# MVNOs in the 5G Era: Advocating the VMNO Concept

## 2.1 The Runup to 5G

IIJ has consistently been a front runner in this field since launching its MVNO business in 2008 (initially deployed on a W-CDMA network, on LTE since 2012). The market environment facing MVNOs has changed significantly over that time, and IIJ has developed a diverse range of advanced MVNO businesses that serve many users, including business and consumer services, MVNE services, IoT/M2M, and full MVNO operations. The total number of subscriptions under these services now exceeds three million, and that number continues to grow, making IIJ Japan's biggest MVNO in both name and substance.

Against that backdrop, competition in the MVNO space grows more intense by the day. With direct regulations on sales of smartphones, in particular, being tightened every year, the vertical market structure consisting of MNOs—offering high-end devices on expensive rate plans premised on generous cashbacks and two-year contracts—and MVNOs—focusing on middle-class and low-end devices on "no-frills" plans—has crumbled, giving way to multifaceted competition. As MNO sub-brands and Rakuten Mobile, Japan's fourth MNO, continue to rise, some MVNOs are already struggling to earn a profit. And some of those MVNOs have no choice but to withdraw from the market. Why is this happening?

An MVNO business can only provide the limited mobile services that its host MNO provides. Based on considerations like profitability and differentiation versus peers, MNOs are relatively free to choose what type of services they provide from among all of the feasible technologies. In contrast, so long as it uses an MNO's network, an MVNO's choices are constrained by that. As successive generations of cellular communications technology rolled out, from 2G in the 1990s to 3G and 4G LTE, so too have mobile services evolved, from initially only being pay-as-you-go voice services to packet data communications, VoLTE, flat-rate and packet-based voice plans, carrier aggregation, and LPWA. Yet these services are only provided to an MVNO pursuant to the technological and economic conditions between it and the MNO, so it is fundamentally difficult for MVNOs to differentiate themselves.

There are avenues open to MVNOs, however, if they can unbundle part of the MNO's network and operate it themselves to provide their own mobile services to the extent the equipment permits. The rise of this practice of unbundling is synonymous with the history of MVNOs. Japan's Ministry of Internal Affairs and Communications approved the unbundling of packet gateway[*1], known as "Layer 2" type of MVNO in Japan, in 2008, and this has since become mandatory for Japan's three MNOs. Yet the three MNOs are not
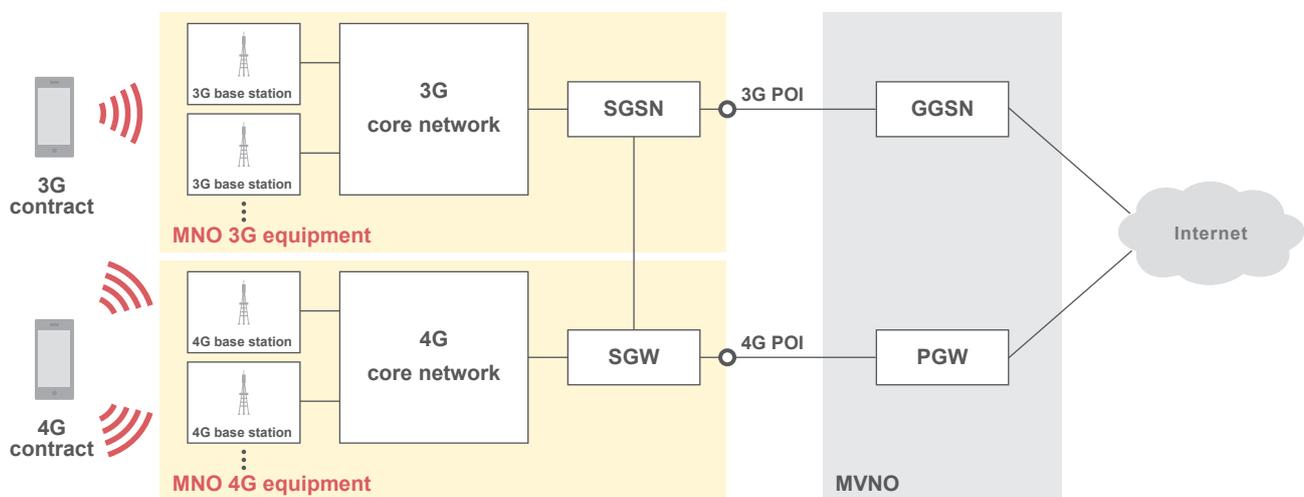


