fallen to 44%, this percentage has been fairly stable for the past few years. The second-largest Japanese operator, KDDI's au, has picked up a small share from SoftBank Mobile.

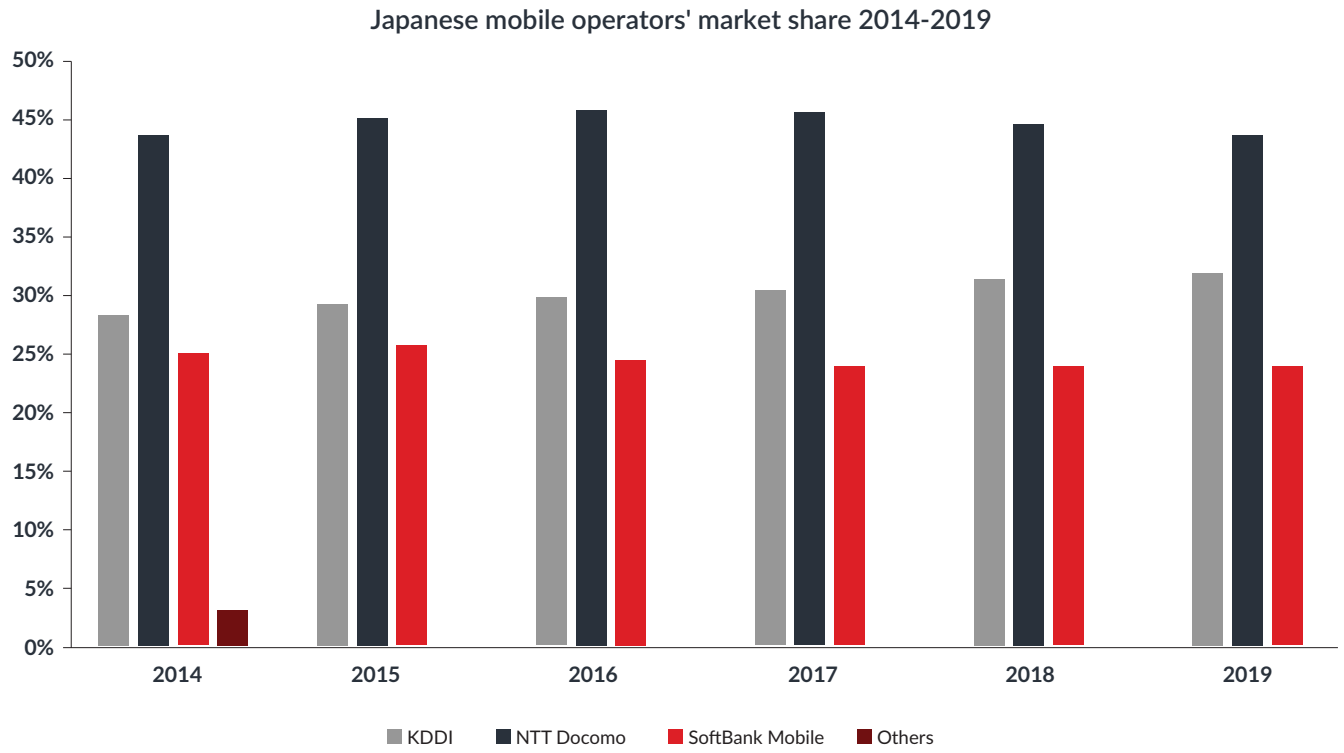
There also has been an explosion in the number of mobile virtual network operators (MVNOs) in the last two to three years, with up to 50 companies now selling SIM-only services. They account for roughly 10% of total Japanese mobile subscriptions, and Rakuten Mobile is the largest of Japan's MVNOs. The graphics below and on page 9 show the number of subscriptions by technology and market share for the Big Three operators.

A tough market

Even though Japan's mobile market is stable today, not all efforts to enter have been successful. For a brief period between 2001 and 2006, Vodafone owned Japan's third mobile operator before selling to Softbank. The telco's decision to leave Japan was attributed to an unsuccessful rollout of 3G and subsequently providing inadequate mobile phones, which alienated subscribers.



TM Forum, 2020 (sources: World Cellular Information Service and Omdia)



TM Forum, 2020 (sources: World Cellular Information Service and Omdia)

Indeed, the Japanese mobile market presents contradictions. On one hand it has been slow to follow the same global trends as other developed markets. For example, the iPhone and Android ecosystems took a long time to take hold in Japan because operators built their content ecosystems around domestically manufactured clamshell feature phones that were included in customers' contracts. However, bundling many services into the mobile subscription – an approach that's now in vogue worldwide – has been a feature of the Japanese market for the last 25 years.

As such, when Rakuten seeks to bring its own service and commerce system to Japanese consumers, it must contend with the stickiness that rival operators have already generated by allowing their customers to buy a range of digital and non-digital services. This stickiness is the main reason for the operators' low churn rates. We estimate that churn varies from between 0.5% per month to 1% per month in Japan, which is much lower than the global average of around 2%.

> Average revenue per subscriber (ARPU) in Japan is among the highest in the world at $35 to $40 per month, and there has been minimal erosion in recent years because operators have been successful in shifting customers to large data buckets or unlimited pricing plans.

However, subscribers realize that their mobile services are expensive. Indeed, the government has been trying for the last two years to bring down the cost of mobile ownership and usage with initiatives including:

- Awarding a fourth mobile operator's license to Rakuten
- Forcing open the MVNO market
- Urging mobile operators to cut their prices
- Putting an end to early termination fees

The 50 SIM-only MVNOs that have exploded onto the scene offer data-heavy pricing plans starting from $15 per month, which are proving particularly attractive to younger people. Online forums are full of comments from Japanese users who switched to an MVNO and are now spending a third or less what they spent previously on two-year device-plus-phone contracts.

NTT Docomo, KDDI and SoftBank also have cut their prices. In October 2018 the Japanese government said that the operators "had the potential" to cut their prices by 40%, so the Big Three responded by increasing new, lower-priced services and unbundling devices from subscriptions.

However, this has not resulted in a signification decline in ARPU. Most people continue to buy their phone as part of a contract, with many professional people opting for high-end plans that offer unlimited data and regular device (iPhone) upgrades.

On a global level Japan ranks above average in terms of pricing. Analysis by research firm Cable.co.uk ranks Japan 137th out of 228 countries when comparing the average cost of 1GB of mobile data (see below). This puts the country roughly in the middle of the pack when compared to large European and developed Asian economies.

Comparison of global mobile data pricing (shown in US dollars)

Rank	Country	Average price of 1GB 2019	Average price of 1GB 2020	Cheapest 1GB 2019	Cheapest 1GB 2020
1	India	0.09	0.26	0.02	0.02
4	Italy	0.43	1.73	0.18	0.09
12	China	0.61	9.89	0.87	0.14
30	France	0.81	2.99	0.17	0.11
59	United Kingdom	1.39	6.66	0.26	0.22
95	Singapore	2.47	3.67	0.37	0.47
101	Hong Kong	2.55	4.00	1.01	0.62
137	Japan	3.91	8.34	1.04	1.07
140	Germany	4.06	6.96	1.88	1.36
176	Taiwan	5.91	9.49	1.03	0.64
188	United States	8.00	12.37	1.50	2.20
191	Switzerland	8.38	20.22	8.30	1.68
202	South Korea	10.94	15.12	0.47	0.43

TM Forum, 2020 (source: Cable.co.uk)

Perhaps the most interesting comparison is with South Korea which has market traits like Japan's: Both countries have advanced infrastructures with similar adoption rates, and operators have successfully built new revenue streams from value-added services. According to the analysis, the price of mobile data in South Korea is twice that in Japan because of a lack of competition.

The pricing comparisons also reveal some changes between early 2019 and May 2020. In most cases the price of 1GB of mobile data fell significantly during this period, and Japan is no exception with the average price of mobile data falling by half (although the cheapest price for mobile data remained almost the same).

However, only NTT Docomo appears to have been affected negatively by price cuts. Its revenue for the fiscal year ending in March 2020 slipped by 3.9%, and profits were down by 10.9%. KDDI and SoftBank, conversely, saw their group profits hit record highs. KDDI's operating profits rose 1.1% (and operating revenue by 3.1%) while Softbank's operating profits rose by 11.4%.

Driving loyalty

All three Japanese operators are established players, and none uses pricing as the primary way to gain market share. Indeed, pricing is so complex that it's difficult to accurately compare the Big Three. All three focus on signing up postpaid customers to two-year contracts with bundled devices and offering them a range of services and benefits to drive loyalty, including:

- Bundled value-added services, such as content and lifestyle services, magazines, video, emojis and children's games
- Loyalty schemes offering discounts on purchases of third-party goods and services (for example, discounts in stores such as Lawson, a chain of grocery stores
- The ability to pay for goods and services using your mobile phone

In addition to offering mobile bundles, all three operators also bundle fixed broadband and TV (IPTV or cable TV services). However, take-up of TV services has not been as rapid as in some European markets.

Since March 2020, all three Japanese operators have launched 5G services. The early signs are that they will not charge a premium for 5G and will lure customers by offering new value-added services that leverage 5G's benefits such as virtual and augmented reality games and video. All three operators are also seeking to expand their presence in B2B markets.

Rakuten launches Un-Limit

Rakuten launched 4G service in April with a single plan called Un-Limit, which costs ¥2980 ($28) per month, including unlimited data in areas where it has its own network (Tokyo, Nagoya and Osaka) and 5GB per month where it does not (Rakuten Mobile has agreed a national roaming deal with KDDI's au for other areas until it has completed its own national rollout in 2026). The company's launch of 5G has been delayed until September because of the Covid-19 pandemic.

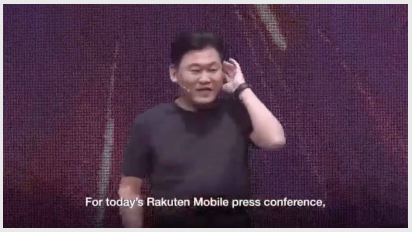
Once a customer reaches the 5GB limit, speeds are either reduced to 1Mbps or customers can buy additional data for ¥500 ($4.67) per gigabyte. Voice and messaging are free using Rakuten's IP-based service called Link (including domestic calls and SMS to non-Link users), but calls made using the voice-calling screen icon and without Link incur charges.

