White Paper

Building a Successful Hybrid Cloud Infrastructure

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IDC OPINION

Enterprises are increasingly adopting a hybrid cloud infrastructure as it combines the best of private and public clouds. Private cloud fulfills regulatory requirements and addresses latency issues, while public cloud supports scalability of IT resources and access to innovation accelerator services.

IDC's recent study shows that hybrid cloud and multi-cloud approaches are becoming the norm with at least 60% of Asia/Pacific excluding Japan (APEJ) organizations across all industry verticals deploying a mix of public and/or private clouds for various workloads.

Despite the high growth of public cloud market, on-premises private cloud is still the preferred deployment choice for most organizations in the region with non-cloud application churns favoring private cloud for easy lift and shift scenario.

All said, the choice of cloud deployment models will still be an application-led decision, and the growth of cloud-native applications development will swing to public cloud deployment.

Public cloud services continue to be the largest opportunity and engine of growth for the cloud market in the region. Public Infrastructure-as-a-Service (IaaS) enterprise consumption spending in 2019 totaled US$12.9 billion. That amount is estimated to triple to US$41.4 billion in 2023, representing a compound annual growth rate (CAGR) of over 37%.

AT A GLANCE

KEY STATS

- At least 60% of organizations deploy a mix of public and/or private clouds.
- The public IaaS enterprise market will triple from US$12.9B in 2019 to US$41.4B in 2023.
- In the same period, the private cloud market will grow from US$11.9B to US$22.6B

WHAT'S IMPORTANT

- The next big wave will be the adoption of cloud across distributed locations.
- By 2021, over 90% of enterprises in APEJ will rely on a mix of on-premises/ dedicated private clouds, several public clouds, and legacy platforms to meet their infrastructure needs.

KEY TAKEAWAY

Cloud service providers need to develop strong multicloud integration and management capabilities, and align their service offerings around the distributed cloud stacks.

Public cloud's dominance is increasingly driven by the fact that the major public cloud platforms, collectively, are becoming the number 1 source for innovation in new technology.

This is also spurred by the continued expansion of public cloud infrastructure deployments across the region by some public cloud service providers, such as AWS, Microsoft, Alibaba Cloud, Google Cloud and Huawei Cloud, to address the geographic requirements of public cloud infrastructure and deliver multi-cloud options for enterprise customers via "sell with" models with independent software vendors (ISVs) and private cloud infrastructure providers.

Private cloud infrastructures also show significant growth as non-cloud application churns which favor private cloud deployment. The combination of spending on hardware, software and services that enable enterprises to build and own their own private cloud systems and services (enterprise private cloud) and private cloud infrastructures delivered "as a service" by service providers (hosted private cloud) generated $11.9 billion in 2019. However, private clouds will grow at a slower rate of about 17% through 2023, reaching $22.6 billion (close to half of the public cloud infrastructure).

This growth is also driven by the emergence of "local cloud" offerings: a new class of remotely managed and distributed offering from the public cloud providers like AWS Outpost and Oracle Cloud at Customer that connect, and are compatible with, their public cloud offerings. This will facilitate the increasing shift of workload on cloud infrastructures (both public and private), extending deployment from enterprise datacenters to cloud to edge locations.

With the increase in cloud-native workloads and continued shift of existing workloads onto cloud infrastructures, it is necessary to enable application interoperability across any cloud infrastructures via containerization technology. Organizations' infrastructure end state will be a hybrid IT environment, a mix of public clouds, private clouds and some traditional non-cloud IT infrastructure, leveraging different cloud platforms across multiple service providers for scalability, performance, and governance.

IN THIS WHITE PAPER

This IDC White Paper explores the customer challenges associated with building and managing a hybrid cloud infrastructure in the context of the digital transformation (DX) journey. It also highlights the top priorities, business and IT challenges, and trends impacting cloud adoption for Asia/Pacific organizations, and provides guidance for end-user organizations.

SITUATION OVERVIEW

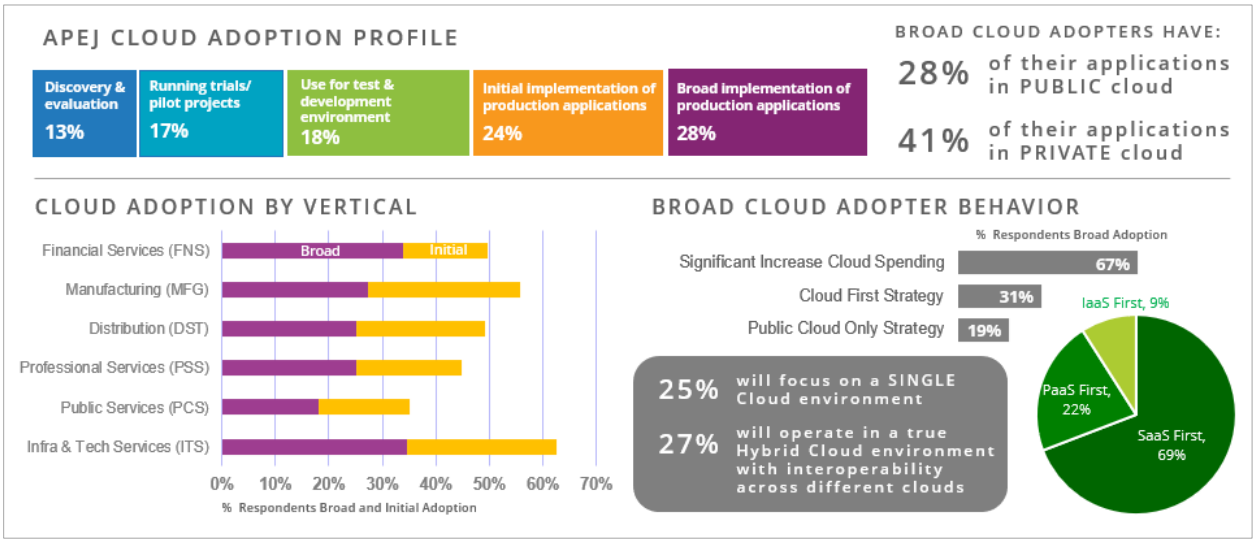
The State of Cloud in Asia/Pacific

Enterprises' continuing strategic focus on digital innovation and transformation to stay competitive will be a key driver of cloud growth. APEJ spending on the technologies and services that enable the DX of business practices, products, and organizations is estimated to be US$375.8 billion in 2019. This spending is expected to steadily expand to 2023 at a CAGR of 17.4%. Most of these initiatives (and resulting digital innovations) will require cloud technologies and solutions to power them, making DX the number 1 driver of cloud spending for the foreseeable future.

Figure 1 provides a snapshot of the state of cloud adoption in APEJ, based on IDC's Cloud Pulse 2019 that surveyed 931 IT decision makers and influencers responsible for their organizations' cloud adoption strategies and investments.