Figure 1: Illustration of Packet Exchanger Unbundling (Layer 2 Connection)

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*1   The GGSN (Gateway GPRS Support Node) in 3G, the PGW (Packet Gateway) in 4G LTE.

obligated to unbundle HLR/HSS[2], which is the equipment used to manage SIM cards, but the government guidelines say it is desirable to do so, and so full MVNOs—which take on the operation of the unbundled HLR/HSS and offer a range of innovative services that other MVNOs are unable to—are now appearing in Japan, starting with IIJ in 2018. Please see IIR Vol. 38[3] for an overview of IIJ's efforts to develop new services as a full MVNO.

But with the era of 5G approaching in earnest, we find ourselves at a new turning point facing a trajectory that is not simply an extension of business to date. The early stages of the 5G era sees NSA[4] implementations relying on existing 4G infrastructure, with very little changing on the infrastructure front relative to 4G. SA[5] implementations that do not rely on 4G infrastructure are set to follow, and MNOs' 5G networks are expected to have a high degree of virtualization by the time these implementations roll out. Efficiently achieving the broad end-to-end QoS[6] goals of 5G—namely enhanced mobile broadband, massive machine type communications, and ultra-reliable, low-latency communications—requires the introduction of virtualization technology and the horizontal layering of networks based on this, or in other words, network slicing.

From an MVNO perspective, however, a big question remains unanswered. Will an unbundling strategy continue to work on virtual networks in the 5G SA era? If not, how will MVNOs be able to differentiate themselves?

## 2.2 5G and MVNOs

Two major issues present themselves when we consider the possibilities for unbundling in the 5G SA era. One is network segmentation. Unbundling is a way of dividing a network vertically at a point of interface (POI[7]), but this does not appear to work well with network slicing. In short, network slicing (horizontal division of a core network into slices) is set to be introduced to achieve the broad end-to-end QoS goals for 5G, but if MVNOs further physically separate out only part of the core network, this could hinder efforts to achieve the required QoS levels.

The other issue relates to operational aspects. Having generally standardized specifications for technical interfaces between operators at POIs is desirable. That's not the only consideration, though. The fact that autonomous operators are on either side of a POI creates very heavy operating restrictions. Even if the technical specifications for the POI are met, neither operator can make configuration changes or add new functions unless both operators are in agreement. In the 3G and 4G LTE world, once a POI was built, its configuration did not need to be changed all that frequently, and this applies in the case of Layer 2 MVNOs as well as full MVNO arrangements. Hence, the operating restrictions did not really hinder the smoothness of business. With 5G, however, slices (virtualized core network) need to be operated dynamically in order to achieve the various QoS goals for providing communications services that meet users' needs. Achieving this level of flexibility using the conventional method of unbundling would be awfully difficult in the 5G SA era.

*2    Called the HLR (Home Location Register) in 3G and the HSS (Home Subscriber Server) in 4G.
*3    Internet Infrastructure Review (IIR) Vol. 38, Focused Research (1) "Why IIJ Seeks to Become a Full MVNO" (https://www.iij.ad.jp/en/dev/iir/pdf/iir_vol38_EN.pdf).
*4    Non-standalone
*5    Standalone
*6    Quality of service
*7    Point of interface

## 2.3 The VMNO Concept

With the aim of addressing these two issues facing the 5G SA era, IIJ and the Telecom Services Association, an MVNO industry organization, are advocating the concept of VMNOs as a new kind of virtualized telecommunications operator for the 5G era. This original idea arises from a European report.

In a March 2017 report[8], European think tank CERRE put forward two scenarios laying out a path to European leadership in the 5G space. The first it dubs the "Evolution" image, in which the approach used up until 4G continues in the 5G era. The second, dubbed the "Revolution" image, involves a major break from the conventional approach. Central to the Revolution scenario is the idea of VMNOs, or Virtual MNOs. The report points out that there are too few MNOs to achieve the 5G mission of providing dedicated communications services to a wide and varied array of industries, and that because they are constrained by the physical interface, MVNOs will not contribute with the same level of flexibility over their business. In the Revolution scenario, the MNOs open up an adequate set of APIs for controlling comprehensive 5G network slicing, allowing the market entry of a multitude of VMNOs, which have the same degree of flexibility as MNOs to roll out 5G solutions tailored to specific industries.

