Direct-Cloud, Multi-Cloud, and Connected-Cloud – Terminologies Make a Move in Cloud Computing

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Abstract*— Cloud computing is constantly evolving with innovations. So, the cloud service providers are investing big in finding solutions for the challenges confronted by the business organizations in the ever-changing technological world. However, still, there is a little reluctance among the organizations to ultimately adopt the public cloud because the mission-critical applications and the mission-critical data require high-level security and availability which are questionable in the equally growing hacking technology. The hacker's comfort zone is Internet, and the Internet is the primary medium for communication between enterprises and cloud service providers. So, the cloud service providers come up with a solution called Direct-Cloud which bypasses the internet and establishes a private connection between the enterprise and cloud service provider. The primary objective of this paper is to familiarize the terminology direct-cloud as it makes a massive move in Cloud Computing. So, this paper presents a study that describes direct-cloud, its architecture, benefits, the comparison between different direct-cloud solutions and the guidelines to choose a suitable direct-cloud solution. Also, the terminologies Multi-Cloud and Connected-Cloud are gaining attention among the enterprises to meet the growing needs of the business. Hence the paper further explores the direct-cloud deployment in the multi-cloud and connected-cloud environment.

***Index Terms*— Direct-Cloud, Multi-Cloud, Connected-Cloud, Private Connection, Cloud Service Provider, Public Cloud, Private Cloud**

I. INTRODUCTION

Cloud computing is a technology that can provide storage, infrastructure, and software applications on demand to the enterprises thereby reduce the cost of application development, infrastructure set up, storage devices and maintenance [27], [37]. The technologies and tools provided by the cloud computing for the parallel applications are inexpensive when compared to traditional parallel computing technologies [27]. The characteristics of cloud computing are reliability, scalability, security, flexibility, mobility, improved performance, increased productivity, reduced cost, on-demand service, and maintenance [18], [27]. Also, Bigdata, Mobile, Systems Management, Back-up, Help Desk, and Security are the fastest areas of growth in Cloud Computing [16].

The enterprises can set up their private cloud, or they can utilize the services from the public cloud. Amazon AWS, IBM Cloud, Oracle Cloud, Google cloud and Microsoft Azure are some of the promising cloud service providers. They contribute to the business world by providing the cloud in various forms like Software as a Service, Platform as a Service and Infrastructure as a Service [12], [27], [43]. Besides these services, the cloud service provides further facilitates the computing world with the services such as Desktop as a Service, Recovery as a Service, Database as a Service, Mobile Back-end as a Service [12].

The businesses understand their customer, and they change their business methods and procedures according to their needs. When growing needs are addressed by cloud computing, it is well received by the enterprises to compete in the global business. The driving factors scalability, agility, and cost are the main reasons for the adoption of cloud computing by the organizations [16]. According to IDG Communications, 73% of IT buyers are using the cloud at least for one application [44].

However, availability and security are significant concerns in cloud computing, and many organizations are still not ready to take their mission-critical applications to the public cloud [1], [2], [12]. As the Internet is the medium for communication between cloud service providers and enterprises, the risks of having Distributed Denial of Service (DDoS) is high. This kind of attack is a significant threat to cloud computing technology, and it makes the service unavailable. According to the Cloud Survey conducted in 2018, 77% of people consider security as the major challenge in adopting the cloud [51]. Nevertheless, it is essential to make the mission-critical data and application available all the time. So, the cloud service providers are highly investing in developing the technologies that make the cloud services highly available, secure, and cost-efficient with better performance. One noticeable technology from them is direct-cloud, which helps to optimize business services with enhanced security. This paper presents a study on direct-cloud and related concepts. Also, the paper discusses two more evolutions in cloud computing technology, Multi-Cloud, and Connected-Cloud. These two technologies enable the organizations to get services from more than one service providers and more than one type of cloud. However, connectivity becomes a significant issue, and direct-cloud solution tries to deal with these issues.