FIGURE 1

State of Cloud Adoption in Asia/Pacific (excluding Japan)



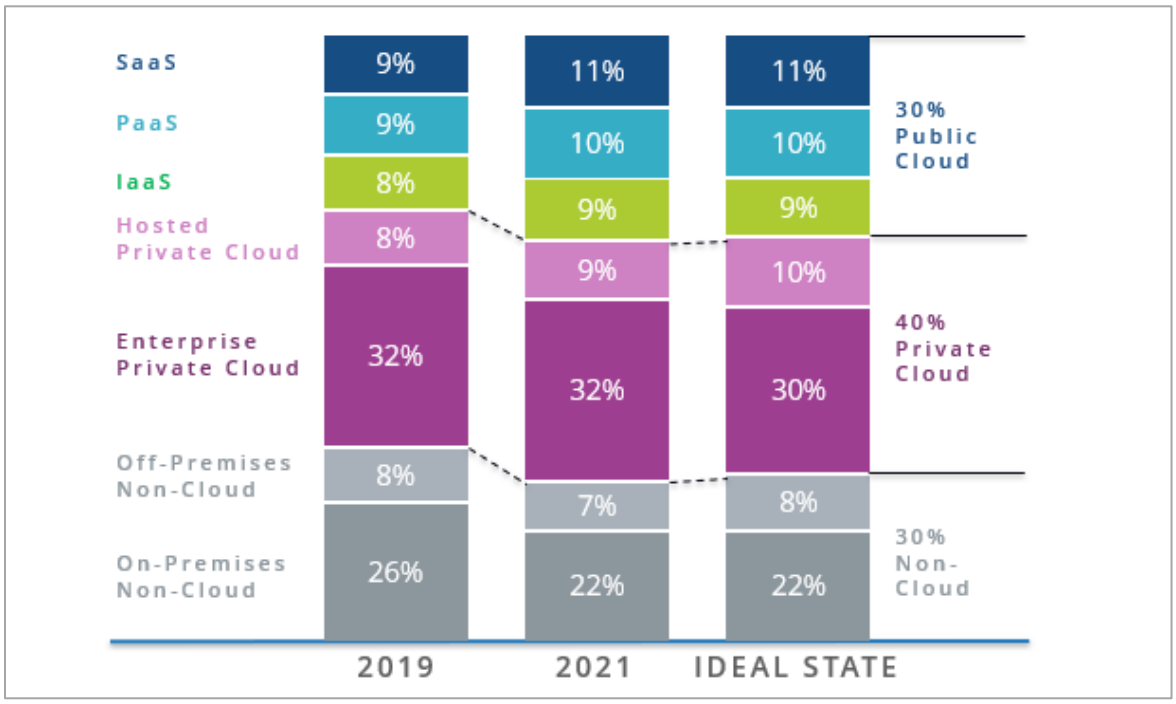
Source: IDC Cloud Pulse Q1 Survey 2019 (N = 931, APEJ)

It shows that more than half of APEJ enterprises already have their production workload on cloud, just passing the threshold point of cloud vs non-cloud, and we expect the adoption rate to accelerate in the coming years. Looking at the percentage of workload distribution in public and private cloud infrastructures, it is also evident that private cloud continues to be the primary deployment model in APEJ. This is expected because non-cloud application churns prefer private cloud deployment for ease of migration and management.

IDC's Cloud Pulse 2019 survey shows substantial workloads will be shifting to cloud but a proportion (30%) of legacy applications will remain as non-cloud leading to a hybrid IT environment (see Figure 2).

FIGURE 2

Overall Workload Placement in Asia/Pacific Excluding Japan



Source: IDC Cloud Pulse Q1 Survey 2019 (N = 931, APEJ)

In recent years, there has been a tremendous movement of applications across all cloud/non-cloud environments in the region, which includes the new builds, migrations and retirements. This trend is expected to accelerate as new cloud platforms and frameworks continue to emerge to meet growing customer needs for mainstream competencies.

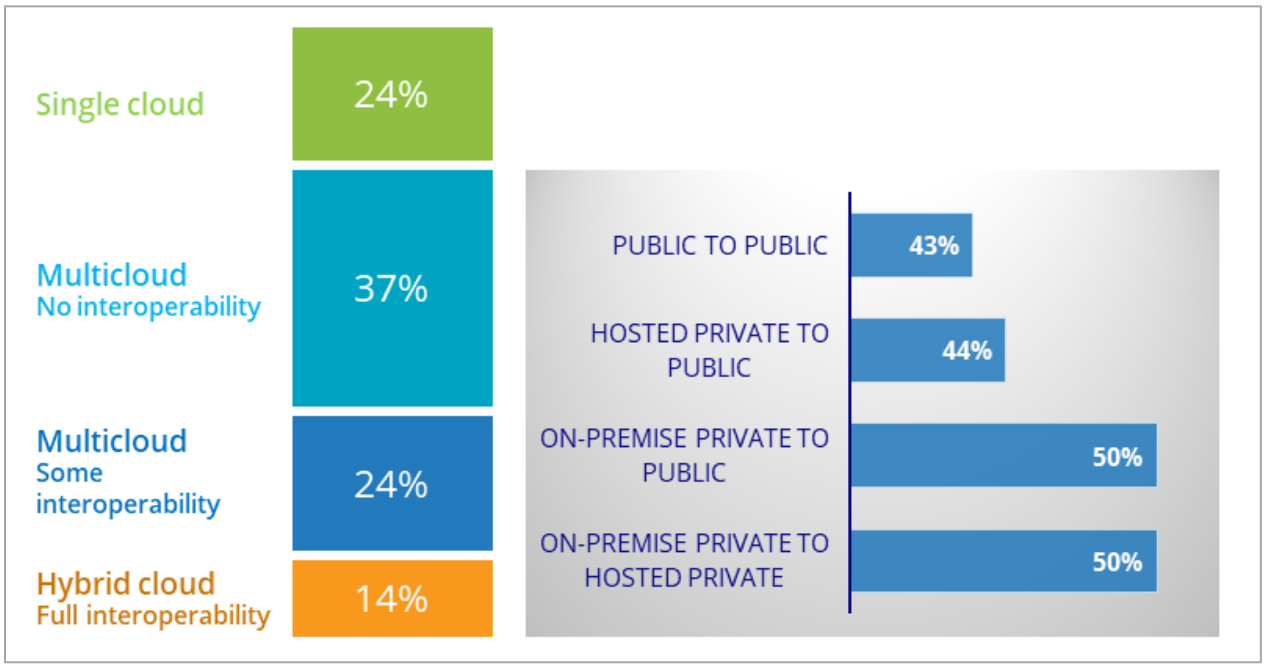
Although the “ideal state” of workload placement overall does not look dramatically different from today, there is a dramatic shift “under the hood” due to portfolio churn. More than 60% of survey respondents are reporting repatriation of workloads from public to private clouds especially among the larger enterprises. However, public cloud environment is garnering the greatest “net growth” of above 30% due to the acceleration of new cloud-native builds on public cloud platforms.

Although on-premises private cloud is still the preferred deployment of choice with most organizations in the region, public cloud’s elasticity is preferred by enterprises lacking economies of scale, such as SMBs. There has also been a rapid growth of new digital businesses in the region that favor public cloud's scalability and speed of deployment, especially among tech startups and online businesses, who are partial to public cloud deployment over private. All these developments have all contributed to the rapid growth of the public cloud market.

However, it must be noted that many enterprises in the region still hold most of their legacy applications, data and systems on-premises. They will need time to fully migrate them to cloud infrastructures (private and public), taking into account the shelf life or end-of-life of existing IT assets, and keeping a close eye on costs, while causing minimum disruption to their business.

FIGURE 3

Hybrid and Multicloud Approaches in Asia-/Pacific (excluding Japan)



Source: IDC Cloud Pulse Q1 Survey 2019 (N = 931, APEJ)

Figure 3 shows the state of hybrid and multicloud approaches in the region.