CERRE went a step further in a September 2019 white paper[9], saying that the sort of full MVNO arrangements used up until 4G may no longer be possible on 5G virtualized networks, and it is thus calling for the VMNO concept to be pursued. Figure 2 shows the anticipated structure of the relationship between host MNO and VMNO (we simply refer to this as a "light VMNO" in the figure and this report).

Unbundling under the current generation splits the core network at POIs into an MNO side and an MVNO side. A major difference with the light VMNO setup is that the MNO operates the combined core network integrally itself. The light VMNO only has the OSS/BSS[10] systems that control operations and business, which access a slice using an API on the MNO's network.

Adopting this structure means that the light VMNO can manage the virtualized core network (i.e., slice) on the MNO's virtualization infrastructure via the API provided by the MNO. Two sets of APIs will be required. One is for managing the QoS of the core network embodied by each slice, meaning the QoS of communications services provided to users. The other is for managing slices themselves, which includes, for example, adding new slices and deleting unneeded slices.

One other VMNO model that IIJ and the Telecom Services Association are advocating is that of the full VMNO. Light VMNOs run their businesses atop the virtualized infrastructure provided by the host MNO. The major difference with full VMNOs, on the other hand, is that they own the virtualized infrastructure in parallel with the host MNO. Figure 3 shows the anticipated structure of a full VMNO.
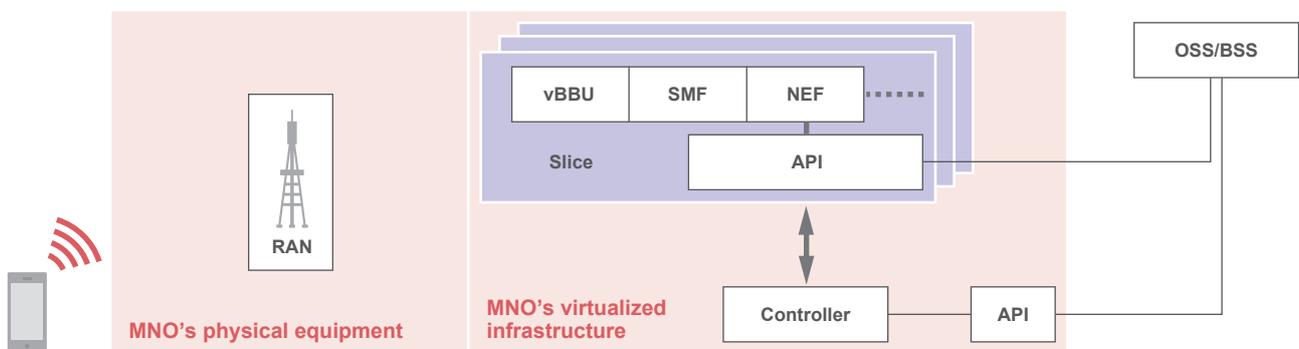


Figure 2: Anticipated structure of a light VMNO

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*8   "Towards the successful deployment of 5G in Europe" (https://cerre.eu/wp-content/uploads/2020/06/170330_CERRE_5GReport_Final.pdf).

*9   Ambitions For Europe 2024 (https://cerre.eu/wp-content/uploads/2020/05/cerre_whitepaper_ambitionsforeurope2024.pdf).

*10  Operation Support System / Business Support System

The difference between light and full VMNOs lies in the ownership of the virtualized infrastructure. Light VMNOs rely on the host MNO's equipment except for the OSS/BSS, whereas a full VMNO is independent of the MNO's equipment except for the wireless part. This difference means that full VMNOs have an additional degree of technical and operational independence from the host MNO, making it possible to collaborate with other wireless operators. This is the sort of independence full MVNOs in the current generation have. Full VMNOs are likely to collaborate with multiple 5G wireless networks with their own virtualized core networks.

The Telecom Services Association's MVNO Committee put these VMNO concepts to the Ministry of Internal Affairs and Communications' study group on the competitive environment in the mobile market, which subsequently said in a February 2020 report that both of these VMNO models should be considered as concepts for virtual telecommunications operators in the coming 5G SA era. The VMNO concept has thus become the most prominent option for how virtual telecommunications operators will be set up in the future.

