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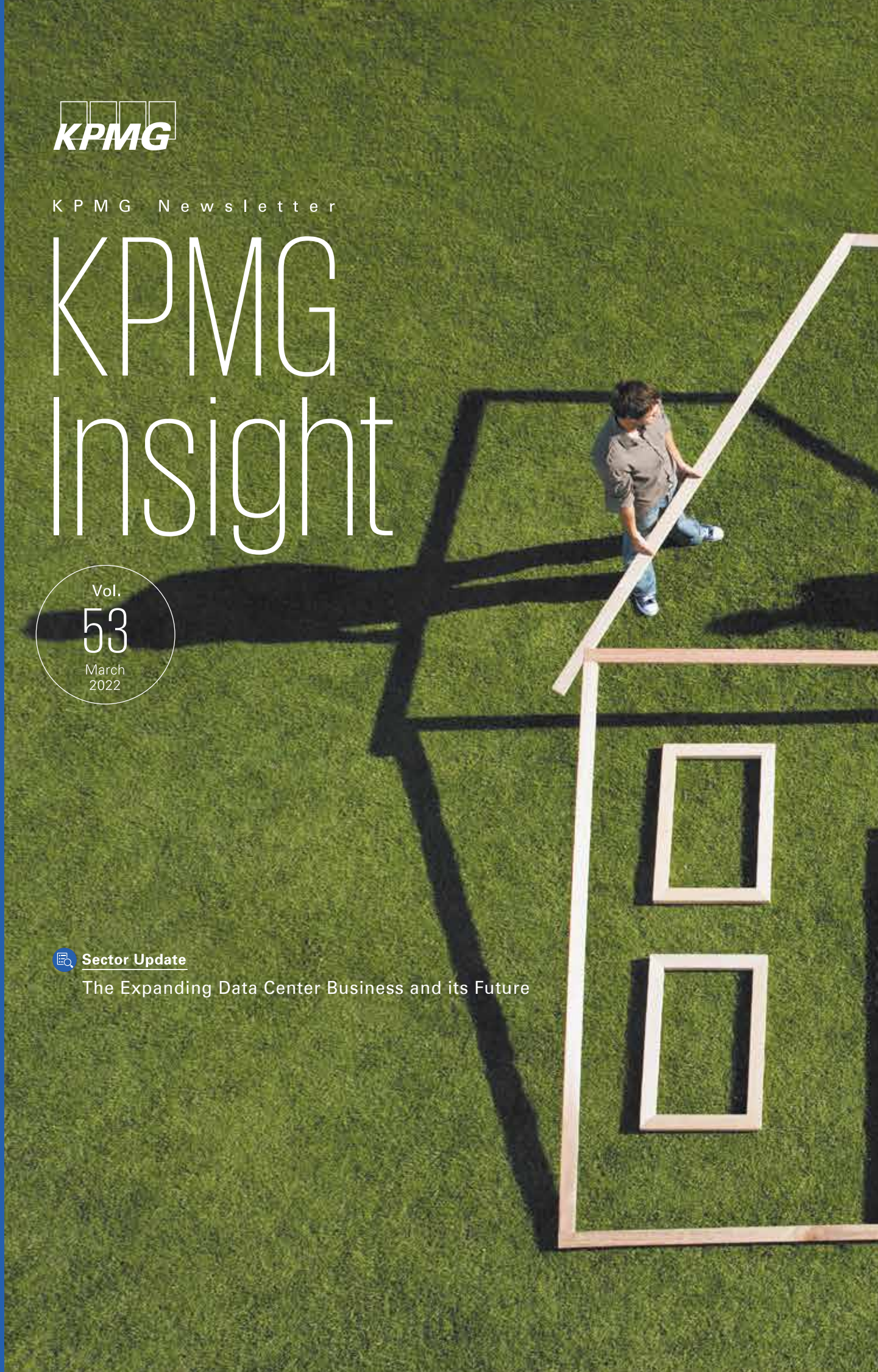

Sector Update

The Expanding Data Center Business and its Future

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There are many who, though have heard of a data center (hereinafter referred to as "DC"), do not exactly know what kind of business it is. In fact, DC is something that should be called the essential function forming the basis of the digital society. This DC business is now facing challenges posed by the evolution of cloud computing, IoT, and AI. That is because of the rising needs for new types of DCs such as cloud-type DCs (IaaS/PaaS), connectivity DCs, hyperscale DCs, and edge DCs. This report will clarify the factors essential for success in the DC business going forward, such as the requirements of new DCs and users.