Three in four enterprises in the region already operate in a mix of public and private cloud environments. Only a quarter employ a single cloud. Hybrid and multi-cloud approaches are now the norm, meaning that the interoperability of applications across different clouds will become a key architecture requirement in the coming years.

IDC research also shows the shift among developers to modular application design that leads to an expanding, disaggregated IT application portfolio where interdependencies between applications and data will rise dramatically. Each business application has 4-8 other application dependencies, and complexity in management is expected to rise rapidly over the next two years in the hybrid multi-cloud environment.

We can also expect public cloud connectivity to improve significantly in the face of broad-based consumption demand for a myriad of services to be run effectively across multiple cloud service providers (see Figure 3).

Complexity and cost management will come into focus as enterprises place significant value on application performance, security and costs. The growing volume of data held outside the core datacenters across multiple clouds will also increase the complexity. It is reported that cloud security remains the top inhibitor to cloud adoption. However, IDC research also reveals that this sentiment has shifted over the past two years and has now become a driver for cloud adoption as organizations strive to modernize their existing IT infrastructures.

Public Clouds Becoming the Primary Route to Access IT Innovation

Over the past several years, major public cloud services suppliers have introduced a steady stream of innovative IT services, including a wide variety of artificial intelligence (AI) related services, blockchain services, Internet of Things (IoT) back-end services, augmented reality/virtual reality (AR/VR) back-end services, robotics back-end services, encryption services, container services, serverless computing services, and even new computing hardware services (GPUs, FPGAs, AI-optimized processors, and quantum computers). We expect that the pace of IT innovation launches on public clouds will continue and, more likely, accelerate over the coming years.

Developers seeking access to the latest IT innovations are likely to find them on one or more of the major public cloud platforms. Therefore, virtually 100% of enterprise developers and commercial developers will build public cloud services into their digital offerings; indeed, many developers will center their development efforts on the PaaS offerings in the public clouds.

Organizations that do not aggressively leverage these public cloud developer services will quickly find themselves isolated from most IT innovations in the marketplace.

The variety of cloud services and third-party professional and managed services focused on enabling traditional enterprise workloads on public clouds has expanded dramatically over the past few years. We expect the ecosystem of tech companies supporting these cloud environments to expand rapidly as well, providing cloud services and professional and managed services in the public and hybrid cloud arenas.

This will push third party companies to be trained and focused on helping enterprise customers migrate to cloud environments, create new innovations in the cloud, and manage their increasingly large and growing cloud-based infrastructure environments in their cloud adoption journey.

New Cases of Distributed Cloud Offerings

IDC has previously predicted that the public cloud would be going everywhere and a new "distributed cloud" model that supports on-premises and edge ("hybrid") deployment, as well as multivendor ("multicloud") support of public cloud software stacks, would emerge.

This has already become a reality as one by one, the major public cloud platform players announced their distributed cloud platforms over the past one year. This on-premises, edge, and multicloud expansion of public cloud vendors' platforms will also become the dominant model. IDC has forecast that by 2023, at least 25% of public cloud stacks will be deployed on on-premises and edge systems.

IDC believes the next big wave of cloud adoption will be fueled by enterprises adopting the cloud across distributed locations and that the ability to support "hybrid" and "multicloud" — that is, distributed cloud — deployments will be a must for all cloud service providers. These are becoming "the stacks that matter" — for the next decade and likely beyond.

IDC believes the next big wave of cloud adoption will be fueled by enterprises adopting the cloud across distributed locations, and that the ability to support "hybrid" and "multicloud" deployments will be a must for all cloud service providers.

Suppliers will be providing "on-premises" and/or edge products or services to enterprises that are built on, connected to, or somehow provide value within the context of the public cloud service providers' portfolio of technologies and services.

Lingering Worries About Security

IDC's 2019 Industry CloudPath Survey of almost 2,000 enterprise respondents has shown that at least 40% of enterprises evaluating clouds (either public cloud and/or private cloud) have indicated security as the area of greatest concern. This is not new as concerns about security in the cloud have been a constant finding in all cloud user annual surveys conducted by IDC since 2009.

However, the same 2019 Industry CloudPath Survey also reveals that a similar percentage of respondents cited security capabilities available from cloud service providers as a top benefit of moving to the cloud.

The results vary somewhat between IT executives and line-of-business executives, with the former pointing to security as the top benefit while the latter ranking security number 2, behind business agility.

While security (and related issues of privacy and trust) continues to give pause to enterprises moving systems and data to the cloud, the interval of these pauses will shorten over time as the reasons to move to the cloud become more compelling with the inclusion of stronger security measures.

Security will remain a high priority for enterprises moving to the cloud, and also a major source of opportunity for cloud vendors that can effectively address these concerns. IDC expects security will transform from being an inhibitor to an enabler for enterprises' move to cloud in the next few years.

Concerns About Vendor and Technology Lock-in and Interoperability

Lock-in to proprietary cloud services remains a concern for many enterprises. Although developers (and their organizations) are excited about the new capabilities offered by each public cloud service provider, IDC 2019 Industry CloudPath survey shows that 30% of enterprises are reluctant to become too dependent on single-source services.

Over the past few years, IDC has seen a growing number of major cloud service providers showing a willingness to embrace open source models, and have begun to introduce multicloud offerings, allowing some of their cloud services to run on competitors' clouds.

There is also a growing community of third-party cloud, professional, and managed services providers focused on helping enterprises interconnect to/from proprietary cloud services.

The continued progression of these approaches and the adoption of hybrid cloud infrastructure will gradually diminish the lock-in concerns of enterprises.

Total Cloud Infrastructure Market

Table 1 shows the APEJ total cloud infrastructure market size and forecast by enterprise consumption model from 2018 to 2023. The forecast shown is expressed in US dollars. Table 2 shows the APEJ total cloud infrastructure market size and forecast by deployment location for 2018–2023.

TABLE 1

APEJ Total Cloud Infrastructure Revenue by Enterprise Consumption Model 2018 – 2023 (US$M)

	2018	2019	2020	2021	2022	2023	2018-2023 CAGR (%)
PUBLIC CLOUDS	8694.8	12,866.1	18,533.2	25,471.9	33,156.2	41,370.9	36.6
Infrastructure as a service (IaaS)[1]	8,318.4	12,385.8	17,927.2	24,705.7	32,189.8	40,152.2	37.0
Professional services[8]	376.5	480.3	606.0	766.2	966.4	1,218.7	26.5
HOSTED PRIVATE CLOUDS	4,214.2	4,849.1	5,777.1	6,911.8	8,262.6	9,837.3	18.5
Hardware[2,3]	2,414.4	2,687.6	3,083.9	3,575.6	4,125.1	4,693.2	14.2
Software/systems infrastructure software (SIS)[5,7]	566.3	660.6	799.4	951.3	1,129.5	1,351.0	19.0
Professional services[8]	1,233.5	1,501.0	1,893.9	2,384.8	3,007.9	3,793.1	25.2
ENTERPRISE PRIVATE CLOUDS	6,060.8	7,017.2	8,073.9	9,510.5	11,075.8	12,729.4	16.0
Hardware[2,4]	4,291.4	4,914.7	5,527.5	6,414.9	7,319.9	8,168.9	14.0
Software/systems infrastructure software (SIS)[5,7]	1,006.5	1,208.0	1,432.8	1,706.8	2,004.3	2,351.6	18.5
Professional services[8]	762.9	894.6	1,113.6	1,388.8	1,751.6	2,208.9	23.7
TOTAL	18,969.9	24,732.4	32,384.2	41,894.2	52,494.5	63,937.6	27.5