## 2.4 Benefits of the VMNO Concept

So the VMNO concept is making steady headway, but what benefits will it bring?

In its white paper, CERRE claims that the new market structure brought about by VMNOs has the potential to deliver a vibrant level of competition in both the B2B and B2C markets alike. This is because a large number of VMNOs, relative to MNOs, can be expected to appear as the number of MNOs is limited because of the finite availability of wireless resources and, to take a more macro view, in gradual decline due to industry consolidation. VMNOs, like the current generation of MVNOs, are virtual telecommunications operators that do not themselves receive radio spectrum allocations, so market entry is not restricted by natural conditions such as the scarce availability of spectrum resources. And unlike the current generation of MVNOs, the flexibility of their business will not be restrained by the conditions under which MNOs provide functionality or the depth of unbundling, so they will be able to assemble the functions that their customers need from a broad range of options to provide communications services with the required QoS levels. The presence of VMNOs like this in the market will naturally stimulate competition
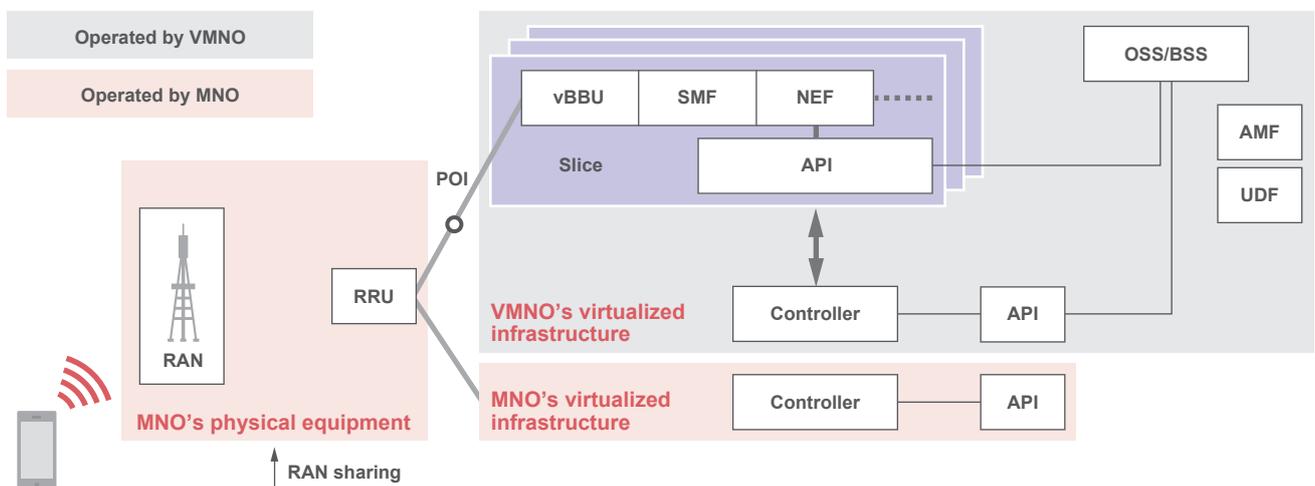


Figure 3: Anticipated structure of a full VMNO

and likely make it even easier for users to obtain the services they need in the 5G SA era.

In Japan, too, the Telecom Services Association's MVNO Committee says that the presence of VMNOs with a high degree of flexibility would accelerate the creation of innovative solutions. This benefit of VMNOs is likely to solve the problem of 5G adoption in markets/regions where 5G adoption rates are expected to be relatively slow, such as among SMEs and in rural areas.

Moreover, full VMNOs with core networks that do not rely on a specific MNO's wireless infrastructure can be expected to play a key role in driving the rollout of "local 5G"[*11], which Japan's Ministry of Internal Affairs and Communications is pushing heavily for. Full VMNOs have all components required by a local 5G operator, including SIMs, devices, virtualized infrastructure, the core network, and the OSS/BSS. And because these are independent of the operation of any specific wireless network, full VMNOs are in a position business-wise to use a whole range of wireless networks without hindrance, so they can meet the requirements of local 5G operators without worrying about sticking with any specific wireless network, which puts them in an unrivaled position. At IIJ, we believe that by being local 5G enablers, full VMNOs will be able to create completely new types of communications businesses between themselves and local 5G operators that want high-quality, low-cost private cellular connectivity on their own sites, prime examples being the owners of stadiums, hospitals, hotels, factories, and the like.