Further, since power consumption is high in the DC business, the business will have to transform itself in the future from the sustainability perspective. In light of that, this report will also look at measures to decarbonize DCs as well as to make them green. Please also note that the views expressed in this report are the personal opinions of the authors.

Satoshi Wada

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POINT 1

Issues with conventional DCs

Demand for conventional DCs (hosting, housing) has been stagnant due to the evolution of IoT and the changes in the usage requirement with the advent of new technologies in the infrastructure field. At the same time, they fell into unit price wars given the dwindling differentiating factors, and the business environment is becoming increasingly severe.

POINT 2

User demand for different types of DCs

The purpose of use of DCs and the conditions vary depending on the users such as cloud computing vendors, telecommunication companies, financial institutions, and general users. Due to that, the requirements sought from DCs also tend to be diverse including scalability, location and connectivity, communication speed, ease of operation, and cost.

POINT 3

Future image of DC

With data traffic anticipated to continue growing drastically in the future, development of large-scale DCs such as hyperscale DCs as well as edge DCs that process data at the source is expected to advance. Combination with 5G/high-speed communication is a precondition for edge DCs.

POINT 4

Sustainability measures are indispensable

The power consumption at the DC facility becomes the emission rate of the DC operator. At the same time, on the user side, this would be the power used for own servers, and in the case of cloud usage, this would be the supply chain's carbon discharge. Development and expansion of green DCs contributing to a decarbonized society is being demanded by users as well as investors.

I

Conventional DC

1. Introduction

DC primarily denotes a facility that houses servers and network equipment. You probably would have seen photographs, etc. of near-futuristic and inorganic-looking spaces lined with a large number of servers. There are about 600 DCs in Japan operating commercially. In addition, if you include the DCs being operated by companies themselves as their IT infrastructure and the servers installed inside offices, the total is believed to be around 90,000, meaning the potential market is quite huge.

2. Definition and types of conventional DCs

In this report, we define conventional DCs as enterprise-type DCs operated by DC vendors for end users. These conventional DCs can be largely divided into three types based on the ownership of servers and other devices and the format of usage, etc. (see Fig. 1).

The first one is housing or colocation, where companies and other such users set up their own servers and the maintenance, operation and management are also carried out by the user. This is a service that is similar to space leasing.

The second type is hosting, where the servers and network equipment set up by the DC vendor are used by accessing them remotely or by other means from outside.

The third one combines the above two types and is called managed service. In this type, the user arranges for and owns the servers and other devices, with the DC vendor entrusted with their maintenance and operation.