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The paper is presented in the following manner; Section II describes Direct-Cloud architecture, features, benefits, solutions, and guidelines to choose the solutions. Section III and Section IV describes, Multi-Cloud, and Connected Cloud respectively, Section V discusses the performance of Direct-Cloud, and Internet-based connection along with the statistics report about direct-cloud, multi-cloud and connected-cloud. Finally, Section VI concludes the paper.

II. DIRECT-CLOUD CONCEPTS AND ARCHITECTURE

A.Direct-Cloud

Direct-Cloud is a cloud solution that provides a direct, quality, secure and reliable connection between the enterprises and cloud service provider. Though the direct connection is denoted in different names such as cloud-connect, dedicated cloud, direct-connect and cloud-direct, the authors of this paper find 'Direct-Cloud' a suitable name. In earlier days the cloud computing connection was from public network to public cloud which is depicted in Figure 1. The main disadvantage of this public to public connectivity is that it is prone to threats that make the services of public cloud insecure and unavailable. So, direct-cloud enables a private network to public cloud connectivity [20].

Figure 1. Public Network to Public Cloud

B. Architecture

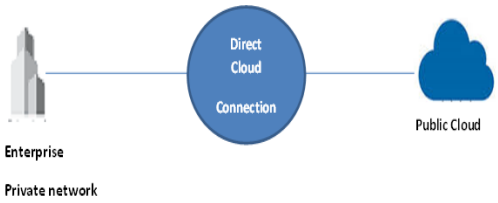

Figure 2. Direct-Cloud Architecture

Figure 2 shows the architecture of Direct-Cloud where exists private connectivity between enterprise and public cloud providers. The private connection is established between the core router of an enterprise and the core router of the cloud providers. Ethernet, Metro Ethernet, MPLS, VPLS [4] are some of the connectivity options supported by Direct-Cloud solutions. Since the connection is direct and private, it ensures security and availability.

C. Why Direct-Cloud?

The importance of the organizations to have a Direct-Cloud is described below [4]. The Direct-Cloud implemented in the enterprises will

- increase the speed of access from the cloud
- be more secure while accessing cloud
- make the cloud services available without interrupt
- provide reliable communication
- scale up the infrastructure
- be cost-effective

A. General Features of Direct-Cloud

Some of the general features of the Direct-Cloud are

- A range of bandwidth options
- Low latency
- Ethernet layer two service
- Efficient routing protocol support
- High Throughput

D. Benefits of Direct-Cloud

The Direct Cloud provides the businesses with the following benefits [10] [18], [19], [20] [24].

1) Enhanced security

Encryption techniques protect data on both sides of the transportation of data. The private network adds a level of security, and on the other side, the public cloud adds another level of security. Moreover, the risk of hacking is less in private connections compared to the Internet connection. Though there is some security issue, it would be only inside the private network and easily identifiable. So, the private connection is more secure than the Internet-based connection.

2) Fast access

The processing of data is optimized, and the delay is minimized with the help of direct connections. The separation of traffic and giving priority to the traffic related to cloud services increases the speed between a private network and cloud service providers.

3) Reliability

There is no concern of downtime and server crashes as the private network is within the control of an enterprise. So, it ensures the end to end data transfer.

4) High Performance

In the private network, the traffic is prioritized, so it provides high-speed connectivity between the private network and cloud service providers with reduced latency hence high throughput is achieved.

5) Scalable

Direct-Cloud solutions enable organizations to scale up their infrastructure according to their services or business needs. They may adjust the bandwidth in the future, and they can get connected to more than one cloud service providers as time evolves and needs are high.

6) Cost-effective

The cost of the infrastructure is minimized by leveraging existing network environment of the organization. Moreover, once the private connection from

enterprise to cloud service provider is set, connections to some other cloud service providers can be established at a cheaper rate.

F Direct Cloud Solutions – Examples and Features

Amazon AWS Direct connect, Microsoft Azure ExpressRoute, Google Cloud Interconnect, IBM Direct link are examples of Direct cloud solutions. Moreover, some third-party direct cloud solutions such as Colt Dedicated cloud access [10], ViewQwest Direct cloud connect [18] and Epsilon Cloud Connect [23] that provides private connectivity between enterprise location and cloud service providers. Table I describes some of the unique features of public cloud direct connect solutions from Amazon, Microsoft, Google and IBM [5], [6], [7], [8], [9], [28], [31].