For users in Tokyo, Nagoya and Osaka, these prices represent significant savings over the other operators. For example, NTT Docomo's "Gigaho" plan, which was launched in October 2019, is specifically designed as a low-cost plan for heavy data users. But a two-year, one-person Gigaho contract including 30GB of data costs ¥6,980 ($65) per month – more than twice the price of Rakuten Mobile Un-Limit. Furthermore, in an effort to build momentum in the market, Rakuten Mobile is offering its service for free for one year to the first 3 million customers who sign up.

Besides cost savings, Rakuten Mobile's value proposition comprises:

- A richer suite of voice and messaging services than other mobile operators. Rakuten's Link could be considered an attempt to offer a service like WhatsApp, but the difference lies in the interconnectivity between Link and fixed and mobile phone users not on Link. This allows someone who makes a call using Link – regardless of whether it is a domestic or international call – to break out on the PSTN.
- Rakuten has launched its own device, the Rakuten Mini which measures just 10.6cm by 5.3cm, and other new "unique" devices are planned. In addition to creating a differentiated form factor, the Rakuten Mini has been designed to make it easy to use Rakuten Group services.
- Full integration with Rakuten's existing "points" loyalty scheme. For example, Rakuten customers who activate Link will receive ¥3300 ($28) worth of Rakuten Points that can be used to make purchases on Rakuten's shopping website.

Watch Rakuten's Un-Limit press conference:



Startups in other countries

While it is unusual for companies to build greenfield mobile networks, a handful of startups have been successful in other countries, some more so than others.

Reliance Jio launched as a mobile operator in India in 2016 and has since become the country's largest operator with 387 million customers and a 36% market share. Jio is part of Reliance Industries, India's largest company by revenue and profit.

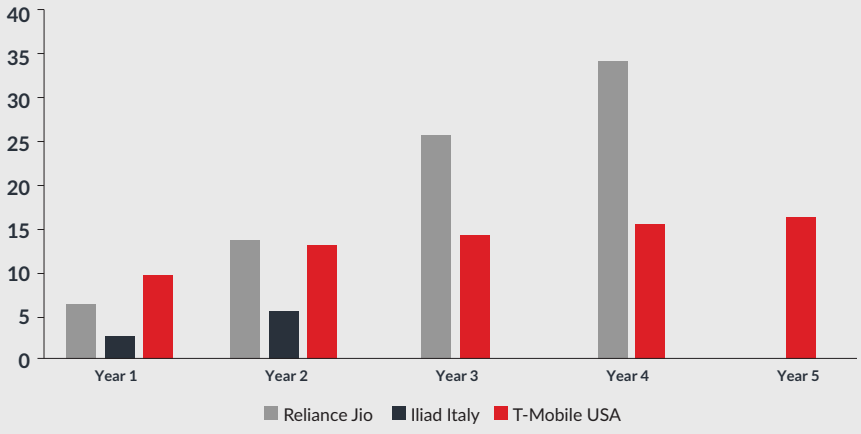
Iliad, a French company, entered the mobile market in Italy in 2018 quickly becoming Italy's fourth-largest operator, but the company has struggled to gain market share despite an aggressive pricing strategy (€5.99 per month with 30GB of data and unlimited SMS messages). At the end of 2019 Iliad had 5.8 million subscriptions, equivalent to 6.3% of the market.

Tele2 became the Netherlands fourth mobile operator in 2015, but the business was sold in 2017 to T-Mobile Netherlands, one the country's existing three operators.

T-Mobile USA is different from the other startups because it was formed in 2001 following the acquisition of two existing operators rather than as a greenfield brand. However, it is worthy of inclusion in this analysis because in the last 10 years, the company has managed to break the stranglehold of incumbent operators AT&T and Verizon. At the end of 2019, T-Mobile USA had 88 million subscribers and 17% market share.

The graphic below compares market share for Jio, Iliad Italy and T-Mobile USA for each year of their existence. Jio clearly has been most successful with a steady and dramatic increase from 2016 to 2019.

Market share for mobile startups for each year of their existence



Data for Reliance Jio is from 2016 through 2019; Iliad's is from 2018 and 2019; and T-Mobile's is from 2012 through 2016 when the company successfully turned its business around

TM Forum, 2020

Lessons learned

The spectacular success of Jio offers every new market entrant confidence that it is possible to carve out strong market share, but the company is the exception rather than the rule. It is extremely difficult for a challenger to compete with incumbent mobile operators, particularly in a market as mature as Japan.

Most startups steal market share by offering lower prices. In Italy, Iliad's initial offer was €5.99 for 30GB of data plus unlimited voice calls and text messages. This was less than half of the price of similar plans available in the market. Jio took an even more radical approach, offering voice and SMS for free and mobile data pricing that was one fifth the rate charged by competitors. Over time, however, Jio has steadily increased prices.

Customer experience is also a competitive differentiator for new players. They may highlight transparency, simplicity, the ease of using digital channels or they may offer value-added services. Reliance Jio, for example, has built a large portfolio of apps to offer alongside its LTE data services. Mobile operators generally are transitioning to a smaller number of pricing plans, with new greenfield operators only offering two or three data-centric packages.

Finally, clear brand proposition is important. In Italy, Iliad has presented itself as a simple, easy-to-understand no-frills brand. In the US, T-Mobile called itself "the Un-carrier" in an attempt to position itself as an outsider capable of addressing customers' dissatisfaction with services provided by incumbent operators. Jio focused on data: India was still a voice-centric market when Jio launched, and right from the start Jio made it clear that its mission was to bring mobile data and value-added services to the market.

In the next section we'll look closely at how Rakuten aims to differentiate itself in the Japanese market and how the company is using cloud native technology to power its network and operations.

Section 3

A (very brief) history of Rakuten Mobile

Rakuten's journey toward launching a fully virtualized 5G mobile network started in 2014 when the company entered the Japanese market as a mobile virtual network operator (MVNO) in effort to expand into telecoms and TV. In the same year Rakuten bought IP voice and messaging provider Viber for $900 million, and by 2019 the company had become the leading MVNO in Japan with an 18% market share. Today Rakuten has 2.3 million MVNO customers in Japan and wants 70% of them to switch to the Rakuten Mobile network before deciding when to retire the MVNO offer.

Rakuten made its pitch for a full mobile network operator's license in December 2017, and synergies with the parent company's core business were a key driver right from the outset. "There is no doubt that mobile devices are the most important user touchpoint for the expansion of existing services and new service development," the company said in a statement when announcing its plans. The parent company's share price fell by 4.9% afterwards, with financial analysts expressing skepticism about Rakuten's ability to launch a successful mobile business in such a mature market.

The house Tareq built

Rakuten was approved as Japan's fourth mobile operator in 2018, and it was at Mobile World Congress in February of that year that Rakuten CEO Hiroshi Mikitani met Tareq Amin, who was then Senior Vice President of Technology Development at Indian mobile startup Reliance Jio. Amin joined Rakuten later in 2018 and is now the company's Chief Architecture Officer with responsibility for constructing the mobile network.

Before Amin came onboard, Rakuten had planned to tap Huawei to build the mobile network, but Amin had other ideas. At Jio he had been developing a vision for a cloud-based mobile network.

"In terms of my overall vision for building [Rakuten Mobile], I have had a vision for what a cloud network would look like since my time in Jio," Amin explained in a lengthy interview for this report. "However, at the time I was not sure that the technology I needed was mature enough."

Moving to Rakuten gave him the opportunity to put his ideas into action. When Mikitani first started talking about Amin's vision, the company's plans were characterized as "more like something from Netflix than something from Vodafone."

> "The telecoms world is finding it hard to change," Amin says. "It has a heritage and a history that goes back 40 or 50 years." By contrast, Amazon and Google have capabilities that "far exceed what we have today in telecoms," he adds.

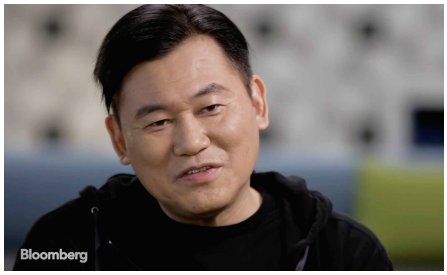
Rakuten's Tareq Amin

In Amin's appearances at industry conferences, or in press interviews, he frequently says, "We see ourselves as an IT company," not a mobile operator. He is mainly referring to the cloud native approach the company is taking to build its network, but the statement also applies to the overall culture of Rakuten.

Amin wants Rakuten Mobile to be more like a webscale company than a telecoms operator.

"One of the reasons I decided to join Rakuten is because I felt that the DNA of the organization did not come from telecoms," Amin says. "The company is an internet services company with expertise in areas such as fintech, banking, ecommerce and travel – there are 71 group companies. The big question for me was how to tap into the group company as a whole and leverage their development capability."

Watch Rakuten CEO Hiroshi Mikitani explain how he chose the company's partners:



Key ingredients for Rakuten's revolutionary network

When Amin began developing Rakuten's mobile network, he was not sure whether the technology he needed was mature enough, but he knew it must include the following:

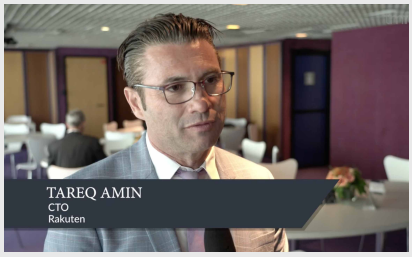
Virtualized radio access – Radio access network functions must be virtual network functions for "operational simplicity" and to reduce the need for field operations. Rakuten Mobile's base stations contain only an antenna and a remote radio head. Everything else is abstracted as software at the edge. "Traditionally it takes two to three days to activate a base station because they have customized software and hardware," notes Amin. Now, for me to instantiate one virtual machine VM to activate the base station takes eight and a half minutes." The maintenance of base stations is minimal. When there is a fault the server blinks red and a field engineer has only to replace the blade.

An open network – Rakuten does not have any "black boxes". Every interface is open and there is no vendor lock-in. Telecoms operators have traditionally bought pre-packaged network and IT systems from vendors with no scope to open them for alterations or swapping components.

Edge deployments – Amin insists that the Rakuten architecture must support a mix of the right edge deployments. Today Rakuten Mobile has close to 300 edge data centers. It co-locates its IT racks in these data centers and deploys vRANs as an application.