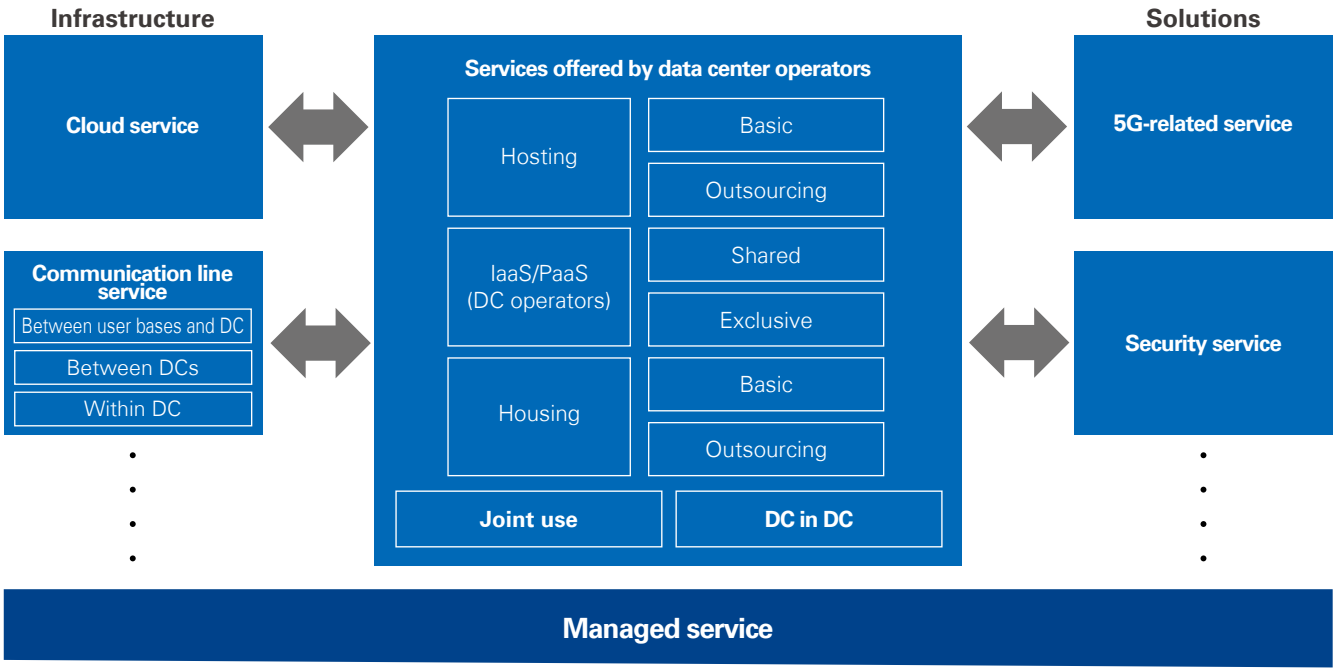
The main criterion to differentiate between housing and hosting is the necessity of company-specific factors. While hosting allows small-scale users to enjoy the economies of scale offered by the DC vendor and enables externalization and variabilization of related operations, it reduces the level of freedom in company-specific requirements. On the other hand, housing (colocation) requires labor as ownership and operation rest with the user, but makes it easier to reflect the company-specific requirements.

3. Issues of conventional DCs

In recent years, the progress of IoT and the advent of new technologies in the infrastructure field have led to dramatic changes in the usage requirements. This, in turn, led to a decline in demand and price wars due to reduced differentiating factors, and the business environment of conventional DC is becoming increasingly tough.

Specifically, housing DCs are facing issues such as decline in number of racks used due to server consolidation

Fig. 1 Service Configuration of the Data Center Business



Source: Prepared by KPMG

and transition to cloud and site closures caused by aging of facilities. Hosting DCs are also facing issues of shrinking market due to increased migration of users to IaaS/PaaS (explained later).

To be sure, there is still persistent demand for conventional DCs as a private cloud base operated under company-specific requirements. Along with responding to such demand, how to offer one-stop solutions to peripheral services such as communication and software will be the key to survival (this is not limited to offering such services in-house but also includes offering them by selecting and procuring such services offered externally).

Common problems include:

- Combined with aging, inefficiency in energy-saving has a negative impact on running costs. This makes it difficult to offer competitive pricing.
- Difficulty in giving additional values in the business of leasing server racks tends toward price wars, and consequently it is easy to end up being a constantly low-margin business.
- Given the low margin, it is difficult to secure funding for measures to address aging and for new investments.

Due to these factors, the conventional DCs are facing a vicious cycle.

4. Advent of cloud-type DCs

SaaS denotes application services offered through cloud, while IaaS/PaaS is its infrastructure version. The IaaS/PaaS market is expected to expand against the background of its introduction as the foundation for DX initiatives and the migration of backbone systems to cloud.

Amidst such a market environment, DCs specializing in offering and using large-scale server clusters that would form the base of the IaaS/PaaS cloud computing format were introduced in the market. With new demand for DX infrastructure as well as high demand for shift from on-premise and housing/hosting service, this type is expected to account for 40% of the domestic market by 20251.

This type of DC is classified depending on the offered format into shared type and dedicated type. While shared type is common, accounting for about 80%, services such as global mega OTT (short for over the top, which broadcasts contents or offers services through the internet, or its provider) that demand higher security performance tend to opt for the dedicated type.

Many of the dedicated type exclusively occupy an entire building block of a DC. There are cases where a user company is fixed at the planning stage itself and the building itself is constructed reflecting the company's specific requirements in the specifications.

An important business among the peripheral businesses associated with the cloud DC is the communication line business. That is because if there are no communication lines, a DC is nothing more than a collection of servers. It is difficult to demonstrate any differentiating factors with a standalone communication line business. And, while the communication unit price within the same bandwidth is declining due to intensifying competition, the domestic market is projected to expand by 90% in the five-year period from 2020 to 2025 thanks to the increasing demand for direct connection with mega cloud service1.