Table I. Direct cloud solutions and features

Direct Cloud Solutions	When to Choose?	Features and Benefits
AWS Direct connect	When there is a need for Private connectivity between AWS and datacenter, office, or colocation environment	• 1 Gbps or 10 Gbps • Reduces Bandwidth Costs • Consistent Network Performance • Compatible with all AWS Services • Private Connectivity to Amazon Virtual Private Cloud (VPC) • Elastic and Simple
Microsoft Azure Express Route	• When Co-located at a cloud exchange • On-premises datacentres/offices to the Microsoft cloud • Any-to-any connectivity between branch offices and datacentres.	• 50 Mbps to 10 Gbps • Microsoft uses BGP, Layer 3 connectivity • Redundancy • Connectivity to Microsoft cloud services • Flexible billing models • Dynamic scaling of bandwidth
Google Cloud Interconnect	10 Gbps Dedicated Interconnect • When organizations can meet Cloud's Point of Presence and requires 10Gbps 50 Mbps to 10 Gbps. Partner Interconnect • When organizations cannot meet Cloud's Point of Presence and 10Gbps not required	• Ethernet connectivity • Guaranteed uptime of 99.99% • Flexible, low-cost VPN • Access internal IPs directly • Scale effortlessly • Connect from anywhere • Fewer disruptions and drops
IBM Cloud Direct link	IBM Cloud Direct Link Exchange • Third-party data center to the cloud, no single tenant connection, more than 1Gbps port speed connectivity is not required IBM Cloud Direct Link Connect • On-premises to a cloud and no single tenant connection, more than 5Gbps port connectivity is not required	• 50 Mbps to 10 Gbps • Hybrid connectivity • Global reach with industry-leading partners • Flexible pricing options

	IBM Cloud Direct Link Dedicated • Third-party data center to the cloud and more than 1Gbps port speed connectivity • Third-party data center to the cloud, single tenant connection, more than 1Gbps port speed connectivity is not required, need not co-locate hardware next to IBM Cloud • On-premises to a cloud and single tenant connection • On-premises to a cloud and no single tenant connection but requires more than 5Gbps port connectivity	
	IBM Cloud Direct Link Dedicated Hosting • Third-party data center to cloud, single tenant connection, not required more than 1Gbps port speed connectivity, need to co-locate hardware next to IBM Cloud	

G Guidelines to choose a suitable Solution

When choosing a Direct-Cloud solution, the enterprise could consider the following [4]

1) Various bandwidth options provided by the cloud providers
2) Service Level Agreement
3) Internet connectivity in distributed locations of cloud providers.
4) Layer 2 connectivity option
5) Scalability features
6) The cost involved and cost strategy in case of future addition of some more services from other providers

III. MULTI-CLOUD

A. Multi-Cloud Architecture

Multi-Cloud is a cloud computing evolution where different services like SaaS, PaaS, and IaaS are provided on demand to the organization from various cloud service providers. For example, an organization may get IaaS as a service from some web hosting company and PaaS as a service from Microsoft Azure and SaaS as a Service from Dropbox. This technology helps the organizations to distribute the big-data, software and applications in more than one cloud service provider's environment and there is no synchronization required between those providers [29]. The enterprises are no more dependent on one cloud service provider. They may get services from more than one public cloud that is shown in Figure 3. Besides public clouds, the organizations may also use services from a private cloud.