Ruthless automation – Automation is part of Rakuten's culture. All the executives we interviewed stressed the company's focus on driving it across all aspects of its business.

Watch Amin explain Rakuten's approach during an interview at Digital Transformation World 2019:



Time to evolve

Although the word "architecture" is in his title, Amin points out that his focus is more on the business side of Rakuten Mobile. He is keen to talk about the humility and accessibility of the parent company's senior management team, with whom he has daily "huddles" to discuss all aspects of the business, from strategy to technology and branding. The point is to use cross-functional and cross-departmental teams and leverage capabilities across the entire business.

When Amin arrived in Japan in June 2018, the mobile business had only 10 employees. His first step was recruiting a DevOps team.

> "I wanted people that know IT really well," Amin says. "I don't want people who have been in telco for 30 to 40 years. I was building something adventurous. I thought it was time for telecoms to evolve."

Most of the people Amin recruited are cloud architects, cloud engineers and software developers. There is no middle management, which means he has 28 people reporting to him directly.

"We wanted agility in decision-making, in the ability to take corrective action," he says. "The speed of doing things here is unreal. We take the view that 15 people in a team is maximum and is probably too big. We want small, nimble teams. There is no bureaucracy, and we are all completely open and available."

The managers we spoke to in the technology division at Rakuten Mobile all paint a similar picture of diverse and young employees who are often under 30. Sagiv Draznin, VP of Operations, notes that 40 nationalities are represented in his team, and many teams employ recent graduates (one person we spoke with says he has seven graduates on his team). Across the group people are working on projects and challenges that take them way out of their comfort zone.

Not far from the tree

Rakuten Mobile is very much part of the parent organization – it is not a subsidiary. From an organizational perspective, Amin heads up the Global Architecture Division alongside other functions such as finance, marketing, operations and ad sales.

Specific examples of how Rakuten Mobile leverages its parent organization (and vice versa) include:

1. Rakuten Mobile will use Rakuten's mobile identity system for its own customers and a single authentication system will allow customers to access different services from their Rakuten Mobile device.
2. Rakuten "members" will receive points for using the Rakuten Mobile service and vice versa.
3. Rakuten Mobile has already leveraged the relationships that its parent company has forged with merchants across Japan as it has acquired sites to house its base stations. This includes relationships with hotels through its Rakuten Travel subsidiary. Passive infrastructure costs largely comprising the cost of finding and using sites for base stations represents the majority of total capex.

In the next section, we'll look at how Rakuten Mobile went from concept to launch in less than three years.

Section 4

Rakuten's big bet on virtualization and cloud

Rakuten has built a carrier-grade mobile network based on network functions virtualization (NFV). It demonstrates the viability of a virtualized, cloud native, multi-vendor network based on 3GPP 5G standards, and Rakuten Mobile is the first mobile operator in the world to build a radio access network using Open Radio Access Network (O-RAN) technology.

These are the principles that define the company's approach:

There are no "black boxes" – everything runs on commercial-off-the-shelf hardware.

Everything is virtualized, and over time applications will move to Rakuten's own cloud connectivity platform to become cloud native.

Edge computing is key. Rakuten plans to deploy 4,000 edge data centers throughout Japan enabling 96% population coverage by March 2026.

Network and operations environments are multi-vendor. Rakuten is working with several traditional suppliers such as Nokia and Cisco as well as smaller startups such as Robin.io.

Requests for proposal are not used to procure technology. Instead, Rakuten identifies potential partners with interesting technology and reaches out to them on a case by case basis.

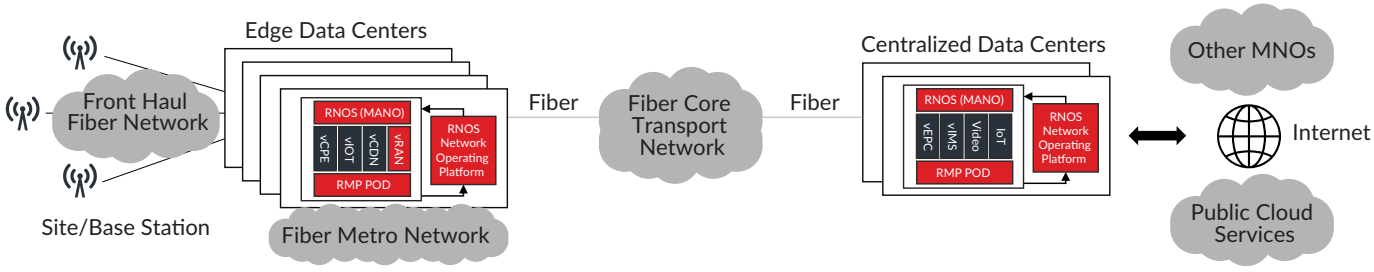
Rakuten handles some integration internally but more often, suppliers are required to do their own integration.

The graphic below shows how Rakuten envisions future networks and illustrates the success factors and benefits associated with it.

Rakuten's view of future networks

Success factors		Benefits	
Virtualized, decoupled RAN architecture	Standardized, open hardware and software frameworks	Reduced site equipment through virtualization	Lower latency through optimization of network locations (edge vs. central)
Optimal mix of edge and centralized data center resources	Pervasive automation and zero-touch control	Reduced capacity requirement through pooling and orchestration of resources delivering more with less	Reduced site leases, maintenance/ site visits, operations, and power usage through less equipment at sites

Example of future mobile network



Is it cloud native?

While Rakuten executives often describe the company's network as "cloud native", it is questionable whether that label should apply when vendors such as Nokia and Cisco are providing software and services that are tightly integrated. It is not clear that their network elements could be broken down into smaller components and then swapped out.

"This seems more of a classic 'best-of-breed' implementation than a fully open, multi-vendor situation and to some extent, replicates much of the vendor lock-in that the industry is trying to do away with," writes Yesmean Luk, Senior Consultant at research and consulting firm STL Partners.

Rakuten is, however, taking a disaggregated approach to deploying its RAN by using O-RAN technology, which is built entirely on cloud native principles. Rakuten has worked closely on O-RAN with Boston-based Altiostar in which it has a stake. Altiostar claims to be the first company to virtualize the RAN and develop cloud native, containerized radio access technology.

Altiostar contends that this will "allow service providers to develop 5G services that are even more responsive to consumer needs over their entire network deployment lifecycle" and claims that its vRAN software "dramatically improves the economics, deployability and scalability of 5G RANs."

Automated operations

Rakuten's operations support is designed for automation, and Tareq Amin, the company's Chief Architecture Officer, thinks the term "OSS" is unworthy of the platform the company is developing because operations have been automated.

As Tim McElligott, Senior Analyst at TM Forum, explains, "Traditional functions within OSS remain the same – FCAPS (fault, configuration, accounting, performance, security) as well as inventory, RF planning, work order management, analytics and more. However, Rakuten means to eliminate the mediation layer by relying on open adapters [APIs] and a single Hadoop big data architecture leveraging AI and machine learning built into a platform that is completely closed loop and ties all these OSS functions as well as IT functions together. Rakuten believes this will reduce fragmentation and support the efficient management of its cloud platform."

'The horizontal layer that touches everything'

Operations plays a high-profile role in the Rakuten Mobile business. Sagiv Draznin, the company's VP of Operations, was previously with Verizon, where he was head of packet core development. At Rakuten, he explains, operations is "the horizontal layer that touches everything," and he applauds Amin for his foresight in recruiting someone with a background in software architecture to lead operations.

Draznin arrived at Rakuten in mid-August 2019. Until then the company had been in build mode, "Rakuten 1.0" as he describes it. "When I arrived we shifted to Rakuten 2.0 and how to operate the network," he says.

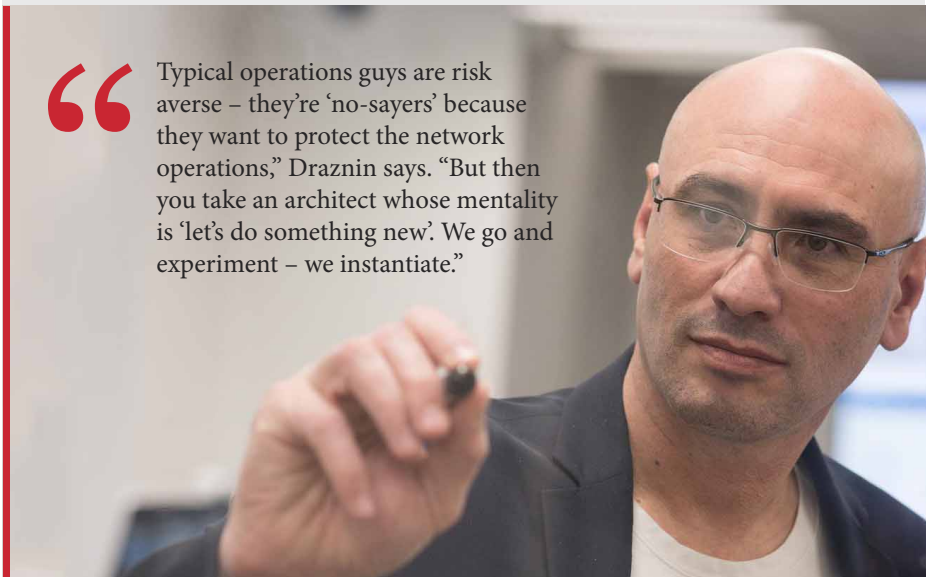
Developing a service experience center was one of Draznin's first tasks, and to do this he used an approach called Site Reliability Engineering, a discipline that Google developed to apply software engineering to infrastructure and operations challenges. Like many other executives at Rakuten Mobile, he learned on the job.

"I didn't know Google SRE," Draznin explains. "But I am an explorer and I learned it out of a book."

This approach is fundamentally different from the traditional telecoms approach, in which "network operations has mainly been about getting vendors to do stuff for you," Draznin says, adding that he sees operating in the cloud as "the new frontier".

Key focus areas for Draznin over the next one to two years will be shifting from OpenStack to Kubernetes and containers. His vision also includes the use of AI and machine learning to drive automation. Rakuten Mobile has already set up an AI Operations team to head in this direction.

> "Typical operations guys are risk averse – they're 'no-sayers' because they want to protect the network operations," Draznin says. "But then you take an architect whose mentality is 'let's do something new'. We go and experiment – we instantiate."