1. For more details on IaaS, see IDC Worldwide Semiannual Public Cloud Services Tracker - Forecast 2019H1.
2. For more details, see IDC Worldwide Quarterly Cloud IT Infrastructure Tracker - Forecast 2019Q2.
3. Hardware for hosted private clouds was estimated as equivalent to the "private cloud off-premises" segment in IDC Worldwide Quarterly Cloud IT Infrastructure Tracker.
4. Hardware for enterprise private clouds was estimated as equivalent to the "private cloud on-premises" segment in IDC Worldwide Quarterly Cloud IT Infrastructure Tracker.
5. "Software/SIS" is the sum of spending on storage, security, management, network, and system software to enable the creation/delivery of cloud services.
6. IDC's Cloud Team developed data for software/SIS specially for this study; as with hardware, provisioning hosted private clouds was considered equivalent to the "private cloud off-premises" in IDC Worldwide Quarterly Cloud IT Infrastructure Tracker.
7. IDC's Cloud Team developed data for software/SIS specially for this study; as with hardware, provisioning enterprise private clouds was considered equivalent to the private cloud on-premises segment in IDC's Worldwide Quarterly Cloud IT Infrastructure Tracker.
8. Data is derived from Worldwide Digital Transformation Professional Services Forecast, 2018-2022 (IDC #US44124518, December 2018) from the cloud segment plus the portions of the other three 3rd Platform pillars that leverage the cloud. Note: In contrast, the DX professional services cloud data reflects only projects that have a primary goal of putting foundational cloud services delivery capabilities in place (i.e., excludes projects with mobile, big data, and social solutions as the focus). The split across three cloud delivery models was developed specially for this study.

Source: IDC, 2019

TABLE 2

APEJ Total Cloud Infrastructure Revenue by Deployment Location, 2018-2023 (US$M)

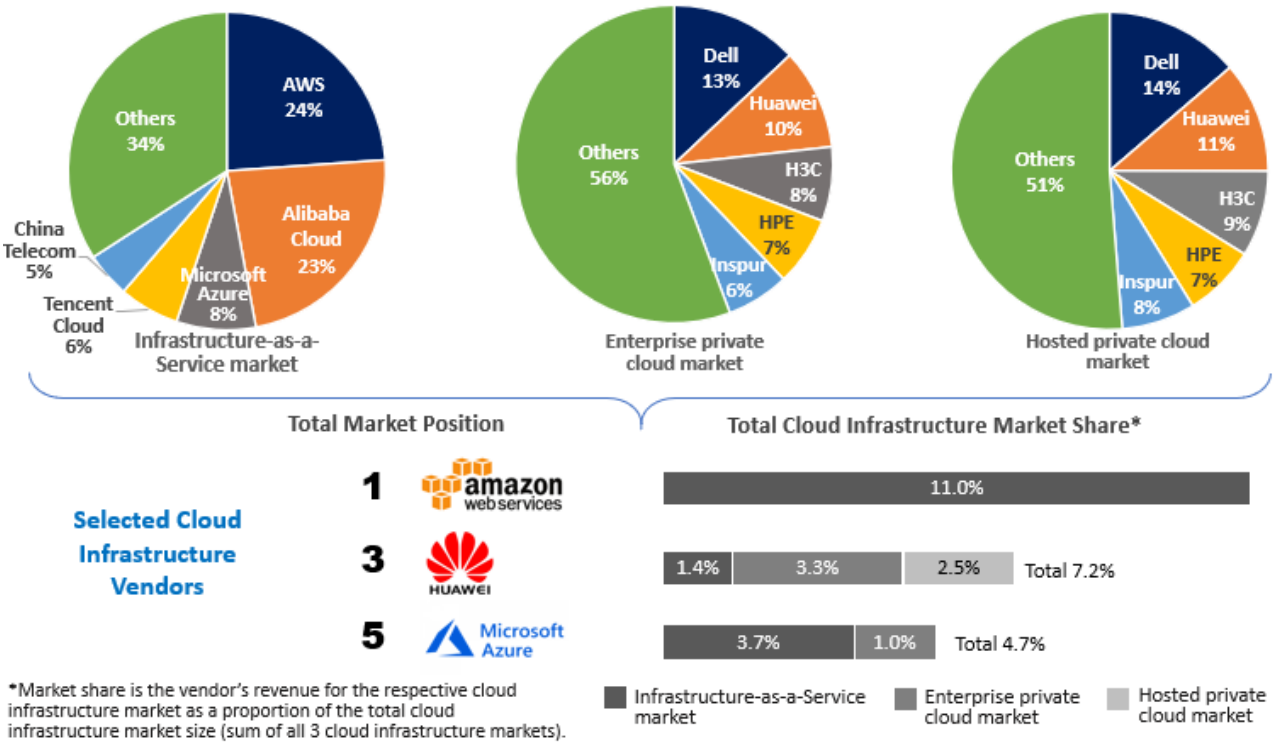
	2018	2019	2020	2021	2022	2023	2018-2023 CAGR (%)
Off-Premises	12,909.1	17,715.2	24,310.3	32,383.7	41,418.7	51,208.2	31.7
On-Premises	6,060.8	7,017.2	8,073.9	9,510.5	11,075.8	12,729.4	16.0
Total	**18,969.9**	**24,732.4**	**32,384.2**	**41,894.2**	**52,494.5**	**63,937.6**	**27.5**

Source: IDC, 2019

The total enterprise consumption spending on cloud infrastructures is valued at US$24.7 billion in 2019 and will grow at a CAGR of over 27% through 2023, to US$63.9 billion. Public cloud infrastructure spend will be growing at twice the rate of private cloud infrastructure during this period, driven by the previously discussed role of public cloud as the primary source for innovation in new technology, and the continued geographic expansion of public cloud infrastructure deployments by some of the major public cloud service providers in the region.

FIGURE 4

Key Vendors in the Total Cloud Infrastructure Market



Source: IDC Public Cloud Services, Cloud IT Infrastructure and Software Trackers, 2019

Prominent public cloud infrastructure providers in the APEJ region are AWS, Alibaba Cloud, Microsoft, Tencent Cloud and China Telecom (source: IDC Public Cloud Services Tracker). For private cloud infrastructure, the major vendors include Dell, Huawei, H3C, HPE and Inspur (source: IDC Cloud IT Infrastructure and Software Trackers). Taking the cloud infrastructure market as a whole, three of the top cloud infrastructure vendors in the region are highlighted below for their unique approach to the hybrid cloud infrastructure market:

- **AWS** – Started as a pure play IaaS player with its EC2 compute and S3 storage. Progressed to hybrid (VMware Cloud on AWS) and on-premises (AWS Outposts) recently.
- **Huawei** – Started as a hardware vendor offering private cloud infrastructure build with its compute, storage and networking hardware and software. Progressed to IaaS play with its Huawei Cloud offerings. With the recent convergence of its private and public cloud offerings, it now provides the full stack of hybrid cloud infrastructures.
- **Microsoft** – Started as a software vendor SaaS player and moved to IaaS play with its Azure VM, and partnering other ISVs to run their SaaS offerings on Azure. Progressed to hybrid and on-premises (Azure Stack on edge locations through partnership with hardware vendors like Dell, HPE and Huawei).