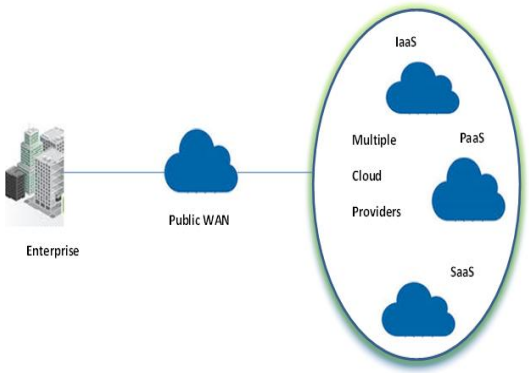

Figure 3. Multi-Cloud Architecture

B. Benefits of Multi-Cloud

1. Increased Productivity
2. Increased flexibility
3. Cost Efficiency
4. Many Choices
4. No dependency on a single provider
5. Experience of different vendors
6. Capability to analyse the performance
7. Reduced latency with nearer cloud
8. Customization
9. Ability to function even one provider is offline

C Disadvantages of Multi-Cloud

Though the multi-cloud environment provides organizations with many benefits, still there are a few issues. They are

1. Security
2. Maintenance issues
3. Many choices lead to confusion

D Multi-Cloud in connection with Direct Cloud

The main disadvantage of multi-cloud technology can be overcome with the help of direct-cloud solution. When

an enterprise gets services from more than one service provider, connectivity, security and availability problems raise. However, with the same private connection established for a Direct-Cloud, the Multi-Cloud is also made possible. That is, when an organization needs any service from any of the cloud providers, it could opt for a direct-cloud solution which is capable of scaling up in the future. Then the same organization can utilize the established direct-cloud connection for the multi-cloud when there is a necessity of getting serviced from many providers. Fig. 4 shows the architecture of multi-cloud with a direct-cloud. With the direct connection of enterprises to multiple clouds, for example, AWS, Oracle cloud, and IBM cloud, the business is taken to the next level as the data travels across the world [20].

IBM Cloud Direct Link Exchange, IBM Cloud Direct Link Connect are providing multi-cloud environment support [5]. One of the leading cloud platform user ParkMyCloud points that many of their customers prefer AWS with Azure and some prefer AWS and Google Cloud as their multi-cloud strategy [50].

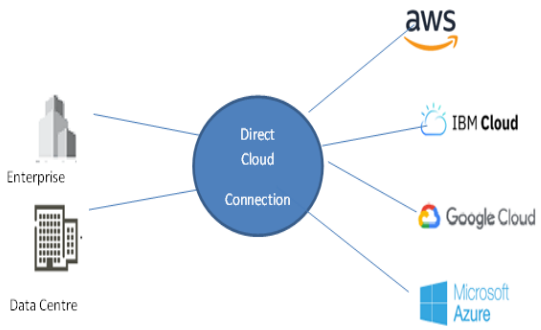

Figure 4. Multi-Cloud with Direct-Cloud

IV. CONNECTED-CLOUD

A Connected-Cloud Architecture

Connected cloud is the prominent technology in cloud computing that connects the different service models private and public. Connected-cloud differs from multi-cloud where different services are accessed from multiple cloud service providers, and there is no connection between the multiple clouds. Figure 5 depicts the architecture of connected-cloud. It is commonly mentioned as Hybrid Cloud in the cloud computing environment. The evolution of the Internet of Things that generates a large amount of data is gradually increasing the need for connected-cloud among the enterprises [44]. Cloud survey conducted in 2018 reports 40 percent in public cloud and 39 percent in private cloud as far as the organization's workload is concerned [51]. Oracle Cloud at customer, VMware Cloud, Dell EMC, and HPE Pointnext are some companies that provide customers with a hybrid environment [44].

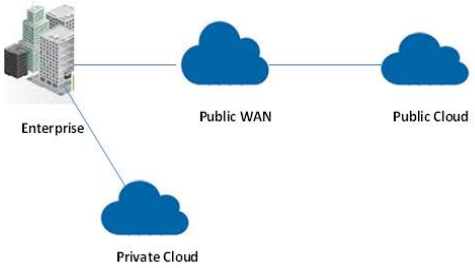

Figure 5. Architecture of Connected-Cloud

B Benefits of Connected-Cloud

The businesses use private clouds to store mission-critical applications, to store highly confidential data and to minimize the bandwidth cost spent for accessing the data from the public cloud storage. However, they also need the services from the public cloud that adds values to the business and to store the big data generated from the business environment. So, the enterprises are in the connected cloud and offered with the benefits of this connected cloud technology such as reduced cost, high performance, both on-premises, and off-premises services, flexibility, scalability, choice of storage depends on preference of data and server reliability [22], [34], [35], [44].