Rakuten's Sagiv Draznin

Cloud-based BSS

For Rakuten, mobile communications is simply another service the company provides to members and another channel for its rewards and cashback platforms. Like customers of any of Rakuten service, mobile customers are given a member ID that allows them to move between different products, services and websites.

Because its loyalty program includes many partners, Rakuten wanted a cloud-based partnership management and reconciliation solution for the mobile business. The company is partnering with Netcracker for a digital business support system (BSS) platform that offers a 'Blueprint' for out-of-the-box customer journey templates, business processes, functional capabilities and pre-configured 'Sandbox' software to visualize the solution and define key performance indicators.

Through a series of workshops, Rakuten and Netcracker identified more than a thousand functional capabilities critical to the enablement of new business processes as part of the mobile services rollout. The aim was to validate the out-of-the-box solution and capture process deviations to identify additional or new functional capabilities. Rakuten found that most capabilities were covered out of the box, which meant a dramatically shortened development and testing phase.

No RFPs

Rakuten does not use traditional requests for proposal to procure network and IT technology. Rather, the company seeks out the best vendors on its own. In many cases, Rakuten executives reach out to companies they've worked with in the past. As the VP of product marketing for one of its suppliers explains, "They target vendors that they find interesting."

A traditional RFP process sends the message that the communications service provider (CSP) knows exactly what it wants and needs. The vendor's job is simply to meet these requirements. While Rakuten Mobile certainly has an idea of what it is looking for, it wants to learn about new or unique capabilities vendors may have.

"They expect you to be visionary, to come to them with offers and ideas," says the VP. He contrasts this approach with telecoms operators more generally. "With other operators, you're not free to pitch ideas. Most large operators have no interest in half-baked solutions – they are just not set up for small cycles of innovation."

"They expect you to be visionary, to come to them with offers and ideas," says the VP. "With other operators, you're not free to pitch ideas. Most large vendors have no interest in half-baked solutions – they are just not set up for small cycles of innovation."

> "The approach Rakuten is taking fundamentally changes the CSP-supplier relationship. "We are more partners than customers," the VP says. "We work with them every day and have a weekly meeting and we are always working on new ideas. There are things that we can learn and implement with them that can then be implemented with other operators. We have a trusted advisor type of role."

This is not to say that working with Rakuten is easy. The company does not employ systems integrators, so vendor partners must be prepared to do their own integration. Often this can mean working directly with competitors. The vendors that we spoke to recognized that this was not always easy and that senior Rakuten technology managers did make themselves available when it was difficult for vendors to come to a solution between themselves.

In the next section, we'll look at Rakuten's future plans, which include launching 5G in September.

To learn more about how the relationship between CSPs and suppliers is changing, read this report:

Section 5

5G: Just another service?

There has been huge interest in Rakuten Mobile's 5G rollout, so when the company announced in May that it will delay the launch of 5G until September as a result of disruption to its supply chain because of the Covid-19 pandemic, there was speculation about whether the delay was really because of the difficulty of building a 5G network.

In truth, Rakuten is not attributing as much significance to the 5G rollout as observers are – at least not when it comes to new revenue streams.

> "My big question is why we as an industry pursued 5G so aggressively," says Tareq Amin, Rakuten's Chief Architecture Officer. "Is it really delivering in terms of new business models?"

This is not to say that 5G is unimportant to Rakuten's evolution. The company needs to launch 5G services because of its relatively small LTE spectrum allocation. Rakuten only has 20MHz paired spectrum at 1.7GHz, but it has a further 100MHz in the 3.7GHz band and 400MHz in the 28GHz band for 5G.

While Rakuten has not divulged which 5G services it is developing for the B2B market, the company is a true evangelist when it comes to building a network and support systems that enable it to capitalize on new opportunities, whatever they may be. From a technology perspective, 5G represents the adoption of a fully cloud native architecture.

Rakuten's 5G network uses containers rather than virtual machines, and while the company will continue to use solutions from some of the vendors supporting its LTE service, such as Altiostar, it also is bringing in new, smaller partners. For example, it is working with the Silicon Valley startup Robin.io, a five-year-old company with about 60 employees, to build its NFV container-based infrastructure.

Edge computing is also key for Rakuten. Edge data centers are a cornerstone of the business model and technology roadmap for 5G, and they already feature in the company's LTE network. 5G edge and adherence to 3GPP's multi-access edge computing (MEC) specification are an evolutionary part of Rakuten's strategy. Indeed, the company plans to build 4,000 edge data centers throughout Japan enabling 96% population coverage by March 2026. These centers will house multiple base stations and MEC systems.

Targeting other markets

Along with rolling out 5G, Rakuten plans to expand by selling the platform technology it is developing. Amin has made no secret of his ambitions to take Rakuten Mobile's technology capabilities into overseas markets. He intends to market a solution called Rakuten Communications Platform (RCP), which the company describes as "a platform aimed at offering solutions and services for the deployment of virtualized networks at speed and low cost by telecoms operators."

> "Over the past 13 months I have hosted 100 mobile operators in Japan, and we discussed future possible collaboration," Amin says.

"Most of them said the same thing – that they lacked skills regardless of whether they were Tier 1, Tier 2 or Tier 3. They recognized that they were behind in software. Skill sets are what we are offering. We have an abundance of IT skills and developers."

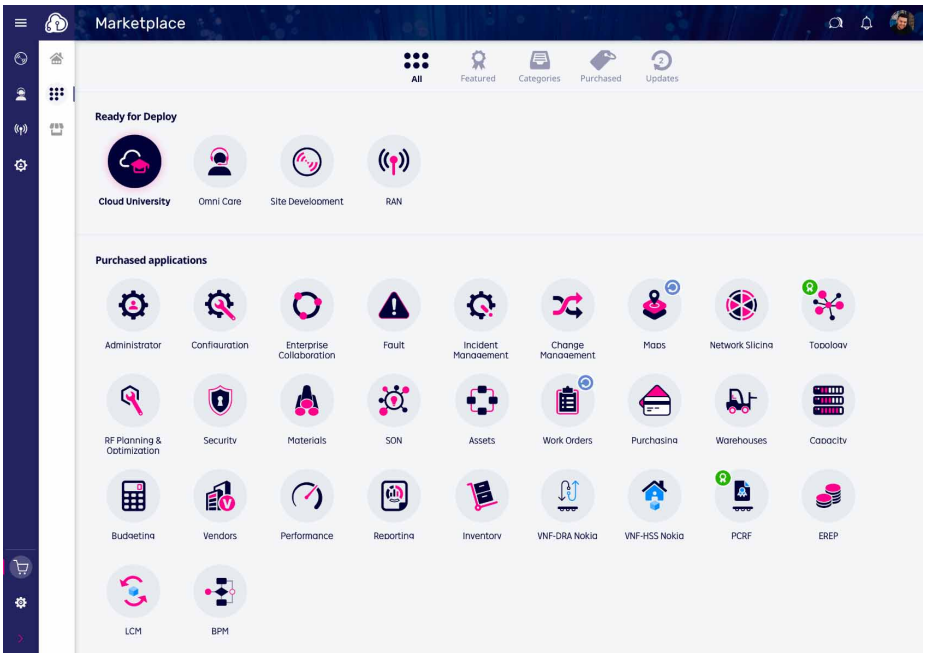
Rakuten Communications Platform

Component	Differentiation	Architecture	Outcomes
CUSTOMER & PARTNER ECOSYSTEM	• XaaS Marketplace • API Ecosystem	CHANNELS; PARTNERS; CONNECTED INDUSTRY; DIGITAL BUSINESS PLATFORM *	• Flexible Business Models • Future-proof APIs
PLATFORMS	• Full Automation • Agile Service Dev • Service Lifecycle	B RAKUTEN NETWORK OPERATING SYSTEM (RNOS): INTELLIGENT OPERATIONS; NETWORK CONTROL; SERVICE DESIGN & DEVOPS; UNIVERSAL CLOUD ORCHESTRATION; BILLING	• ~30% OpEx Savings • Automation Library • AI Roadmap
INFRA-STRUCTURE	• COTS Hardware • Hybrid Support • Cloud Partners	A vRAN CLOUD NATIVE FUNCTIONS; C RMP POD (MEC); PHYSICAL NETWORK; 3rd PARTY CLOUD	• ~40% CapEx Savings • Resilient in Design • Strong Vendor Ecosystem

The graphic above illustrates the platform, which aims to bring together all the necessary components for mobile operators to support their own digital ecosystems of partners.

The plan behind RCP is to partner with some of the firms that Rakuten Mobile is working with today and for them to market their capabilities through the "RCP Marketplace" which is like an app store from which operators can purchase different solutions and services. It's not clear yet how compensation will work, but as Amin notes, "Rakuten is really good at doing partnerships."

The screen shot below shows an example of the RCP Marketplace:



In the next section, we'll assess Rakuten's prospects for success.

Section 6

Assessing Rakuten's prospects

The success of Reliance Jio in India has changed perceptions about the viability of launching a new mobile network operator in a competitive market. Before Jio it was widely accepted that even aggressive market entrants would struggle to win more than a 10% to 15% share over a five-year period and that to achieve this they would need to erode the profitability of the market for all the players.

It remains unclear whether Rakuten will follow in Jio's footsteps, or whether it will struggle and fail as so many third and fourth operators have in western European markets. The company has some things going for it. The fact that it is part of Japan's largest national ecommerce and payments retail group inspires confidence that Rakuten Mobile will be able to develop the kind of digital experience for customers that the telecoms industry has so far failed to deliver. And Rakuten has done an excellent job outside Japan in positioning itself as a mobile pioneer that is bringing cloud economics to the stodgy telecoms market.

Rakuten's shareholders are less convinced, however. When the company announced in 2018 that it had secured a license to operate Japan's fourth network, shares fell by 6%. In the quarter ending March 31, 2020, Rakuten posted a ¥31.8 billion ($290 million) loss on its mobile business. This brings total losses since the fourth quarter of 2017 to ¥107.2 billion ($977 million).

Asking the questions

We have identified six questions Rakuten will need to answer if the company is to become a successful mobile operator.

1. Are the savings enough to lure Japanese mobile users away from other networks?

For heavy data users in areas where there is network coverage, Rakuten's service is less than half the price of the three incumbent operators. But Japan is not a price-sensitive market. A large portion of its economy is composed of middle-class subscribers who have plenty of disposable income.