FUTURE OUTLOOK

Distributed Clouds

IDC predicts that by 2021, over 90% of enterprises in APEJ will rely on a mix of on-premises/dedicated private clouds, several public clouds, and legacy platforms to meet their infrastructure needs. IDC's Cloud Pulse survey 2019 has shown that hybrid and multicloud deployments are now the norm for APEJ organizations with 75% of enterprises reported to be operating in a mix of private and public cloud environment with a majority of the cloud connection points in on-premises private clouds.

Hybrid cloud will increasingly be an important part of enterprise architectures as storage and computing shift to the edge to address the need to collect and process large volumes of data locally. Hybrid cloud strategies on top of multicloud architectures will also provide additional levels of integration and portability to support distributed demand of many emerging data-intensive applications.

With the continued deployment of public cloud software stacks like Azure stack and OpenStack on on-premises and edge systems, more APEJ enterprises will be motivated to adopt cloud platforms across distributed locations and from different public cloud service providers to meet their business goals.

Multicloud Management

As APEJ enterprises move towards adopting hybrid and multicloud strategies, the requirement for cloud interoperability and management increases. IDC's Cloud Pulse survey 2019 has shown that management of complexity and the lack of automation tools are two of the top obstacles organizations face in their journey to cloud.

As APEJ enterprises move towards adopting hybrid and multicloud strategies, the requirement for cloud interoperability and management increases.

End users in the region are following the global trend of adopting Kubernetes and multicloud management tools and processes to enable an efficient approach to the growing complexity across the range of cloud deployment types. IDC predicts that by 2022, 55% of APEJ enterprises will deploy unified VMs, Kubernetes, and multicloud management processes and tools to support robust multicloud management and governance across on-premises and public clouds.

This convergence of cloud and container management solutions will accelerate as policy engines, cost management, performance monitoring, and other management activities increasingly rely on shared analytics and data lakes to support end-to-end root cause analysis, automated configuration and remediation, and ongoing optimization activities.

In light of this, we will see more management and governance services being offered by the major public cloud providers in the form of purpose-built SaaS solutions that will be widely deployed to support consistent infrastructure configuration, migration, and monitoring across on-premises and public clouds, and container infrastructure and services. End-user experience, cloud cost tracking, transaction health, compliance, and security policies will all need to be consistent across multiple clouds and applications. IDC survey shows that users in APEJ are cognizant of the need as cost management and containment is the top area of investment they will focus on in the next two years.

Hyperagile Applications

IDC predicts that by 2023, half of APEJ enterprise applications will be deployed in a containerized hybrid/multicloud environment to provide agility, delivering a frictionless deployment and management experience. This is driven by enterprises' need to make their data and applications interoperable across different cloud platforms among multiple service providers. The mass adoption of container deployment platform across all clouds and on-premises IT infrastructures will enable containerized workloads to run on any infrastructure, delivering a frictionless consumption experience for enterprises and public cloud users.

Public cloud vendors are playing a huge role in container adoption through partnerships to create a large and open ecosystem like Kubernetes, which is supported by some of the major cloud providers in APEJ like AWS, Microsoft Azure, Alibaba Cloud and Huawei Cloud. Containers and cloud-native applications have already been established and proven to be successful in web-scale companies. It is beginning to gain traction in enterprises and will be changing how they approach development and operations (DevOps).

Hybrid Cloud Infrastructure Usage Scenarios

The growth of public cloud adoption in the enterprise IT environment has made “hybrid cloud infrastructure” the new norm in IT organizations. But hybrid cloud infrastructure is not a homogenous requirement or a single capability, and it is important for organizations to understand their specific hybrid usage type, roadmap and needs.

Enterprise IT organizations' adoption of public cloud infrastructure to replace or complement their existing infrastructure has evolved at a relatively steady pace in the region. As discussed in the earlier section, the majority of organizations today are actively using IaaS in one form or other. However, there continues to be demand and investment in on-premises infrastructure systems. This demand and continued investments are driven by three broad factors:

- There are a number of workloads that cannot be immediately moved to public cloud due to latency and colocation restrictions. This could be with respect to physical entities (such as an

operations floor) or other applications and data sets that cannot move to the cloud (such as a legacy data processing application running on a mainframe).

- There are workloads and data sets that cannot be placed in a public cloud due to regulatory compliance or internal policy restrictions. These are often a result of misperceptions or a lack of understanding of public cloud security models, limited regulatory or compliance certifications offered by the public cloud services provider, or simply the lack of availability of such certifications. These continue to be a major factor slowing the momentum of workload movement into public cloud.
- Nearly all large enterprise IT organizations have existing on-premises infrastructure and datacenter investments. The use of public cloud infrastructure does not mean an immediate discontinuation of these assets, and the adoption of public cloud is often a gradual process in these enterprises.

These have resulted in a growing number of organizations adopting a hybrid cloud infrastructure environment – a mix of public, on-premises private and hosted private cloud infrastructures. Some organizations are able to manage these infrastructures in an integrated manner with full interoperability with most if not all their application workloads, resulting in a "true hybrid" cloud infrastructure. However, these organizations make up a minority – about 14% as shown in Figure 3. The variance and lack of consistency make it challenging for most IT organizations to specify and implement the level of hybrid integration required.

IDC research has highlighted six broad scenarios of hybrid cloud infrastructure use by IT organizations which are summarized in Table 3.

TABLE 3

Six Hybrid Cloud Infrastructure Use Scenarios

Usage Scenario	Description
Best-of-breed infrastructure	Use of public cloud or on-premises infrastructure for specific workloads or components, based on what serves the needs best
Tiering and archive	Use of public cloud for tiered placement of older or noncritical data or workloads from on-premises infrastructure
Test/dev and staging	Use of public cloud for development, testing, and staging phases of applications or upgrades, with production being placed into on-premises infrastructure
Backup and disaster recovery	Use of public cloud as a backup and disaster recovery (DR) site to an active on-premises infrastructure site
Migration	Use of hybrid infrastructure as a means to execute a gradual migration from on-premises into public cloud infrastructure
Bursting	Use of public cloud, alongside on-premises infrastructure, as a mechanism to provide additional infrastructure capacity when needed for temporary periods of time

Best-of-breed Infrastructure

Public cloud and on-premises infrastructure options have their respective benefits and challenges. The components of workload portfolio are best served by the specific benefits available on one or the other. Use of public cloud and on-premises may be either integrated or completely disconnected, e.g.,

- Integrated – Separation of layers in a three-tier application architecture, using public cloud for low-latency access at the presentation tier, and on-premises infrastructure at the data tier.
- Disconnected – The use of public cloud for specific customer-facing applications such as digital marketing assets and on-premises infrastructure for internal workloads such as enterprise resource planning (ERP) applications.

Hybrid infrastructure usage by new digital economy companies, including those that were born in the cloud, typically operates in a disconnected manner. This type of usage does not normally run the same workload on both infrastructure location, and does not require a high level of consistency in public and on-premises cloud infrastructure environments. But such set up would benefit from consistency in the control and operations of the resources (provisioning, auditing, monitoring, etc.) so that all resources can be managed with consistent workflows and tools.

Tiering and Archive

This scenario is driven by the growing demand to capture and store data for both operational and business activities, resulting in rapid expansion of data volume that pushes the boundaries of available on-premises storage capacity. Thus, organizations turn to public cloud as a destination for older or less critical data to optimize the use of on-premises capacity for current and business-critical data. This drives the need for storage tiering across hybrid cloud infrastructures shown in Table 3.