C Disadvantages of Connected-Cloud

Though connected-cloud offers many advantages to companies, there are a few disadvantages in it. They are [44]

i) Complexity in managing clouds
ii) Difficulty in keeping track of more than one cloud
iii) Security risks associated with public cloud

D Connected-Cloud with Direct-Cloud

Like the multi-cloud environment, this connected-cloud also is vulnerable to attacks because of public network connection with cloud service providers. Since direct cloud replaces the public connectivity and being a security mechanism to protect from Distributed Denial of Service attack, the architecture of connected-cloud can be redesigned as Figure 6.

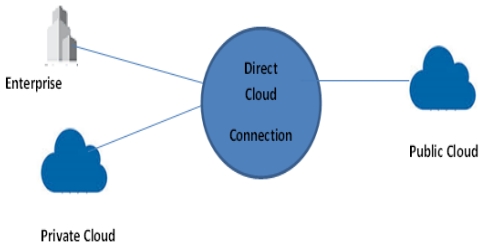

Figure 6. Direct-Cloud in Connected-Cloud

V. DISCUSSION & RESULTS

According to Gartner [4], the direct-cloud connection is better than internet-based connection in terms of security, performance, and availability. Figure 7 presents the survey result. Moreover, the survey guarantees that the private connectivity-based cloud service is expected

to be adopted by more than 50% of small and medium-sized organizations.

Amazon has got multiple tenants using AWS Direct Connect in Phoenix, Arizona. It also ensures that AWS Direct connect would be a perfect solution for providing secure connected-cloud environment [48]. Microsoft Azure is growing 70-80 % in the businesses annually. Its ExpressRoute was offered in London, Singapore, Hong Kong, Silicon Valley in 2014 and Microsoft launches Azure ExpressRoute service in Taiwan shortly. Moreover, this Direct-cloud solution could perform higher in the connected-cloud environment also [49]. IBM cloud direct link and Digital realty have collaborated to provide hybrid solutions to organizations that make a dedicated connection to IBM Cloud in 15 metropolitan areas [54]. Google Cloud Interconnect is also becoming widespread.

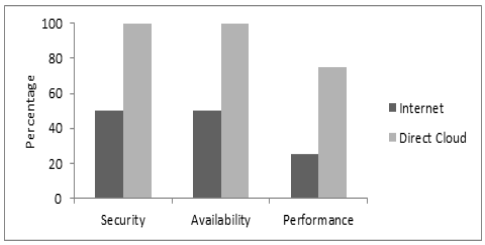

Figure 7. Direct-Cloud vs. Internet-based connection

William B. Norton has compared the direct-cloud solutions against the Internet-based connection. He has calculated the total cost per month for sending 50Mbps traffic over direct-cloud solutions and the Internet. Table II shows the outcome of the calculations [52]. From the table, it is evident that Direct-cloud solutions are more cost-effective than Internet based connections.

Table II. Direct Cloud vs. Internet- Cost per Month

Direct Cloud Solutions	Cost of Direct Cloud	Cost of Internet to Cloud
Amazon AWS Direct Connect	$1029	$1446
Google Cloud Connect	$1148	$1736
Microsoft Azure ExpressRoute	$1005 for metered, $1075 for unlimited	$1636

The performance and cost effectiveness of direct-cloud solutions are well clear from the above results stated. Along with this, understanding the adoption rate of multi-cloud and connected-cloud is essential. Hence the paper discusses some statistics about those strategies. 451 Research survey says that 69% of organizations are having a plan of running a multi-cloud environment in 2019. The survey of about 1,000 tech executives and cloud practitioners concludes that more than 80% of companies are already in multi-cloud strategy [50]. Virtustream and Forrester Consulting survey conducted in 2018 states that 86% of enterprises already adopted multi-cloud [55]. According to Forbes, 81% of companies use a multi-cloud strategy [56]. The survey of RightScale conducted in 2019 results that 84% of organizations have got a multi-cloud strategy [53]. The same survey results are shown in Figure 8.