The impact of MVNOs is the best indicator of the price-sensitivity of Japanese consumers. According to Japanese government data, there were 22.3 million MVNO customers in Japan divided among more than 80 companies at the end of June 2019 accounting for 12.2% of the total market.

MVNOs are particularly popular among foreign nationals, and they are also used for data-only devices such as tablets. Until the launch of Rakuten's service in April, MVNOs were seen as the only option for short-term contracts (for example, six-months). Rakuten's pricing and contract terms are highly competitive with MVNOs.

2. If cost savings aren't enough, what about better customer experience and service bundling?

Japanese consumers have a reputation for being extremely quality conscious. This applies to the sales process and after-sales service as well as the product itself. This is where Rakuten Mobile could score highly.

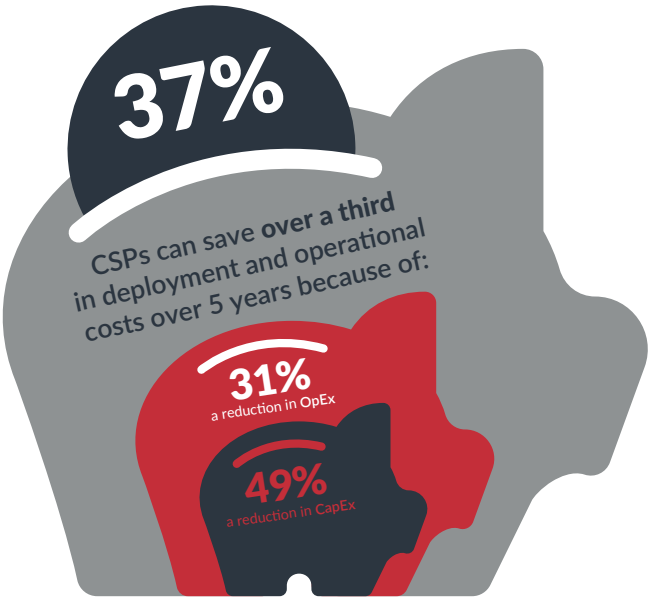
> Taking out a mobile subscription is time consuming in Japan and new customers often must revisit a shop to complete the sales process the day after they started the transaction. Rakuten Mobile aims to slash activation times from two to three hours to just 10 minutes.

While service bundling has emerged as a major trend globally in the last five years, it has been a feature of the Japanese market for the last 20. NTT Docomo, KDDI's au and SoftBank all bundle value-added services, fixed broadband connectivity and payment options with their subscriptions. Rakuten's point-based loyalty system is extremely attractive, but it will not be easy to persuade customers on rival networks to switch.

3. Will vRANs live up to the hype?

Research from independent research firm Senza Fili Consulting suggests that the cost of building and operating a virtualized radio access network (vRAN) is significantly lower than a conventional RAN (see infographic). The firm based its estimate on cost assumptions from cloud native software vendor Mavenir which sponsored the research. Mavenir developed its assumptions using data from the company's mobile operator customers.

vRANs save money



TM Forum, 2020 (source: Senza Fili Consulting)

Indeed, many Tier 1 mobile operators support vRANs, including Vodafone, Telefónica and Etisalat. However, this does not mean that they are deploying the technology widely. vRAN technology is immature and lags in terms of network performance. It will take some time before vRANs can match end-to-end systems, particularly in urban areas which require greater capacity.

Rakuten Chief Architecture Officer Tareq Amin often talks about the cost savings the company will achieve through the deployment of a cloud-native network. At Digital Transformation World in Nice in June 2019, he said that Rakuten could build a 5G network for just a third of what it would cost using the approach taken by a traditional LTE operator. He estimated that if a traditional telco were investing about $8.8 billion in 5G, Rakuten would spend just $2.8 billion. On other occasions he has spoken about a 40% cost reduction for an LTE and 5G network.

Considering the total cost of ownership, it will take about five years after Rakuten's 5G launch to assess whether Amin's predictions are right. However, it is interesting to speculate about where the cost savings will result (see panel).

How can Rakuten build a network for 1/3 the cost?

When considering the potential for cost savings, it is important to understand how mobile operators build and operate traditional networks and where they may save with vRANs.

The total cost of a RAN – including backhaul – mainly comprises passive network elements. For the backhaul this means digging trenches if it uses fiber. For the RAN itself, the operator must pay for site acquisition, tower infrastructure, network computing and radio equipment, and connectivity between the two.

The RAN represents a relatively small proportion of an operator's total costs. Research firm Omdia estimates that the RAN market was worth $33 billion to vendors in 2019. Total CapEx for mobile operators in 2019, based on various research firm estimates, was around $160 billion to $180 billion.

The potential cost savings from adopting vRAN architectures are across CapEx and OpEx. The Senza Fili research suggests that there may be a 49% cumulative CapEx savings to be achieved from the adoption of vRANs. However, given that most RAN CapEx is for passive infrastructure and there are no clear savings from passive infrastructure in the adoption of vRAN, it is unclear how the savings will be achieved.

Likely savings from adopting vRANs will come from:

- Lower energy costs resulting from changes in how radio antennas are connected into the cell site cabinet within each base station
- Lower energy costs resulting from the centralization (and moving to the cloud) of so-called base band units (BBUs)
- Operational savings on truck rolls (with virtualized and cloud-based network elements, base stations can be activated and repaired remotely)

Potential savings from reduced power consumption should not be underestimated. Research from China Mobile Research Institute indicates that power accounts for a third of total RAN OpEx. The research notes that OpEx represents 60% of the total cost of building and operating a RAN over a six-year period, with CapEx making up the remaining 40%. This means that power accounts for 20% of the total cost of the RAN.

Regardless of whether vRANs result in substantial savings, they do represent new competition for Huawei, Ericsson and Nokia, which dominate the 5G RAN market. Indeed, operators that are active in the Facebook-backed Telecom Infra Project (TIP) which has driven the development of Open vRAN technology have made no secret about wanting to create competition.

Rakuten has based its entire network architecture on vRAN technology. The company has close to 300 edge data centers where it co-locates IT racks and deploys vRAN as an application. In additional to any potential cost savings, this also has the advantage of bringing content closer to the user and reducing latency.

Where Rakuten may have an advantage is in its transition from LTE to 5G. It has already built edge into its LTE architecture, which means the company can avoid the cost and complexity that most operators face in considering how to re-architect their networks to exploit new opportunities in 5G.

4. Will the synergies with Rakuten Mobile's parent company make a difference?

Apart from offering loyalty points, Rakuten Mobile has said little about the extent to which it is leveraging or will leverage the capabilities of its parent company. The executives we interviewed made reference to using the parent company's data and skills in data science, and suggested leveraging the "seller" ecosystem and piggy-backing onto Rakuten's identity platform.

But it is not obvious precisely how much benefit those synergies will bring. For now, the mobile operator's technology team seems to be wholly focused on getting the network running and building cloud native capabilities. Exploring and executing on synergies will come later.

5. Will cloud native network and support systems enable Rakuten to enter new markets?

Our conversations with Rakuten Mobile executives suggest that they are unconvinced by many of the use cases that operators across the world are exploring for 5G. The irony of this is that Rakuten Mobile will be one of the earliest operators in the world to deploy capabilities such as network slicing and edge computing – it already uses edge data centers for its LTE network.

Perhaps the clearest opportunities for Rakuten Mobile to leverage 5G in B2B lie in improving efficiency and delivering new services to its core ecommerce business. For example, Rakuten would be in prime position to start developing new retail capabilities using 5G in areas such as delivery of products using drones, asset tracking and warehouse automation.

6. Will Rakuten Communications Platform justify Rakuten Mobile?

At the end of this year Rakuten will take its Rakuten Communications Platform (RCP) to market (see page 20). This will comprise a suite of capabilities for mobile operators to make the transition from LTE to cloud native 5G.

In June NEC announced that it is jointly developing a containerized 5G mobile core with Rakuten to be made available on RCP. The idea behind RCP is that mobile operators can mix and match many solutions and capabilities delivered by Rakuten and its vendor partners on the RCP.

It is still too early to speculate on the business potential of RCP. However, it is worth noting that mobile operators globally are seeking to bring in new vendors to build open networks and introduce competition among existing vendors.

Additional features & resources

Proving What is Possible: Teaming up with Rakuten Mobile, Allot takes part in the launch of something completely new

Beating the odds. That is what Rakuten mobile is about. When 'experts' said it could not be done, the team at Rakuten got fired up. Build the world's first cloud-native, multi-vendor virtualized network and roll it out to Japan's consumer mobile market. Sure. Why not?

Rakuten did it. But every vendor who worked with Rakuten toward this unbelievable goal felt like they were an integral part of the process. That had a lot to do with the level of professionalism and the innovative atmosphere. But it was also a function of the way Rakuten viewed the vendors on the project.

> "By leveraging Allot's world-class technologies and expertise, we will be able to provide our customers with a comprehensive secured mobile service."
>
> Tareq Amin, Chief Technology Officer, Rakuten Mobile

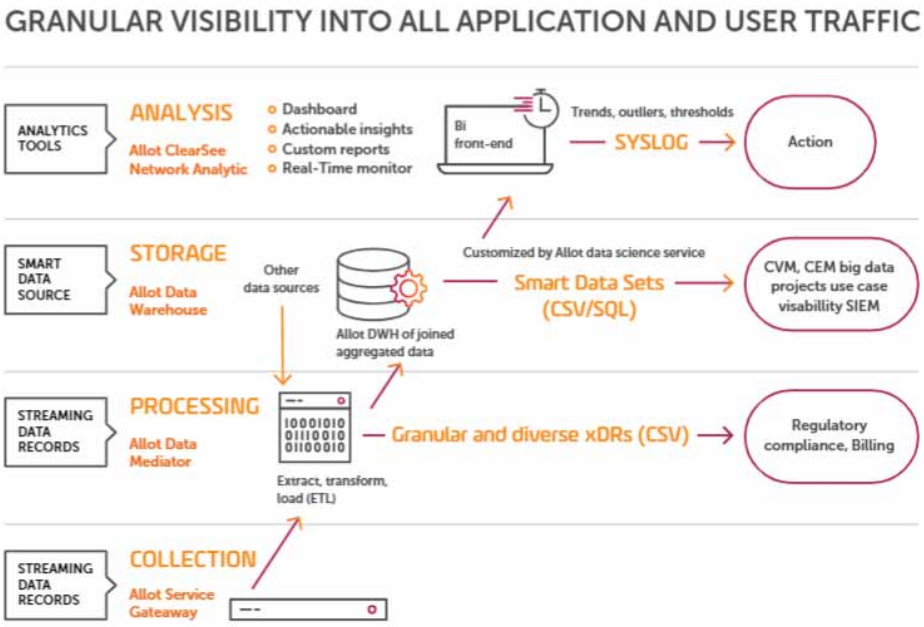
Tareq Amin, Chief Technology Officer at Rakuten Mobile, praised Allot, saying, "By leveraging Allot's world-class technologies and expertise, we will be able to provide our customers with a comprehensive secured mobile service." This is indicative of the prevailing attitude throughout the project.