With the increasing archive data movement into public cloud and the use of analytics and data warehousing capabilities on public cloud, we are seeing a shift by organization to move from "tiering and archive" type usage into a "best-of-breed infrastructure" type usage.

TABLE 4

Standard Tiered Storage Types Across Hybrid Cloud Infrastructure

Tier	Description	Used for
0	SSD, RAM, PCIe Flash	High-performance workloads, mission-critical data required for high-performance applications, where delays can cause damage to the organization
1	Fast disks, All-flash storage, Hybrid flash storage	Mission-critical or highly sensitive files that are in constant use by the business and require high security & governance
2 & 3	Slow-spinning HDD, disk-based backup appliance, cloud storage, tape storage	Backups of mission-critical data, which requires high reliability but not instant retrieval from backup
4	SATA drives	Warm data that maybe required by organizational users but not is not in constant use. Only for periodic reporting.
5	Tape storage, cloud storage archive tiers	Cold data that is rarely or never accessed. Only maintained for regulatory reasons or kept for possible future use.

Test/Dev and Staging

Movement of the application development, testing, and staging operations into the public cloud environment. This often involves the development of the deployment and upgrade pipelines into the public cloud environment and the creation of an overlay in the public cloud environment to match the one that is on-premises. This type of usage typically sees high value in having consistent operational environments on both public cloud and on-premises, reducing the overhead of deploying and managing the overlay environment.

Backup and Disaster Recovery

Public cloud infrastructure can help optimize the use of on-premises infrastructure capacity by serving as an alternative to a physical backup and disaster recovery (DR) site. For smaller organizations that do not intrinsically have the scale or geographic spread for a geo-separated infrastructure, public cloud offers a way to build in a level of resilience and availability without the investment and overhead of a separate site. For larger organizations, using public cloud infrastructure as the backup and DR site for specific workloads can be an effective mechanism to gain familiarity and start the integration of public cloud into the organization's IT environment. We are seeing organizations using public cloud as a backup site for specific workloads, and then eventually moving these workloads completely to public clouds. It is common to see enterprise IT organizations start from a "backup and DR" type usage to a "best-of-breed infrastructure" type usage.

Migration (Often to Public Cloud Infrastructure)

When organizations make the strategic call to completely migrate all IT infrastructure to public cloud infrastructure, it is not a step function transition but a gradual one that may take several months or years as they build competence, migrate workloads, and transition processes. This is where organizations build up a hybrid cloud infrastructure with the primary intent of migrating workloads gradually into the public cloud environment as they progress on this adoption path. Such organizations typically have a higher affinity to cloud-native stacks and approaches and often look for ways to modernize their applications on-premises, alongside the hybrid infrastructure implementation and migration of other parts of the portfolio.

Bursting

This is where public cloud infrastructure is being used to meet temporal infrastructure capacity usage needs. Compared with the other usage types discussed previously, bursting requires a higher level of integration and consistency across the on-premises and public cloud environments. Not all applications or workloads are suitable for this usage, especially the large, monolithic and vertically scaled enterprise applications. As such, bursting is not yet prevalent among enterprise IT environments beyond specialized use cases involving infrastructure-intensive operations running custom or semi-custom applications.

Building a Successful Hybrid Cloud Infrastructure

Thinking through these hybrid cloud infrastructure usage types will help organizations identify the initial adoption plan and the long-term path towards public cloud adoption, as well as narrow down the hybrid infrastructure-related functionalities and operational capabilities that need to be acquired or developed. These six hybrid usage types are not mutually exclusive; organizations may find they have a mix of needs across types, especially where they are maturing on their cloud adoption journey and transitioning from one type to another as discussed in some of the usage types. Even so, thinking of

hybrid usage and plans in terms of these types can help organizations be specific and anticipate evolutions in their hybrid infrastructure needs and plans.

For organization to succeed in building a successful hybrid cloud infrastructure, below are some specific integration capabilities that the IT organization needs to have:

- **Control plane integration** – Ability to execute control plane functionalities (such as provisioning, monitoring, access control assignment) with resources on both public cloud and on-premises infrastructure using the same application program interfaces (APIs) or a common "single pane of glass" user interface. This may be implemented and achieved in various ways, including integration within a control tool or API library, alignment across the API on both infrastructure destinations, or overlay stacks (on public cloud and on-premises infrastructure) that deliver this consistency.
- **Data infrastructure integration** – Ability to access data sources on public and on-premises environments in a consistent manner. Data sources can include constructs like file systems, data bases, or data warehouses, and consistency in the data infrastructure allows applications to continue interacting with data sources in a consistent manner even as changes are made in the data source location or application location.
- **Network layer integration** – Ability to have infrastructure resources on public cloud and on-premises destinations reside on a common logical network, typically a private layer 3 network with private IPs that can directly communicate with each other. This is particularly valuable in usage scenarios where components need to seamlessly communicate with each other across premises, such as bursting and best-of-breed infrastructure used in an integrated manner.
- **Physical connectivity** – Availability of a high-throughput low-latency connection across the public cloud infrastructure environment and on-premises infrastructure. This is typically implementable using MPLS and/or other similar site-to-site connectivity services (such as AWS Direct Connect, Azure Express Route, Equinix Cloud Exchange Fabric) between on-premises and public cloud locations.
- **Environment consistency** – Having a consistent operating environment on both the public cloud and on-premises locations such that applications can move from one to the other in a near-seamless fashion with no changes needed.

Additional hybrid enabler capabilities, such as automated migration and orchestration, can be built on top of these functionalities to further simplify the customer experience around hybrid operations.

HUAWEI CLOUD – A REVIEW

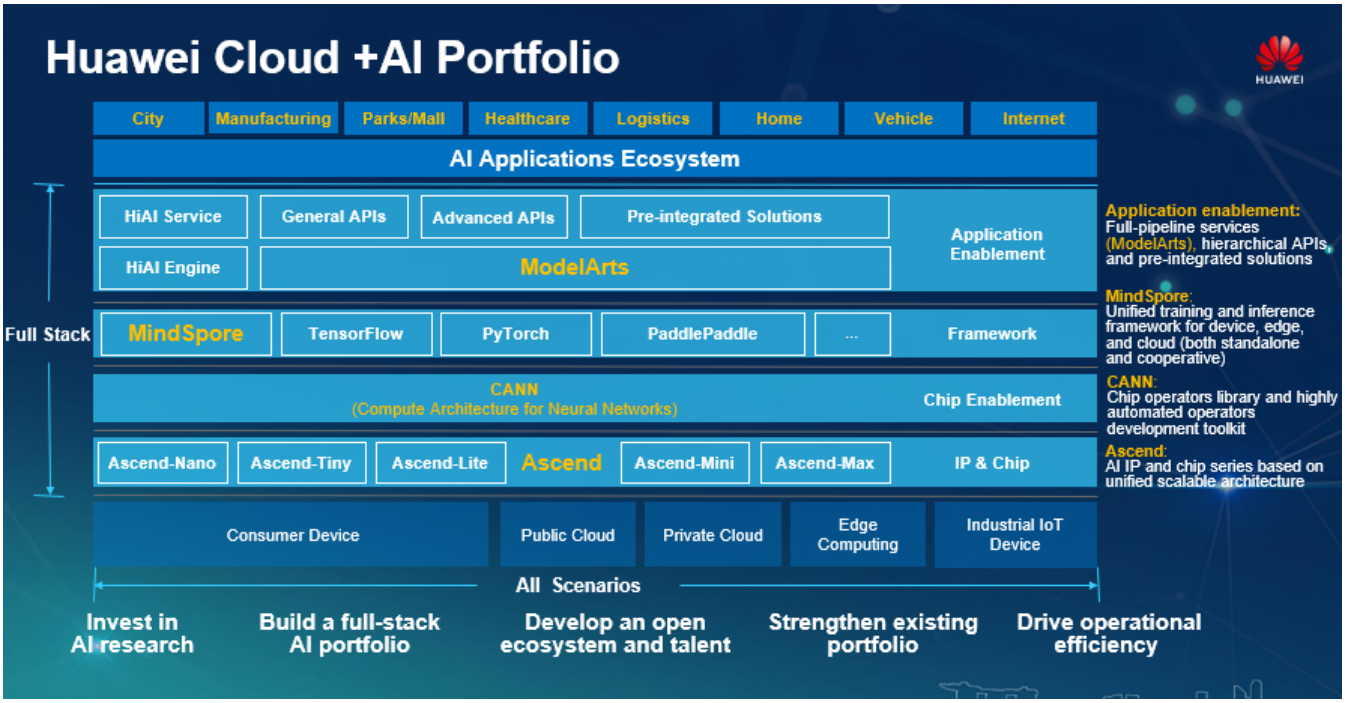
Huawei Cloud is Huawei's signature cloud service brand. By bringing together over 30 years of experience in ICT infrastructure products and solutions in one package, Huawei believes it can help governments and enterprises build what they need into their profile with building block-like ease. This is part of Huawei Cloud's commitment to provide stable, secure, reliable, and sustainable cloud services to help organizations of all sizes grow in today's intelligent world. To support this, Huawei Cloud pursues a vision of "inclusive AI" – that is, providing AI that is affordable, effective, and reliable for everyone.