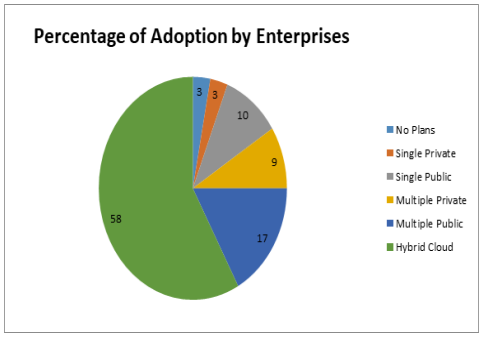

Figure 8. Adoption of Cloud strategies by Enterprises

According to Fortune, the adoption rate of connected-cloud has increased from 19% to 57% in 2016, and according to IDC CloudView, 73% of organizations have got connected-cloud strategy [46]. IDC, RightScale and HBR surveys clearly show that the migration of enterprises to the connected-cloud environment is unstoppably increasing. [47]. When compared to multi-cloud, the adoption rate of hybrid that is connected-cloud has been reduced in 2018 [51]. However, according to Forbes report hybrid cloud's growth would be $97.64 billion by 2023 in the global market [56].

VI. CONCLUSION

With the growth of cloud computing, it is being made possible to store big data generated from various sources of the organizations. Moreover, the enterprises are quite contented with the services provided by the cloud service providers that enhance the productivity in businesses. The increase in productivity leads to many more businesses to migrate to the cloud. However, Security, privacy, and availability are significant concerns for the enterprises to migrate their business data and applications entirely to the cloud. So, the technological advancement called direct-cloud takes up those challenges and attempts to provide a secure cloud environment with high availability and high performance. On the other hand, multi-cloud and connected-cloud strategies are being adopted by many organizations. The direct-cloud could be useful in multi-cloud and connected cloud environments to ensure security and availability. This paper has presented a survey about direct-cloud solutions, multi-cloud, and connected-cloud. The survey results illustrate that the private or direct-cloud connection yields many benefits to the businesses when compared to the traditional Internet-based connections and multi-cloud and connected-clouds are the recent cloud strategies for many business enterprises.