The Rakuten team did not just provide a long list of specifications as is common in large telecom projects. They had their requirements, no doubt. But the project was much more collaborative in nature. Allot, for example, was selected for its industry leading network visibility solution, among others, and was told, 'Now tell us what we can do with it.' This attitude toward innovation and collaboration was, for sure, a major factor in the successful launch of the Rakuten mobile network.

On the Allot side of the equation, Allot, as a vendor, deployed a number of solutions with various functions, all on a single unified inline platform that supports the NFV architecture of the Rakuten network. All the Allot solutions were deployed so that Rakuten could start to provide services from the moment the network went live. All the services furnished by Allot solutions are managed from the same interface and provide unified reporting for easy operation.

The following are the solutions deployed by Allot in the Rakuten mobile network:

- Network visibility for the network planning department
- Inbound/Outbound DDoS attack detection and mitigation
- Parental Controls and anti-bullying solution for social media



Network Visibility

The network visibility solution from Allot, SmartVisibility, delivers a clear, granular view into network, application, user and security data. This helps to prioritize and control traffic, secure the network, ensure it meets business requirements and optimize user experience. The actionable intelligence generated through SmartVisibility supports an integrated set of tools that enables QoE optimization through:

- **Real-time Network Monitoring –** granular views, in 5-15 sec resolutions, into what is actually happening in the network – for operational monitoring and realtime troubleshooting
- **Network Analytics –** Out of the box dashboards, featuring aggregated and near realtime analytical insights on network performance, utilization, and subscribers' perceived QoE
- **Self-service Reporting –** Customizable reporting that turns any business query into actionable insights
- **Smart Data Source –** Exports raw and curated data to third party BI Analytics systems to enrich legacy reporting

Leveraging these functions Rakuten can:

- Turn any business query into customized reports and actionable insights
- Target customer segments via data-driven marketing campaigns and service bundling
- Enable informed and timely capacity investments aligned with customer experience and business goals
- Facilitate real-time and precise troubleshooting

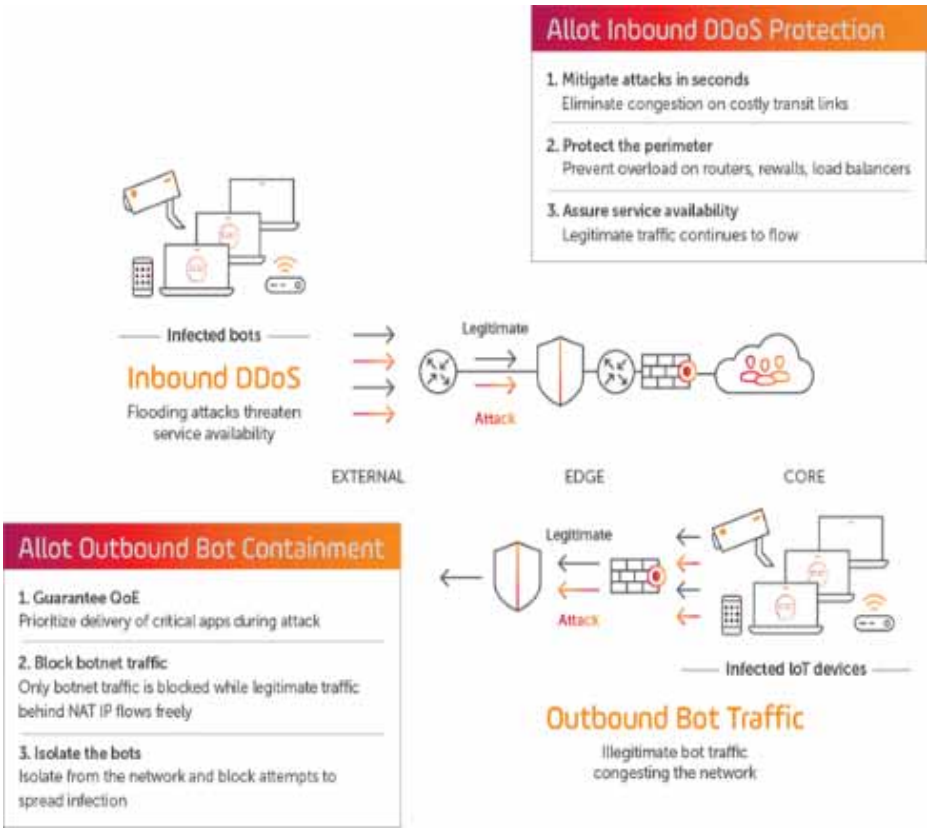
All this enables proactive optimization of network resources and customer service plans to maximize revenue and to secure revenue through data-driven detection of potential churners and revenue leakage.

DDoS Attack Detection and Mitigation

DDoS (Distributed Denial of Service) attacks pose some of the most serious threats to communication networks, their services, customers and business. With the growth of IoT, that threat has increased, as botnets, created by hundreds of thousands of infected devices, can disable services for millions of users. 5G is expected to make this even worse. Whether the attacks are aimed at the network or its subscribers, a network operator risks service availability, reputation and revenue if DDoS attacks cannot be mitigated quickly and effectively.

Allot DDoS Secure, the solution selected by Rakuten, instantly detects and blocks both inbound and outbound DDoS attacks. Machine learning and artificial intelligence learn normal traffic behavior, enabling rapid, accurate detection and mitigation of abnormal attack traffic. With Allot DDoS Secure, the operator gets:

- **Both inbound and outbound Mitigation –** Detect deviations from machine-learned normal inbound IP traffic. Identify abnormal outbound activity or malicious connections from IoT devices on your network.
- **Comprehensive forensics –** Investigate threats in real-time with detailed attack, event, and full packet analysis.
- **Scalable always-on protection –** Defend against Terabit attacks from multiple vectors with scalable platforms.
- **Flexible deployment and management –** On-premise, cloud, hybrid, or virtual solutions to best fit the network.



Allot DDoS Secure inspects 100% of network traffic to foil every volumetric attack. It employs machine learning and artificial intelligence to detect even unknown attacks and combines DDoS mitigation with DPI-based traffic management to preserve legitimate traffic and service quality.

Parental Controls and Anti-Cyberbullying Solution

Allot Parental Control service, a part of the Allot Secure family of cybersecurity solutions, allows operators to provide peace of mind to parents who are concerned about the online activity of their children. Using a simple online setup screen, parents can control access to specific URLs and to a wide array of content categories such as gambling, pornography, dating sites, violence, racism and many others. They can also set time limits on browsing, set up different rules for each child's device, and adjust them at any time.

Real-time notifications and monthly usage reports are all part of the service. Operators can deploy this opt-in service in multi tenancy mode that allows consumers to personalize their own security settings or in single tenancy mode that offers a standard set of security features for all subscribers.

Allot also teamed up with Keepers, makers of a mobile app that helps parents to protect their children against cyberbullying and online dangers and harassment. The system

monitors incoming and outgoing messaging on social media platforms, automatically tracks any suspicious, abusive, or inappropriate content, by referencing a constantly updated phrases detection database. The Keepers solution, together with Allot's parental controls solution provide a comprehensive set of services that can be offered to consumer subscribers.

Allot Parental Controls is a member of the Allot Secure family of solutions. Allot Secure is the #1 network-based telco security-as-a-service solution for the mass market. It delivers effortless, device-independent end-user security that achieves adoption rates over 50%. Allot Secure protects more than 23M subscribers worldwide, increasing ARPU up to 5%. Allot Secure merges network-based, gateway, and client security into a unified service featuring a seamless customer experience for event handling, policy setting, and reporting, as well as unified CSP management. With Allot Secure solutions, network mobile, fixed, and converged consumer and business customers are protected at home, at work and on the go.

Meeting the Unique Challenges of Rakuten Mobile

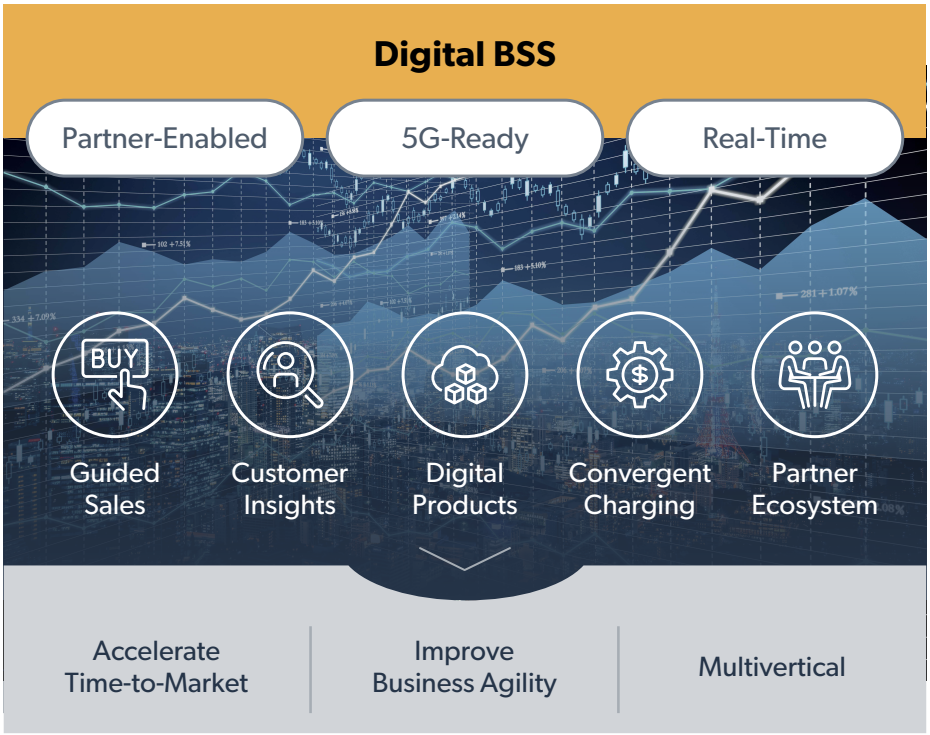
The team at Rakuten has created a visionary offering, deploying the world's first fully virtualized network. Many onlookers said it could not be done. Yet there it is, live and serving the Japanese market. One of Rakuten's secrets is the environment that they built for the project. It was and continues to be truly collaborative. They gave Allot the space to provide solutions and implement them in the best way possible. This created a great opportunity for the Allot team to be considered a Trusted Security Vendor and to work with other innovative vendors who, hand in hand, helped one another build a new secure, visible and service-oriented network like none other.