At Huawei Connect 2018, Huawei Cloud released its one-stop AI development platform ModelArts, AI vision application development platform HiLens, and quantum computing simulator and programming framework HiQ. Huawei also set up its AI Developer Enablement Program to foster collaboration with developers, partners, universities, and research institutions, with the ultimate goal of making AI more

inclusive. Huawei Cloud is set to provide a powerful computing platform and easy-to-use development platform to support the company's full stack, all-scenario AI strategy (see Figure 5).

FIGURE 5

Huawei Cloud Full Stack AI Portfolio*



Source: Huawei

By the end of 2019, Huawei Cloud had launched more than 200 cloud services and 190 solutions, with and more than 3 million enterprise users and developers using Huawei Cloud for development. In 2019, it developed 10,000 consulting partners, which contributed over 60% of total revenue. It also established strategic partnerships with major consulting companies and carriers worldwide. It also cooperated with 2,000 technology partners, and released 3,500 applications in the marketplace, building a tight business and technology ecosystem in the process. HUAWEI CLOUD has obtained more than 50 authoritative security certifications around the world.

Huawei's application and data integration platform, ROMA (Relationship, Open, Multi-Cloud, Any-connect), integrates solutions based on data, messages, and services, and streamlines service control, application management, tenants, and certification between Huawei Cloud and private cloud or existing platforms of enterprises. Huawei believes ROMA will simplify enterprise cloudification, support integration between cloud and on-premises systems and cross-region integration, streamline IT and OT, and connect enterprises and ecosystem partners to enable digital transformation.

Huawei Hybrid Cloud uses the same software stack as Huawei Cloud to extend its cloud services to customers' on-premises data centers to meet governments and enterprises' requirements for data protection and security compliance. Together with the following full stack of offerings and capabilities, Huawei Cloud aims to help enterprises move smoothly to the cloud and achieve digital transformation:

1) **Enabling Kunpeng:** HUAWEI CLOUD platform supports Kunpeng + Ascend + x86 compute power in full stack.
2) **Tailored to government and enterprise needs:** Supports lightweight deployment, multi-level cloud management, and customer-led automated O&M, and matches the organizational model and management process of governments and enterprises, in compliance with graded security protection requirements.
3) **Secure and reliable:** Geo-redundant (3DC) DR and tenant-level DR; full-stack security services covering data, networks, hosts, and management.
4) **A broad selection of cloud services:** Advanced cloud services, including some of the HUAWEI CLOUD EI and PaaS services, can be made available to meet customer needs for data intelligence and accelerate innovation.
5) **Easy access to HUAWEI CLOUD via Cloud Federation:** One-click access to over 200 Huawei Cloud services; efficient collaborations, including "training on Huawei Cloud + local inference" and "development on Huawei Cloud + local deployment". A hybrid cloud deployed in the customer's on-premises data center can share Huawei Cloud's ecosystems through Hybrid Marketplace. Unified authentication and transaction allow for efficient, cross-cloud application deployment.

IDC's Point of View

Huawei's full-stack capability is still a rare value proposition, but increasingly, technology companies, especially hardware vendors, are pushing into this space. The company's full-stack proposition is more prominent for AI than other software solutions, because AI solutions today are closely tied to hardware acceleration, software acceleration, algorithms, and data. However, what is important is the ability to manage and orchestrate the full-stack, rather than owning the full-stack as in the case of Huawei.

Some technology vendors may choose to partner with other vendors to develop jointly-owned solutions. An example is Microsoft which has benefited from the cross-selling opportunities across its ecosystem partners. Nevertheless, by owning the full-stack, Huawei will be better positioned to meet customer requirements faster, which is certainly an edge for the technology to mature into the mainstream market while holding a grand vision of pervasive intelligence.

Data is at the heart of digital transformation. As businesses are digitized and augmented digitally, a larger volume of data is created in the process – and leveraged in new and exciting ways. IDC Worldwide DataSphere estimated that there will be 55.9 billion connected devices globally by 2025, with APEJ accounting for at least 30% of these devices. IDC projects that data created in the region will exceed 40ZB with most of the data being generated by video surveillance applications.

This makes Huawei's pervasive intelligence strategy with its full-stack AI solutions well placed to capture the opportunities that arise from this big bang data. As the data created will not reside in a centralized repository but distributed across different on-cloud and off-cloud locations, it will create a big challenge in managing and integrating these information silos with the on-premises and cloud applications that require this data to run. Huawei's ROMA seems to be well positioned to address this future challenge.

Huawei's strength of vertical integration gives the company its competitive edge in terms of the breath of product and service offerings over other leading technology vendors in the cloud market that are more focused – such as AWS and Microsoft – that choose to work with other ecosystem partners to expand their breath of coverage. However, the company's strength is also a weakness that inhibits its expansion beyond the spectrum of its competencies. Huawei Cloud's success will hinge on the company's ability to form strategic partnerships with the key ecosystem solution providers to build on its cloud platform, and localizing its reach in the diverse APEJ market.

ESSENTIAL GUIDANCE

The following provides essential guidance to end users.

Align Service Offerings Around Distributed Cloud Stacks

Align your on-premises and edge offerings around the public cloud players' new "distributed cloud" (hybrid) stacks: the stacks that will matter most. As IDC has predicted for the past several years, the public clouds — and all the innovative services running on them — are beginning to extend to customer premises and beyond. A new species of cloud — what IDC has termed "local clouds" — is compatible with, and connected to, the major public cloud platforms (see IDC's Worldwide Private Cloud Taxonomy, 2018, IDC #US44502618, December 2018).

For businesses that are highly reliant on Microsoft applications, Microsoft Azure Stack would be the obvious choice. For others, distributed cloud platforms like AWS Outposts, Huawei Cloud Stack Online (HCSO), Google Cloud Anthos, and IBM Cloud Private may be considered.