REFERENCES

1. Gururaj R, Mohsin I, Farrukh A K, A Comprehensive Survey on Security in Cloud Computing, Procedia Computer Science, Elsevier, 2017, 465–472.
2. Velumadhava R, Selvaman K, Data Security Challenges and its Solutions in Cloud Computing, International Conference on Intelligent Computing, Communication & Convergence, Procedia Computer Science, Elsevier, 2015 204 – 209.
3. Direct Cloud Access, https://www.cisco.com/c/en/us/td/ docs/ios-xml/ios/pfrv3/configuration/xe-16-8/pfrv3-xe-16-8-book/pfrv3-dca.pdf.
4. Gartner, A Better way to Reach the Cloud, https://www.gartner.com/imagesrv/media-products/pdf/GTT/gtt-communications-1-3LUAOET.pdf, issue 1, 2016.
5. Get Started with IBM Cloud Direct Link, https://www.ibm.com/cloud/direct-link, last updated: 2019/02/26.
6. AWS Direct Connect, https://aws.amazon.com/ directconnect, last accessed 2019/03/10
7. AWS Direct Connect, https://docs.aws.amazon.com/aws-technical-content/latest/aws-vpc-connectivity-options/aws-direct-connect-network-to-amazon.html, last accessed 2019/03/10
8. Google Cloud Hybrid Connectivity, https://cloud.google.com/hybrid-connectivity/ Last updated: 2019/02/26.
9. ExpressRoute, https://docs.microsoft.com/en-us/azure/ expressroute/expressroute-routing, 2019, last accessed 2019/03/10.
10. Dedicated Cloud Access, https://www.colt.net/product/ dedicated-cloud-access, 2018, last accessed 2019/03/10.
11. Effortless direct-to-cloud backup and recovery for the overstretched IT team and distributed workforce, Arcserve UDP Cloud Direct, arcserve.com, White Paper.
12. Mission-Critical Applications in the Cloud, the 5 Things Every Enterprise must consider, www.xteritycloud.ie/ Xterity_Enterprise_CloudEbook.pdf.
13. Xterity Cloud Drives Competitive Advantage, Expands Services, and Reduces OPEX for Irish Financial Service Company, www.xteritycloud.ie/Xterity-Cloud-Services-ICE-Cube-Case-Study-v01112015.pdf.
14. Xterity Cloud Services ensures global education Fitness Company's uptime, access, availability, (2015) www.xteritycloud.ie/ Xterity-Cloud-Services-Fitpro-Case-Study-v01112015.pdf.
15. Wholesale Managed Dedicated Compute Cloud Services, (2016), www.xteritycloud.ie/Wholesale-Managed-Dedicated-Compute /Datasheet_01_28_16.pdf.
16. Making the Transition from MSP to CSP, www.xteritycloud.ie/ MSP-to-CSP_ebook.pdf.
17. Making the Transition from MSP to CSP with Wholesale Clouds, www.xteritycloud.ie/ MSP_VAR_to_CSP_Wholesale.pdf.
18. Direct Cloud Connect, https://corporate.viewqwest.com/ products/direct-cloud-connect.html, last accessed 2019/03/10.
19. Digital transformation is key, and it all gets unlocked in the cloud, https://www.clouddirect.net/why-move-to-cloud, last accessed 2019/03/10.
20. Zenlayer, Cloud Direct Connect: What is it, and why is it important? https://www.zenlayer.com/cloud-direct-connect, July 31, 2017, last accessed 2019/03/15.
21. The Aspera Direct-to-Cloud transport, https://asperasoft.com/cloud/direct-to-cloud-technology, last accessed 2019/03/10.
22. Cloud Computing, http://www.directnetworksinc.com/cloud/cloud-computing, last accessed 2019/03/10.
23. Friction-Free Connectivity Services supporting your Cloud computing, https://www.epsilontel.com/solutions/direct-cloud-connect, 2019.
24. Connect to the cloud, https://www.alaskacommunications.com/Business/Products/Data-Networking/Direct-Cloud-Service.
25. Connect to the Cloud from your device, https://www.kyoceradocumentsolutions.co.uk/index/ document_solutions/mobile_cloud/Cloud_Direct.html.
26. Michael Desorcie, Direct to Cloud: Getting Started, https://kb.datto.com/hc/en-us/articles/360001005506-Direct-to-Cloud-Getting-Started, last updated: 2019/02/21.
27. Cloud computing, From Wikipedia, the free encyclopedia, last accessed 2019/03/10.
28. Google Cloud Connect, From Wikipedia, the free encyclopedia, last accessed 2019/03/10.
29. Multi-Cloud, From Wikipedia, the free encyclopedia, last edited on 18 February 2019.
30. What-is-multi-cloud, https://www.sdxcentral.com/cloud/multi-cloud/definitions/what-is-multi-cloud
31. Access the benefits of AWS cloud solutions through a private connection, https://www.flexential.com/ connectivity/cloud-connect-through-aws-direct-connect, last accessed 2019/03/10.
32. Kevinoid, Direct cloud-to-cloud copy? https://forum.rclone.org/t/direct-cloud-to-cloud-copy/7219, Oct. 2018, last accessed 2019/02/20.
33. Six future trends involving cloud, https://channeldailynews.com/blog/6-future-trends-involving-cloud, last accessed 2019/03/10.
34. Why Cloud Direct? https://www.clouddirect.net/ company/why-cloud-direct, last accessed 2019/03/10
35. Hybrid Cloud Trends in 2019, https://www.wowrack.com/ blog/hybrid-cloud-trends-2019, last accessed 2019/03/10.
36. Cinia cMatrix - Direct connection to public cloud services, https://www.cinia.fi/en/services/connectivity-services/direct-public-cloud-connection.html, last accessed 2019/03/10.
37. Vangie Beal, Cloud Computing explained https://www.webopedia.com/quick_ref/cloud_computing.asp, updated June 2014.
38. Robust Cloud Infrastructure within a Flexible Architecture, https://www.cloudconnect.net/infrastructure, last accessed 2019/03/10.
39. Cloud Connect, https://www.interxion.com/products/ interconnection/cloud-connect, last accessed 2019/03/10.
40. Cloud Connect, https://www.is.co.za/solution/cloud-connect, last accessed 2019/03/10.
41. Cloud Connect, https://ssetelecoms.com/products/cloud-connect, last accessed 2019/03/10.
42. Interview: Thoughts on the Connected Cloud, http://prodea.com/2018/05/24/interview-thoughts-connected-cloud-%E2%80%8E/, 2018/05/24.
43. http://csrc.nist.gov/publications/nistpubs/800-145/SP800-145.pdf.