5. Signs of recovery of on-premise at some global mega OTT

The general trend around the world is migration to public cloud type where you can enjoy economies of scale by accepting the standardization under "fit-to-standard."

Global OTT also actively utilized public cloud initially and expanded it globally. At the same time, there are signs of end users using public cloud beginning to use a hybrid model (use both public and private cloud) upon re-evaluating private cloud.

The three main reasons for adopting a hybrid model are security, cost, and performance.

Security is based on compliance with the policies regarding security and privacy stipulated by the company with respect to operations.

Users can enjoy higher cost benefits in private cloud depending on the data size, as public cloud primarily employs pay-per-use.

Performance of the hybrid model offers increased freedom to fine tune the data handling, which is a differentiating factor for the company.

If there are no rational reasons for company-specific requirements but a cost item, then cost optimization is a solution through "fit-to-standard." Contrarily, if the company-specific requirement is the source of competitive advantage, it could be termed as the manifestation of carrying out investment properly.

II
User Profile and DC Requirements

There are broadly four types of users and their requirements and selection

criteria of DCs also vary widely.

1.Cloud vendor (IaaS/PaaS)

These are users who demand the highest standards. DC is the base for the cloud computing service they offer, and is directly linked to the service quality, revenue, and brand value, and therefore each company has its own high level of required standards from various aspects such as scalability, connectivity, availability, power capacity, anti-disaster measures, security, access, 24/7 operational structure, sustainability, and cost of the entire lifecycle. In particular, since scalability requires securing rack space in hundreds, users inevitably choose hyperscale DCs (to be explained later).

2.Telecommunication vendor

Internet service vendors, internet service providers (ISPs), DC vendors, etc., though different from cloud vendors in terms of scale, have a high service level as the DC links directly to the service. Internet service tends to place importance on connectivity so as to optimize the end-user experience performance. For DC vendors, the key to usage is location and connectivity in the form of DC in DC, or collocating in another vendor's facility in locations where they have not expanded into (after identifying the difference in quality standards of own DC).

3.Financial institutions

Financial institutions demand very high qualities in terms of performance, reliability, and connectivity from DCs. Currently, systems support the backbone of financial services, and there are cases where the systems are developed with budgets of hundreds of billions of yen, and obviously the user demands high quality and reliability from the DC which forms the base. Moreover, high-frequency trading (HFT), where transactions are repeatedly carried out in stock and other markets at frequencies in the nanosecond range based on algorithms, has become popular. In HFT, even a minute delay will have a significant impact on transaction succeeding or failing, and therefore users tend to demand high connectivity and the highest level of communication speed.

4.General users

While the performance demands tend to vary depending on the service being operated, they tend to focus on ease of operations and cost once the requirements are satisfied. The procurement standards are expected to incorporate sustainability-related demands led by decarbonization in the future.

III
Evolution of DCs

1.Increasing size

The expansion of streaming services following the progress made by cloud computing and the improvements in communication speed have led to dramatic increase in data traffic. Especially, volume of data generated in the last two years is said to be more than the volume generated in recorded history till then2.

Given this market situation, the size of DCs being set up is getting larger with each passing year. The main users of such large-scale DCs are global mega OTTs. Against the background of enriched web contents following the conversion to 5G, demand for large-scale DCs is expected to continue to expand.

The DCs that are driving the market in responding to such huge traffic are the hyperscale DCs (hereinafter referred to as "HSDC"). HSDCs primarily are large-scale DCs that are capable of providing power of 10,000 kVA or higher, and currently their business value is increasing. HSDCs are concentrated mainly in Inzai City in Chiba and the western region of Tokyo in the Kanto area, while in the Kansai region, they are in Osaka city center and the northeastern parts of Osaka prefecture including the Saito area. However, given the limitations on the amount of electric power that can be offered in those areas, it is difficult to expand the existing facilities, or even establish new facilities, as one has to wait for a few years to lay new high-voltage power lines in Tokyo.

The major difference between HSDCs and conventional DCs is the investment amount. A global DC vendor invested an initial amount that ran into tens of billions of yen in the Tokyo metropolitan region for one block of an HSDC it constructed. The entire project, which consists of a few blocks, is rumored to be in excess of 100 billion yen. The source funding for this project came from Asian sovereign wealth funds, and a joint venture of a global DC vendor and a Japanese company will be in charge of its operations. Such developments point to the globalization of the DC business and such projects becoming investment targets as real estate REIT.