These offerings are poised to become widely deployed in on-premises datacenters and in distributed/edge locations. IDC estimates that by 2023, at least 25% of public cloud deployments (as measured by computing core shipments) will be running in third-party, on-premises, and edge locations, powered by public cloud vendors' distributed cloud platforms. (See Growth of Public Cloud Stacks in Dedicated and On-Premises Customer Environments, IDC #US44884219, February 2019).

It is imperative that IT product and services vendors serving enterprise datacenters and distributed/edge locations identify how their offerings will connect to the major cloud service providers' distributed cloud "stacks", as well as the providers' city/country datacenter site deployment for low latency performance.

The professional and managed services opportunity for helping enterprise customers to manage multicloud environment will be huge, and service providers need to ramp up their skills and offerings to take advantage of the opportunity.

Employ Cost Containment Analytics

Many enterprises leverage different cloud platforms across multiple service providers, making interoperability of data and applications between these varied cloud environments a key priority. With increasing applications and data deployment across multiple cloud infrastructures in the hybrid IT environment, a single pane of control and management is required to simplify cost containment of cloud services consumed by enterprise customers. Currently, there are many 'single pane of glass' monitoring and management solutions available through either the public cloud or private cloud providers, for example, AWS Cloud Management Tools (CMT), Microsoft Azure Cost Management, Huawei ManageOne, IBM Cloud Orchestrator, VMware vRealize, and HPE OneSphere, among others. However, these solutions lack the alignment of IT performance and metrics to the enterprise customers' business goals. Cost-containment analytics is necessary on top of just cloud service consumption visibility to bridge the gap of capex and opex IT budgeting. (See Asia/Pacific Excluding Japan Cloud Adoption Trends in Key Verticals 2019, IDC #AP44082919, November 2019.)

Develop capabilities

Hybrid and multicloud deployments are now the norm as enterprises increasingly adopt a hybrid IT architecture to address regulatory requirement, latency issues, and scalability of IT resources. IDC's recent study shows that hybrid and multicloud deployments are now the norm for organizations, with 75% of enterprises operating in a multicloud environment and the majority of these connection points resting on on-premises private clouds. (See Asia/Pacific Excluding Japan Cloud Services Landscape, 2019 and Future Outlook, IDC #AP44083319, September 2019). Developing strong multicloud integration and management capabilities (and creating partnerships) is vital in order to serve the majority of enterprises which have complex, multicloud service delivery environments. The professional and managed services opportunity for helping enterprise customers manage multicloud environment will be huge; service providers need to ramp up their skills and offerings to take advantage of the opportunity.

METHODOLOGY

The Hybrid Cloud market model methodology presented in this whitepaper leveraged multiple off-the-shelf IDC cloud-related documents and trackers, including:

- Worldwide Quarterly Cloud IT Infrastructure Tracker, 2Q19
- Worldwide Semiannual Public Cloud Services Tracker, 1H19
- Worldwide Semiannual Software Tracker, 1H19
- Worldwide Semiannual Services Tracker, 1H19

The tracker's historical and forecast data development is based on a detailed, bottom-up model, starting with the reported and estimated vendor revenue. Our worldwide team has built a large and fast-growing database of vendor revenue and market data to create the most recent year baseline data. Built on top of this historical data, the methodology leverages a wide variety of information sources, including:

- Existing IDC cloud-related markets (e.g., software as a service, IT infrastructure for the public and private cloud, and cloud professional services)
- Public information about IT cloud services providers' revenue, product mixes, customer segmentation, and strategies
- IDC end-user surveys about cloud drivers, inhibitors, and adoption plans
- IDC discussions with suppliers and service providers about their cloud services strategies and plans
- IDC models of historical information technology adoption/diffusion
- IDC models of vendor market share concentration in similar markets

This required the development of additional data, not yet published elsewhere, for software for enterprise clouds and service providers' clouds. That data was created for this study through bottom-up modeling of the percentage of on-premises/other software in each software secondary market deployed to enable cloud services delivery. Market model used in this whitepaper can be referenced to the Asia/Pacific (Excluding Japan) Total Cloud Infrastructure Forecast, 2019-2023 (IDC #AP44698619) published.

TAXONOMY

Taxonomy for the cloud infrastructure markets discussed are defined as follows

- **Public cloud infrastructure**: Multi-tenant Infrastructure-as-a-Service (IaaS) resources for compute and storage). It provides high elasticity and granular scaling with flexible consumption-based pricing. End-users can dynamically provision resources in a self-service manner with very short-term commitments. IDC sizes this market as the sum of revenue that makes up for the IaaS services provided by the public cloud service providers plus any related spending on third-party cloud-related professional services for integration and operation/management of the services.
- **Private cloud infrastructure:** Single tenant cloud-enabled infrastructure resources available to the enterprise. This can be pre-integrated cloud services system or integration of component software and hardware elements to deliver infrastructure services (compute and storage) for enterprise use. IDC sizes this market as the sum of the revenue for the cloud-enabling hardware and software products that makes up the cloud services system plus any related spending on third-party cloud-related professional services (e.g., integration, operation/ management, and colocation). There are generally 2 scenarios of private cloud infrastructure,
  - **Enterprise private cloud** – In this private cloud scenario, the enterprise own the private cloud infrastructure. This infrastructure may be run in the enterprise's own datacenter or collocated in a third-party facility. It is enterprise-owned and operated for internal use.
  - **Hosted private cloud** – In this private cloud scenario, third-party commercial cloud service providers offer enterprises access to private cloud services that the service providers have built, own and operate. This model is essentially a cloud version of traditional managed hosting offerings. It is a service provider-owned and operated enterprise private cloud.
- **Hybrid Cloud Infrastructure:** This will be the integration and consolidation of the mix of public and private cloud infrastructures which include "public-public", "public-private", and "private-private" combinations. This is treated as the summation of all public, enterprise private and hosted private cloud infrastructures in this white paper, also termed as the total cloud infrastructure market.
- **Cloud-related professional services:** As defined in IDC's Worldwide Services Taxonomy, 2019 (IDC #US44916019, March 2019), cloud-related professional services are primarily project-based services that assist customers with planning and implementing a cloud services strategy, which involves deciding how to adopt the use of public clouds, how to build and implement private clouds, or how to use a hybrid of public and private clouds. Cloud-related professional services may include such services as assessments and road map development, workshops and accelerators, implementation of pilot programs or other deployments, and proof of concepts. These solution services may also include assistance in the implementation or adoption of cloud services such as software as a service (SaaS), infrastructure as a service (IaaS), or platform as a service (PaaS) as well as the integration of these services into the customer's IT environment (whether cloud related or non-cloud related). This includes engagements on building foundational cloud delivery/consumption capabilities, as well as other projects that require a cloud delivery capability as a foundational element (e.g., big data/analytics engagements that leverage cloud compute and storage services).

About IDC

International Data Corporation (IDC) is the premier global provider of market intelligence, advisory services, and events for the information technology, telecommunications and consumer technology markets. IDC helps IT professionals, business executives, and the investment community make fact-based decisions on technology purchases and business strategy. More than 1,100 IDC analysts provide global, regional, and local expertise on technology and industry opportunities and trends in over 110 countries worldwide. For 50 years, IDC has provided strategic insights to help our clients achieve their key business objectives. IDC is a subsidiary of IDG, the world's leading technology media, research, and events company.

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