44. Debra Prentice, Market Development DirectorPros&Cons of Public, Private, or Hybrid Cloud, https://www.arrowsolutionsgroup.com/blog/pros-cons-public-private-hybrid-cloud, last accessed 2019/03/10.
45. https://azure.microsoft.com/en-us/overview/what-are-private-public-hybrid-clouds, last accessed 2019/03/10
46. https://www.cisco.com/c/en/us/solutions/cloud/hybrid-cloud/cloud-adoption-rates.html, last accessed 2019/03/10.
47. Mohammed Majeed, Cloud Adoption is Accelerating – Where Do You Stand? https://blog.externetworks.com/cloud-adoption-is-accelerating-where-do-you-stand, last accessed 2019/03/10.
48. Achieving Business Agility in Hybrid Cloud with AWS Direct Connect, https://aws.amazon.com/blogs/apn/achieving-business-agility-in-hybrid-cloud–with-aws-direct-connect, last updated 2019/02/20.
49. www.digitimes.com/news/a20190327PD200.html, last accessed 2019/03/10.
50. Elaina Arce, Multi-Cloud, Hybrid Cloud, and Cloud Spend – Statistics on Cloud Computing, https://www.business2community.com/cloud-computing/multi-cloud-hybrid-cloud-and-cloud-spend-statistics-on-cloud-computing-02121233, last accessed 2019/03/10.
51. Veritis, Cloud Technology Market Performance 2018: Public and Multi-Clouds Take Lead, https://www.veritis.com/blog/cloud-technology-market-performance-2018-public-and-multi-clouds-take-lead/, last accessed 2019/03/10.
52. William B. Norton, Console, Chief Scientist, https://www.caida.org/workshops/wie/1612/slides/wie1612_wnorton.pdf, White Paper, 2016.
53. Larry Dignan, Top cloud providers 2019, https://www.zdnet.com/article/top-cloud-providers-2019-aws-microsoft-azure-google-cloud-ibm-makes-hybrid-move-salesforce-dominates-saas, last accessed 2019/03/10.
54. Paul Hertzfeldt, Cloud Direct Link: Built for Enterprise Cloud,https://www.ibm.com/blogs/bluemix/2018/07/digital-realty-ibm-cloud-direct-link-expand-network.
55. Alison DeNisco Rayome, Why 86% of enterprises employ a multi-cloud strategy and how it impacts business, https://www.techrepublic.com/article/why-86-of-enterprises-employ-a-multi-cloud-strategy-and-how-it-impacts-business/
56. Chaitanya Atreya, Forbes Councils, A Closer Look At Hybrid-Cloud And Multi-Cloud Approaches, https://www.forbes.com/sites/forbestechcouncil/2018/11/26/a-closer-look-at-hybrid-cloud-and-multi-cloud-approaches/#3055c3125841, last accessed 2019/03/10.