Netcracker Digital BSS Delivers an Edge in Mobile-First Customer Engagement

Rakuten has redefined what it means to be a mobile operator in the highly competitive Japanese market by creating a new approach where mobility becomes an integral part of the customer's digital lifestyle. Rakuten's aim is not to become a traditional telecommunications company but rather a company that brings a lifestyle approach to mobility.

Rakuten chose Netcracker as its strategic partner in order to deliver an integrated and consistent experience across its comprehensive digital service portfolio. Rakuten leveraged Netcracker's end-to-end Digital BSS solution (including dynamic and smart multimedia tools) to improve customer engagement while simultaneously incorporating its Super Points loyalty program to drive stickiness across the entire Rakuten ecosystem. Netcracker's solution enabled a personalized, mobile-first experience for Rakuten customers through improved shopping and billing, accelerated and simplified customer acquisitions, easier engagement, revamped onboarding processes, customer journey management, quoting, and loyalty and lifecycle management.

Netcracker Digital BSS automates business processes supporting the entire customer lifecycle from discovery, shopping, ordering and billing to payment and maintenance. It supports traditional, next-generation and value-added B2B2X services from day one. Netcracker Digital BSS provides access to new revenue sources in a digital world while accelerating time to launch and scaling new lines of business, such as IoT, 5G, cloud applications and virtualized services. Some of the key features of Netcracker Digital BSS are highlighted below:



Cross-industry loyalty schemes

It is critical for modern BSS systems to support loyalty schemes that go beyond traditional voice, data and video consumption. Netcracker Digital BSS gives Rakuten the freedom to combine all services and products under a single, unified loyalty program. Under this program, the concept of a digital identity is further solidified by allowing any subscription or purchase to accumulate points that can then be applied to any other service or product within Rakuten's interconnected marketplace. Points earned on travel can be used for discounts on mobile services, for example. The idea of customer loyalty can then be fully realized as Rakuten uses this program and billing model to connect all aspects of a customer's lifestyle to the business.

Going cloud-native

The BSS of the future must have a cloud-native architecture, which provides unprecedented levels of flexibility due to its modular nature and adaptability. Netcracker Digital BSS is based on a single, convergent cloud solution that gives service providers efficient monetization capabilities across new lines of business, rich digital partner ecosystems, cloud and 5G services.

Support for partner-centric B2B2X business models

Enabling multiple business models necessitates having a BSS that supports partners and other players who need to rate and charge for services, then bill their own customers accurately and quickly to keep the order-to-cash cycle as tight as possible. Netcracker Digital BSS provides a rich partner management capability that enables operators and enterprises to bring third-party services into their broader service portfolio. With zero-touch onboarding, resellers, suppliers, distributors and wholesale partners can become part of the expanded services ecosystem. It supports flexible management of complex multilayered partner account hierarchies, empowering everyone in the ecosystem to map the most appropriate services to the right bundle and effectively and efficiently deliver them to the customer. Netcracker's vast pre-onboarded partner ecosystem ensures relationships are profitable and accountability and settlement can be managed even in complex B2B2X settings.

New payment mechanisms

The number of new payment mechanisms is continuing to grow, so the BSS must extend beyond electronic fund transfer and credit cards to Apple Pay, Samsung Pay, digital currencies, near-field communications (NFC) for contactless payments and so much more.

Monetizing 5G and edge-related opportunities

Digital BSS will be key to enabling operators to leverage edge opportunities. It will help them support new, low-latency services, which will be accelerated in every sense by 5G. The BSS must be able to provide distributed rating and charging, including online charging, to many thousands of edge sites.

In addition, these edge sites, collectively and individually, will support a wide range of applications and services, which can be dynamically switched at different times of day, for example to relieve congestion by relying on the dynamism of cloud-native network functions and infrastructure. The BSS has to be equally dynamic and adaptable to allow operators to get the most out of their resources for their own internal efficiencies as well as to give their customers the best quality of services. This needs to be extended to their customers' customers as well.

Intelligent customer journeys

Applying artificial intelligence (AI) to customer journeys means that an operator can constantly evolve how it engages with customers based on what it 'learns' about their behavior, needs and preferences. This could range from which channels they tend to use at what time of day for what purposes and how they like to communicate with their provider.

Proactive, not reactive, care

Operators also need to provide proactive care, addressing any issues that arise before they turn into problems, helping to prevent churn and increase customer satisfaction. Look at it this way: If you're not providing satisfactory service to your customers, you're losing money.

Pricing and promotions

Being able to offer dynamic pricing and promotions to customers at the most appropriate moment – such as when they are about to run out of data or allowing them to transfer data to friends or family – will open up opportunities for greater customer satisfaction, loyalty and revenue.

About Netcracker

Netcracker Technology was founded in 1993 and has been a wholly-owned subsidiary of NEC Corporation since 2008. Driven by its focus on R&D, Netcracker's end-to-end product portfolio and related professional services enable telecommunications and cable service providers, utilities, financial services, logistics and other business services providers to transform their mission-critical back office and front office processes.

Netcracker offers an extensive range of solutions for digital service providers, such as business service innovation, 5G and digital service monetization, IT transformation, hybrid network operations, SDN/NFV realization, modernized cable operations and customer experience management. Netcracker has over 250 customers across more than 60 countries in the Americas, Europe, MEA and APAC regions.

As 5G, cloud and virtualized services continue to drive the industry forward, Netcracker remains steadfast and focused on enabling monetization of any service on any network, bringing together 5G-ready components that enable proactive customer engagement, dynamic pricing and bundling, partner-powered business models and targeted AI-driven customer engagement. Netcracker's solutions are also equipped with best-in-class security features to keep the customer, service, operations and network data secure.

Build an Agile, Open Virtualized Radio Access Network (RAN) on Red Hat Platforms

Most communications service providers (CSPs) are realizing significant value from NFV. NFV has matured markedly in recent years, moving key network functions from physical to virtual for many production deployments, including mobile packet core, firewall, deep packet inspection and video optimization technologies. CSPs are able to accelerate service deployments, simplify daily operations and improve network economics. But, what's next?

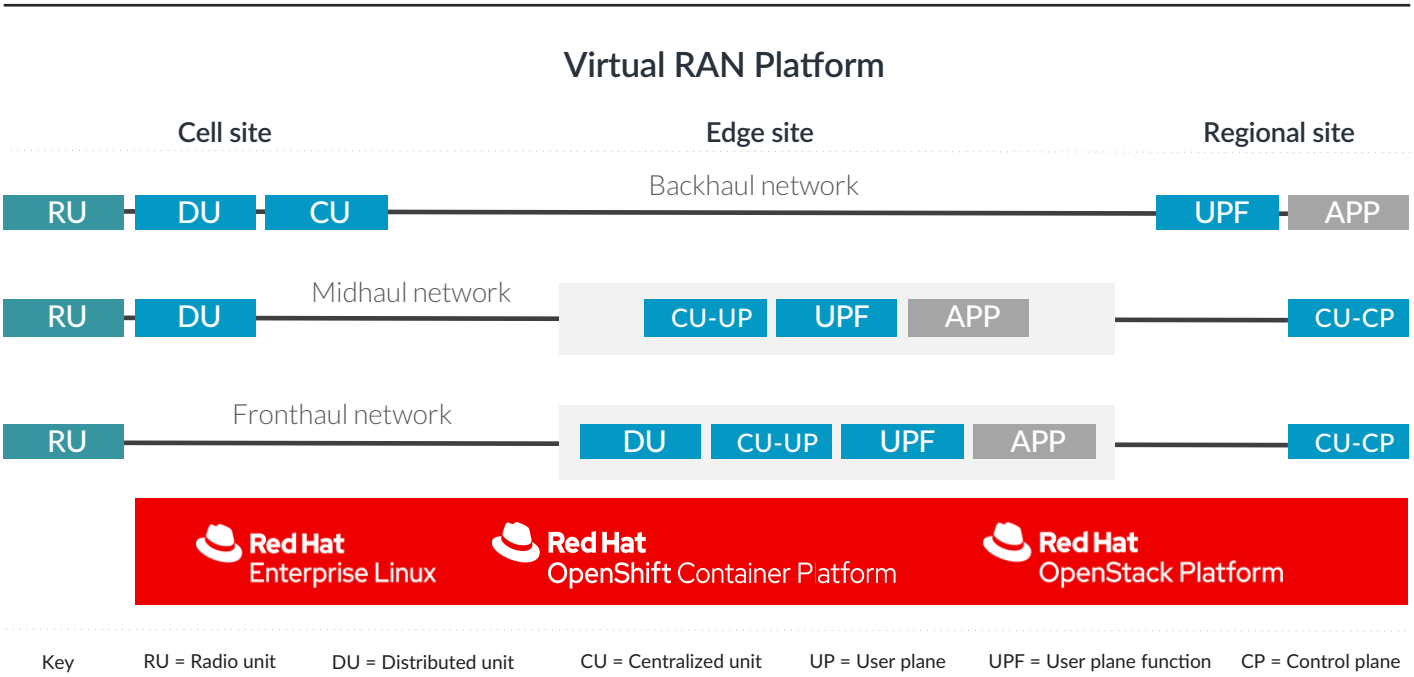
The disruptive innovation from NFV is real, but even more benefits lie ahead when CSPs take the next step of adopting containers and cloud-native architectures. The rewards are many - faster startup times, reduced maintenance, improved ease of use and quicker launch of new services.