Taking into account the size of the investment and the sales ability with respect to global mega OTT (target clients have already been acquired at the project planning stage), in order for domestic

DC vendors to engage in this business, it is necessary for them to adroitly involve related businesses with various specialized skills.

The DC business, especially HSDC, is required to have four capabilities at the time of building and further two after start of operations. Including when you are the owner or when you are involved in the business through investment, etc., it is necessary to formulate a strategy with focus on acquiring these capabilities and ensuring competitiveness upon foraying into the HSDC business (see Fig. 2).

Though the HSDC business is booming, there are also business risks and uncertainties when you look into the future. They include impact of semiconductor shortage on acquiring servers, lack of land suitable for site, shortage of energy in terms of procured power source, especially that of renewable energy when considering sustainability and climate change response.

2.New form of DC — edge DC

Conventional DCs used to focus on the speed of connection to the internet and therefore being located close to internet exchange (IX) was one of the competitive advantages. To be specific, Otemachi and Shinagawa in eastern Japan and Dojima in western Japan fall under this.

With the progress made by IoT and AI, the target of control changed from information to physical entity, and there arose the need to process large volumes of data instantaneously. However, with the existing method of transmitting data to be processed to the cloud infrastructure, the risks and impact, from congestion and processing delays due to increase in communication data and rise in processing lead time due to being physically away, will increase. Against this background rose the need to process

Fig. 2 Key Capabilities of the Data Center Business

Key capabilities			Partner candidates (Providers)
Field	At the time of establishment	In operation	
Real estate	• Finding, acquiring plot • Real estate finance • Construction project management	• Building maintenance • Real estate refinance	• Real estate agents • Overseas DC vendors (REIT)
Utility facilities	• Power source, energy • Air-conditioning • Physical security	• Utility maintenance • Internal building support • Supply and restoration during emergencies	• Maintenance service providers • Air-conditioning system providers • Security vendors
Network	• Backbone network • International network • Internet • Network security • Internal network	• Line acceleration • Inter-connection between data centers • Handling communication line failure and security • Proprietary communication line service • Internal network construction	• Japanese telecommunication vendors • Major overseas telecommunication vendors
Hardware, cloud	• Hardware (server, storage, network switch) • Cloud computing • Overall IT services	• Inter-connection with cloud service • Hosting service • Development of a new cloud service	• Overseas DC vendors • Server vendors • Major cloud service vendors • Software vendors • System integrators • Network vendors
Maintenance and operation	—	• Monitoring of the above four fields • Supervision of work plan • Incident handling	• Software vendors • System integrators • Telecommunication construction companies
Sales, delivery	(Invite key tenants)	• Wholesale sales (large-scale users) • Retail sales (small-scale users) • Marketing • Delivery project management	• Overseas DC vendors • Japanese DC vendors • Software vendors • System integrators

Source: Prepared by KPMG

data close to where it originates. And, the DC that catered to this was the edge DC. Going forward, switching to edge computing, which processes data closer to the users, will advance further in order to avoid delays caused by bottlenecks of cloud processing capability and NW band.

In the US, small-scale DCs of 1MW capacity are being built one after another primarily in provincial cities. This would, for example, enable the broadcasting of large volumes of video data to the end user without strain or delay, by choosing the optimum path with the network connecting to the edge DC, and not necessarily passing through a conventional DC.

Combination with 5G/high-speed communication will be a precondition for leveraging the advantage of an edge DC in avoiding delays. In other words, upon considering entering or getting involved in the edge DC business, it is necessary to acquire the capabilities that would enable connection with 5G mobile network such as:

- offering connectivity that takes into account handling of network slicing.
- carrying out flexible and detailed operation with SDN/NFV.
- offering optimum network matching the traffic characteristics (low latency or low-volume traffic).
- designing connectivity service with APIs rolled out by 5G carriers.

These capabilities were not sought in conventional DCs. However, for many non-telecommunication vendors considering the edge DC business, these are capabilities that they should acquire anew.