## 2.5 Challenges on the Path to VMNOs

Still, many challenges exist on the path to making VMNOs a reality. It will no doubt require action on the technical, business, and regulatory fronts. We take a closer look at each below.

Different technical hurdles present themselves for light and full VMNOs. API standardization is an issue for light VMNOs. The creation of VMNOs can easily be facilitated by standardizing the technical interface criteria for the APIs that light VMNOs need. If this standardization is not done, or is lacking, light VMNOs will have to ask MNOs every time they need an API or functionality developed, which would likely pose a tough impediment to VMNOs. An issue for full VMNOs, meanwhile, is that of enabling smooth RAN sharing. RAN sharing, which enables the sharing of a single wireless network across multiple core networks, is already used by some MNOs in Japan and is set to play a key role on the cost front as 5G rolls out ahead. RAN sharing is currently still confined to within MNO groups, but if RAN sharing across MNO boundaries takes off in the lead up to 5G, this could present a good opportunity for full VMNOs, which are likely to participate in that framework. Since these sorts of standardization efforts will not take place in one country, it will also be necessary to develop a globally shared awareness of the issues to be addressed. IIJ is an associate member of Study Group 3 (Tariff and accounting principles including related telecommunication economic and policy issues) within ITU-T, part of the United Nations' specialized agency focused on standardization in the telecommunications sector. In that capacity, we

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*11　5G systems that a range of entities, including local companies and local governments, can install in arbitrary locations, such as within buildings or other premises, in accord with the individual needs of the region or industry. 100MHz of bandwidth in the 28GHz band (millimeter wave) has already been introduced, and work is underway with the aim of formalizing arrangements for the remaining 800MHz in the 28GHz band, along with 300MHz in the lower-frequency 4.6GHz band, which makes it easier to construct coverage areas, by the end of 2020.

have already submitted a contribution to the study group that includes the VMNO concept, and we expect the discussion to evolve toward even better international recognition and understanding of the issues ahead.

On the business front, there is a need to reconcile the interests of both MNOs and VMNOs. On the one hand, VMNOs can be seen as partners to MNOs in that they increase the profitability of the 5G infrastructure (base stations, core networks) built by MNOs and help popularize 5G by developing new solutions, but on the other, they are competitors when it comes to marketing their solutions. These sorts of conflicts are something MVNOs have long faced with respect to MNOs, and the players in this space will need to continue working, both in the public eye and behind closed doors, to ensure that good partnerships remain in place in the lead up to 5G.

The biggest challenge on the regulatory front is making a major shift in the operator interconnection model for using other operators' equipment, a system in place since Japan liberalized telecommunications in 1985. The Telecommunications Business Act currently provides two models for the use of other operators' equipment: the interconnections model and the wholesale services model. In the context of MVNO data communications, in particular, the base model is interconnections, which places heavy obligations on the MNO side. The data network rental charges (in other words, the connection fees) calculated based on Ministry of Internal Affairs and Communications ordinance are applied in the case of

wholesales services as well, which has meant that MVNOs are able to use an MNO's equipment under the same conditions in both the interconnection and wholesale services models. But in the case of light VMNOs, in particular, there is no POI, that is, no physical point of connection between the operators. And even in the case of full VMNOs, where there will be a POI, there remains a discussion to be had about how the arrangement of such interconnections should be treated under the Telecommunications Business Act and how to think about the connection fees. Issues that will depend on future discussions and debate include whether connection fees should be left up to private-sector negotiations with wholesale services being the only consideration, or whether regulatory intervention should take place with respect to the fees, including how they are calculated and what the upper limits should be.

## 2.6 Conclusion

The prospects of the VMNO business model hinge on network virtualization in the 5G SA era, and as such it is still an idea for the future and not set to arrive anytime soon. But the time needed to build a completely new business model is on the order of years, as was the case for IIJ with the full MVNO model, so we believe it is crucial to get the discussion started at an early stage. IIJ is doing what it can to move things forward, not just through industry groups but through other initiatives as well. Creating a completely new business format will be no easy task, but we will continue working toward the implementation of the VMNO concept.

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Since joining IIJ in 2000, Mr. Sasaki has been engaged in the operation, development, and planning of network services.
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He is a member of the MVNO Committee of the Telecom Services Association, an MVNO industry group.