A compelling opportunity to put container design to work is in virtualizing the RAN. Today, RANs are the primary investment of mobile networks, as their numbers are in thousands or more, and require specialized proprietary hardware that is difficult to upgrade, scale and interoperate with other vendors. A RAN transformation boosted by cloud-native network functions renders infrastructure more flexible, agile and easier to maintain.

Virtual Radio Access Networks (vRANs)

High levels of flexibility and resource efficiency are created in vRAN networks by disaggregating in two different ways. Disaggregating radio baseband function from underlying hardware into software-defined infrastructure enables cloud benefits in RAN operations. Functional disaggregation of baseband units into CU (Centralized Unit) and DU (Distributed Unit), allows more efficient deployment scenarios.

Disaggregation allows non-real time RAN functions to be centralized away from cell sites and delivered via cloud-based architectures in nearby edge data centers. With those structural changes, two architectural choices are possible: open horizontal platforms



and traditional vertically integrated solutions. CSPs gain more comprehensive advantages when cloud-native functions are deployed on a horizontal solution, where the same platform can be consistently extended across the network to support multiple network functions where they are needed.

> “
>
> Horizontal telco clouds have 30 percent lower total cost of ownership - ACG Research

Recent analysis from ACG Research found that horizontal telco clouds have a 30 percent lower total cost of ownership (TCO) than vertically integrated deployments in 4G mobile core deployments.

RAN network needs are more stringent in a number of ways than other NFV implementations. RAN standards require deterministic, low-latency and low-jitter signal processing. RAN fronthaul also relies on network-based timing and synchronization requirements. These strict standards require vendors from different areas of the network – radio, transport and cloud – to work together collaboratively in an ecosystem. When such collaboration is built on open standards, the infrastructure becomes more resilient and helps spur innovation.

Industry alliances and standards are bringing mobile operators and technology vendors together to create multi-vendor, interoperable, autonomous RAN vision and commitment to create solutions for it. A key one among them is the O-RAN Alliance that operates on the principles of RAN openness and intelligence. Another leading standard is Telecom Infrastructure Project's OpenRAN, whose main objective is to develop fully programmable RAN solutions based on general purpose processing platforms and software functions with open interfaces.

Use Red Hat for Open vRAN Solutions

Red Hat offers a common horizontal container-based cloud platform to develop, deploy, and launch new services. In partnership with radio vendors, network equipment providers and systems integrators, Red Hat delivers a platform for open vRAN that is built on the open source foundation of Red Hat® Enterprise Linux® and Red Hat OpenShift® Container Platform, plus Red Hat Ansible®Automation Platform makes it easier to deploy and upgrade.

Red Hat nurtures a growing ecosystem of partners whose container images ensure network functions run reliably and securely. Red Hat's compliance with standards from OpenRAN and the O-RAN Alliance means CSPs can choose the best partner solutions to fit their unique needs.

For service providers who are not adopting cloud-native network functions yet, Red Hat offers Red Hat OpenStack® Platform, which is field-hardened with numerous NFV telco cloud implementations for mobile core, SD-WAN, and more.

Red Hat Enterprise Linux

Red Hat Enterprise Linux provides an intelligent OS that delivers a consistent foundation for hybrid cloud and key features to support the stringent demands of RAN networks.

- Real-time kernel
- Support for Precision Time Protocol
- Hardware accelerated compute using FPGA, GPU and Smart NICs
- Fast data path (SR-IOV)
- Advanced security features

Red Hat OpenShift

Red Hat OpenShift is the leading commercial Kubernetes platform, offering automated operations for hybrid cloud environments, and optimized for scaling network infrastructure using a modular microservices architecture. It includes Red Hat OpenShift Service Mesh to provide a uniform way to connect, manage, and observe microservices-based applications and to optimize how they all communicate and work together.

Red Hat OpenShift combines comprehensive, continuous security with upstream Kubernetes, including networking isolation, identity and access management, integrated secrets management and audit capabilities. Red Hat has been and continues to be a strong advocate with partners in open source communities for adapting container environments to networking applications with technologies like Multus and vDPA. Deploying a container-based programmable network eases integration and creates on-demand infrastructure that adapts and scales faster to market changes.

Red Hat OpenStack Platform

Red Hat OpenStack Platform brings together open, community-powered innovation with hardening, reliability, and support lifecycle management—empowering businesses to deliver new, differentiated services with confidence on a flexible, scalable, and proven OpenStack telco cloud.

Red Hat offers distributed compute node capabilities within Red Hat OpenStack Platform to build open edge computing with centralized management and less operational overhead from the data center core to the edge.

> “Red Hat has been and continues to be a strong advocate with partners in open source communities for adapting container environments to networking applications

Red Hat Ansible Automation Platform

Red Hat Ansible Automation Platform is a simple-to-use automation platform that helps to manage servers, networks and applications. The agentless platform provides support for infrastructure across multi-vendor virtual and physical environments, so that service providers have a flexible tool for automating across their networks.

Why Red Hat?

Red Hat’s open platforms have been an integral part of delivering service agility and significant ROI for CSPs. Rakuten launched a new commercial mobile service on the world's first end-to-end fully virtualized cloud-based network built with an ecosystem of partners, including Red Hat. Vodafone Idea, Ltd., and many others trust Red Hat platforms for their modernized network deployments. Service providers like X by Orange are deploying cloud-native business security services, using Red Hat OpenShift on Amazon Web Services public cloud.

To learn more about how Red Hat can help you in your transformation projects or to schedule a discovery workshop, please visit us at www.RedHat.com/telco.

Open innovation connects industries

Networks transformed for 5G

redhat.com/telco

Red Hat

TM Forum Open Digital Framework

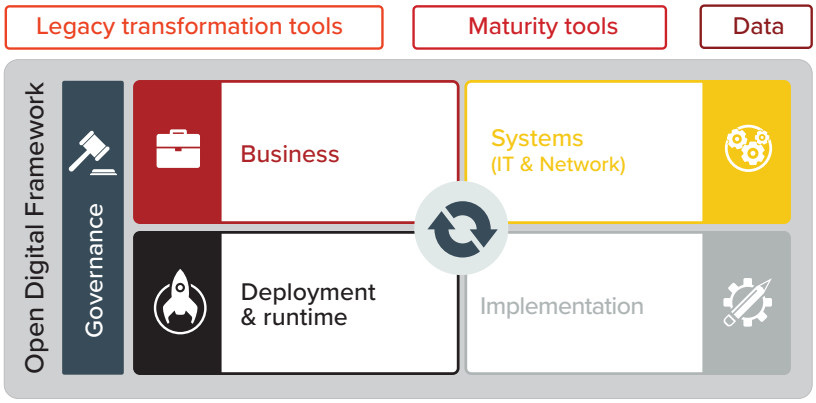
A blueprint for intelligent operations fit for the 5G era

The TM Forum Open Digital Framework (ODF) provides a migration path from legacy IT systems and processes to modular, cloud native software orchestrated using AI.

The framework comprises tools, code, knowledge and standards (machine-readable assets, not just documents). It is delivering business value for TM Forum members today, accelerating concept-to-cash, eliminating IT & network costs, and enhancing digital customer experience.

Developed by TM Forum member organizations through our Collaboration Community and Catalyst proofs of concept, building on TM Forum's established standards, the Open Digital Framework is being used by leading service providers and software companies worldwide.

Core elements of the Open Digital Framework



The framework comprises TM Forum's Open Digital Architecture (ODA), together with tools, models and data that guide the transformation to ODA from legacy IT systems and operations.

Open Digital Architecture

- Architecture framework, common language and design principles
- Open APIs exposing business services
- Standardized software components
- Reference implementation and test environment

Transformation Tools

- Guides to navigate digital transformation
- Tools to support the migration from legacy architecture to ODA

Maturity Tools & Data

- Maturity models and readiness checks to baseline digital capabilities
- Data for benchmarking progress and training AI

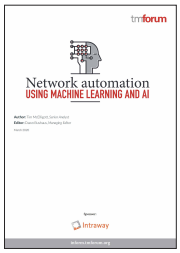
Goals of the Open Digital Framework

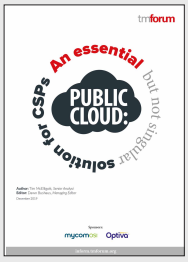
The aim is to transform business agility (accelerating concept-to-cash from 18 months to 18 days), enable simpler IT solutions that are easier and cheaper to deploy, integrate and upgrade, and to establish a standardized software model and market which benefits all parties (service providers, their suppliers and systems integrators).

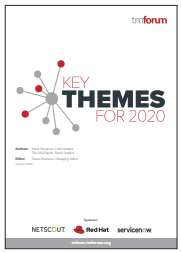
Learn more about member collaboration

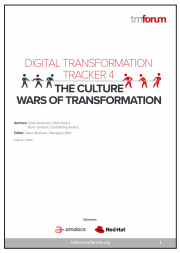
If you would like to learn more about the Open Digital Framework, or how to get involved in the TM Forum Collaboration Community, please contact George Glass.

TM Forum research reports









Meet the Research & Media team

Report Author:
Mark Newman
Chief Analyst
mnewman@tmforum.org

Senior Analyst:
Tim McElligott
tmcelligott@tmforum.org

Editor, Digital Content:
Arti Mehta
amehta@tmforum.org

Commercial Manager, Research & Media:
Tim Edwards
Senior Analyst
tedwards@tmforum.org

Report Editor:
Dawn Bushaus
Managing Editor
dbushaus@tmforum.org

Customer Success & Operations Manager:
Ali Groves
agroves@tmforum.org

Global Account Director:
Carine Vandevelde
cvandevelde@tmforum.org

Digital Marketing Manager:
Anna Kurmanbaeva
akurmanbaeva@tmforum.org

Report Design:
Intuitive Design UK Ltd
info@intuitive-design.co.uk

Published by:
TM Forum
4 Century Drive,
Parsippany,
NJ 07054
USA
www.tmforum.org
Phone: +1 973-944-5100
Fax: +1 973-944-5110
ISBN: 978-1-945220-76-0

For more about TM Forum's Collaboration Community,
please contact **Andy Tiller**