Edge DCs can be readied by loading a processing device in as small as a small-sized container, which therefore will create other fresh related business opportunities; for example, location. Edge DCs are usually established in demand areas close to the users, and therefore need to be set up at multiple sites. In light of this, there has been a movement overseas toward considering outlets of nation-wide supermarket chains as locations for installing edge terminals or acquiring outdoor signboard companies. In Japan also, there were instances where real estate property companies joined with companies offering IoT/blockchain services to provide package services to build edge DCs in idle spaces within dedicated spaces of office buildings, etc. What is even more unique in these examples is that they use smart contracts and non-fungible tokens (NFTs) for the contracts and payments.

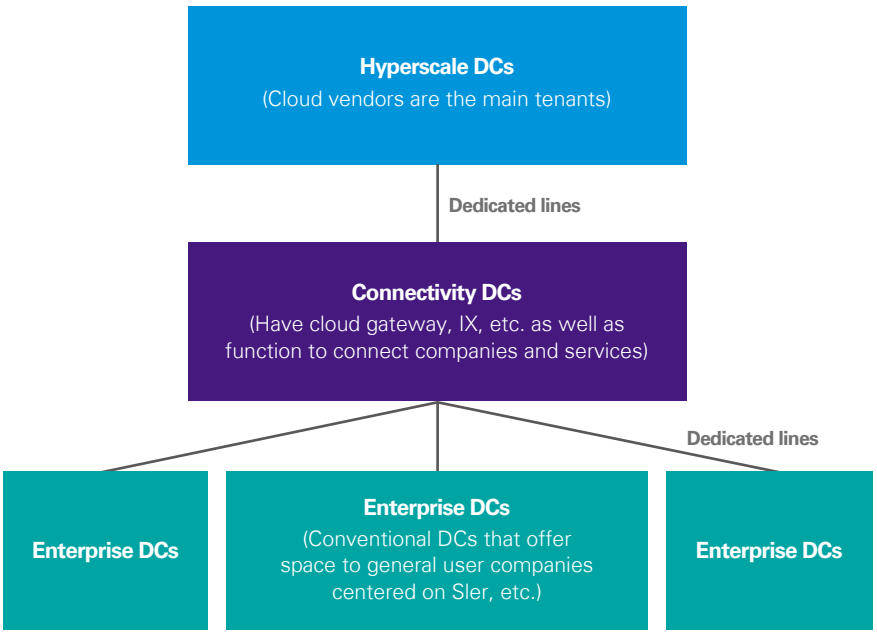
IV
Factors for Future Success of the DC Business

Going forward, the factors necessary for DC vendors to make the DC business successful can be condensed into the following three categories:

1. Scalability: Expanding the size

We use services over the internet, or cloud service, both in our private lives as well as for business, so much so that we cannot think of our daily lives or business without cloud. DCs, which house the server clusters that form the infrastructure for the cloud service, are being increasingly sought to become larger and increase capacity, and the increase and expansion of HSDCs in the suburbs of metropolitan cities, where the needs exist, is expected to continue for the time being. At the same time, the bottleneck for HSDC development is location. In order to construct large-scale DCs, not only the area of the land, but there also are various other requirements that should be satisfied such as stable ground that is earthquake and flood resistant, large capacity lines

Fig. 3 Types and Characteristics of Data Centers



Source: Prepared by KPMG

and sufficient power facilities as well as the lead time, which could take up a few years, and convenience during maintenance and emergencies.

However, such favorable locations are not that many, and development gets concentrated in regions that satisfy such criteria. In recent years, in the Tokyo metropolitan area, HSDC development progressed in the Inzai City, Tokyo Bay area, and Tama area, while in the Kansai region, it is focused in Saito, Ibaraki City, and Keihanna Science City (Kansai Science City). While large-scale development plans, with Inzai City at the forefront, are accelerating, an exploratory meeting is being held regarding development plans in Hokkaido from the perspectives of risk hedging from concentration in metropolitan areas and strengthening of resilience as well as energizing regional communities and sustainability. Where will be the next center of the DC business? That will be the primary interest of the market going forward.

2.Connectivity: Fusion with communication

DCs not only process large volumes of traffic in the internal servers but also connect, over the network, various equipment and services such as cloud services, communication vendors, ISP, Content Delivery Network (CDN), and IoT infrastructure. In particular, the progress of cloud computing seeks DCs to be faster, cheaper, and be able to connect to more diverse services, thus generating demand for urban DCs. Such DCs are called connectivity DCs, and by connecting directly with the HSDCs in the suburbs, they aggregate the traffic by serving as the gateway, and also contribute to improved performance and reduced communication line costs by functioning as a hub for mutual connection of various cloud services, ISPs, telecommunication vendors, submarine cables (international communications) and other such large-scale networks (see Fig. 3).

Connectivity DCs are generally smaller in size when compared to HSDCs (hundreds of racks per company) as they primarily house network equipment (few racks to dozens per company) such as cloud gateways. Nonetheless, deep-seated demand for connectivity DCs is expected to continue including cloud vendors and DC in DC of DC vendors given the tailwind generated by expanding cloud usage. We believe DC construction leveraging favorable locations will continue as we see cases of major real estate companies leading the entry into the business by setting up connectivity DC floors when constructing large buildings in city centers.

3.Sustainability: Realizing sustainability

Sustainability, especially decarbonization, is a pressing task for the DC business. The share of global energy demand accounted for by the telecommunications industry is expected to expand to 20% by 2030, with a major portion of that consumed by networks and DCs.

Power consumption due to DC's facilities are treated as the emissions of the DC vendor itself (Scope 2[3]), and if the user is having own server (on-premise) it becomes the power consumed by the user (Scope 2[3]). In the case of usage by cloud, it is treated as carbon emission of the supply chain (Scope 3[3]). Against this backdrop, users and investors are widely seeking the development and expansion of green DCs that contribute to a decarbonized society. Further, from the perspective of the user, there have been studies showing that switching to cloud computing improves energy efficiency compared to on-premise servers, which is consistent with promoting cloud computing for advancing decarbonization of own company.

Decarbonization of DCs is largely made up of two actions. One is improving the PUE (Power Usage Effectiveness of air-conditioning, power source, and other such facility parts excluding telecommunication equipment). The other is switching to renewable energy.

Major cloud vendors and global mega OTTs have been significantly steering toward green DCs already. In fact, of the top 10 companies procuring green energy globally in the 2000 to 2020 period, six are major technology companies4 engaged in cloud services and the DC business, while the leading global DC vendors have stated goals to introduce 100% renewable energy. Globally, being a green and sustainable DC with decarbonization at the forefront is an indispensable prerequisite for survival. However, in the US, where most of the major DC vendors are concentrated, green energy investments are being promoted by giving tax credits and the enormously profitable technology industry is actively utilizing this scheme. So, attention should be paid to regional characteristics.

In Japan, we are expecting to see investment in green DC research and development such as the announced zero-emission DC plan of Ishikari City, Hokkaido, a project that leverages the advantages of the cold climate and proximity to a renewable energy electric

power plant. Further, the name of a global mega OTT cropped up as a key user of a company that bid for the construction of Japan's first offshore wind power plant in the bidding held in December 2021, pointing to the necessity of paying attention to the competition among cloud and DC operators over the limited renewable energy-based power sources in Japan.

4.Conclusion

Given the impact of mega trends such as digitization of society, increasing use of cloud service in IT services, and sustainability, the DC business is at the turning point for switching to a new business model. In the midst of these changes, including the growth of global mega OTTs, elimination and integration of DC vendors, new entrants leveraging unique assets such as operation knowhow, new technologies, and real estate, diverse players are mutually collaborating and actively engaging in the expanding DC market. In a society where cloud, AI, and IoT are becoming commonplace, the importance of DCs is expected to increase further.

KPMG Japan, in collaboration with the dedicated data center team of KPMG Global, provides support for conducting market research in Japan and abroad, formulating the DC business and entry strategies, and due diligence, etc. We hope that this report will be of help in enhancing your interest in and understanding of DCs so that you can wisely utilize them as a user or take them on as a new business opportunity.

1 Nikkei XTECH ACTIVE. (October 26, 2021) https://active.nikkeibp.co.jp/atcl/act/19/00006/092100173/

2 Bjarkefur, Kristoffer, Cardoso de Andrade, Luiza, Daniels, Benjamin, & Jones, Maria Ruth. (2021) Development Research in Practice: The DIME Analytics Data Handbook Washington D.C., World Bank. © World Bank

3 Supply chain emission classification of GHG Protocol, which is the international standard for calculating and reporting GHG emissions.

4 Bloomburg NEF https://www.ft.com/content/0c69d4a4-2626-418d-813c-7337b8d5110d

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