Cloud Migration Tools:
Overview and Comparison

Awatef Balobaid[(✉)] and Debatosh Debnath

Oakland University, Rochester Hills, MI 48307, USA
`{asbalobaid, debnath}@oakland.edu`

Abstract. In recent years, the use of cloud computing has increased significantly, where remote servers perform computing tasks including analytics, storage, processing, networking, database management, and other business functions over the internet. This ubiquitous computing provides business advantages in terms of productivity, scalability, performance, along with reliability and demographic availability. Businesses including modern day commerce industries are moving to cloud based platforms to reduce cost and increase performance. Many organizations are now migrating towards cloud due to its favorable features. Therefore, it is important for the organizations to have a migration strategy that can ensure an effective migration. In this regards the cloud migration tools can play a significant role. However, there are many research has been done as it is still a comparatively newer topic. In fact, there are only a limited number of research articles available on cloud migration tools. In this paper, we focus on different cloud migration tools and draw a comparison between them. We also analyze the cloud migration and associated aspects of the migration process.

Keywords: Cloud computing · Migration tools · Cloud migration

1 Introduction

Cloud computing when compared to local data center technology, is a new option with so many benefits. This includes cost efficiency, scalability, and agility. However, this does not imply that local data centers are going into extinction. Because of the benefits of cloud computing, many businesses prefer moving the applications and data to the cloud. But before doing so, there are many points to consider. Moving enterprise information and applications to the cloud is a big deal. To ensure that everyone within an organization agrees to migrate their information and application to the cloud, cloud migrations usually requires a feasibility study that covers costs, security, tools, governance, and talent among other considerations [1].

The digital revolution has directed a power from the hands of business to the demands of customers as today's vastly competitive environs provides enough choices [2]. This power shift requires businesses to be efficient, competitive, as well as economical for customer satisfaction. Part of this comprehensive digitalization is a migration of business to cloud computing for information collection, processing and optimization of channels. Gartner has predicted that cloud computing has entered in its

second decade [3]. Cloud migration is the procedure of moving data and applications along with other components of businesses from on-site servers to the cloud or moving businesses components from one cloud environment to another. Cloud migration includes most of the IT related elements movements to the cloud or one cloud provider to another cloud vendor. These elements include data, business applications, networking, storage, analytics, dashboard, and other essentials [4].

A successful cloud migration will facilitate a business to operate efficiently with minimum IT resources on-site because all the heavy lifting of processing powers and storage are available from cloud vendor via the internet. The cloud vendors have a heavy-duty farm of interconnected servers with proper infrastructure such as electricity, cooling, backup generators, security, maintenance teams, etc. A number of servers usually racked in vertical frame connected with fiber optic networking and switches, and have petabytes of storage. Each server has dedicated processor, memory, connecting cables, and accelerators such as graphics processing units (GPUs). These additional accelerators provide several benefits such as enhanced processing and artificial intelligence. Thousands of servers with dedicated connections, storage, and infrastructure at a place for business use such as data storage, organization, processing and disseminating are termed as a data center [5].

The cloud has seen an exceptional progression that can be contributed to its swift pace of implementation, taking priority over old-style:

a. Software as a Service (SaaS) such as Google Apps and Salesforce for CRM and business management.
b. Platform as a Service (PaaS) such as Google App Engine and Azure for application development, database platform, and integration.
c. Infrastructure as a Service (IaaS) such as AWS for storage, virtualization, content delivery network, networking and compute.

Businesses can opt for any of these models for cloud migration as these models also support pay-as-you-go pricing to ease adoption. Due to the enormous prospective for diverse businesses, verticals such as manufacturing, railways, engineering, banking, retail, finance, education, government, and healthcare all are choosing cloud services for enhanced reach and performance as well as resilient elasticity [2, 6]. In the majority of cases, cloud migration needs middleware such as cloud integration tools to channel the deficiencies or mismatching between the cloud vendor and the customer's technologies. A limited number of literatures surrounding migration method are available for research, and references. This study focuses on explaining the current cloud migration process through different migration tools, that are designed to migrate, as well as surrounding topics, such as complete solution basis and the approach principles.

This paper is organized as follows: Sect. 2 discusses the importance of cloud migration. Section 3 outlines some of the benefits and risks associated with cloud migration. Section 4 describes cloud migration consideration. Section 5 presents cloud migration tools, and comparison between them are provides in Sect. 6.

2 Why Is Cloud Migration Important?

Cloud migration brings us to a new era of technology where a business moves its data and various processes to remote servers at a data center for reducing cost, on-demand high processing and storage capabilities, valuable insights, future scalability for expanding markets, access authorization, global accessibility over internet, maximum availability and uptime, data protection, dashboard analytics, shrinking IT support requirements, and many other benefits. Cloud migration has many other associated indirect benefits as well such as disaster protection and several off-site data back-ups with secure disaster recovery. All these features and aspects are attracting existing and new businesses as well as entrepreneurs to make an easy decision of cloud migration and grow without the trouble of local servers and associated costs.

Several businesses have also opted to use hybrid cloud environment where all the business processes are cloud powered, but data is stored in on-site servers or vice versa. It is a combination of public and private cloud platforms with integration and synchronization of services. Hybrid cloud is operated by businesses having concerns related to cloud security and privacy for critical data such as financial sector, healthcare industry, and law enforcement agencies. With hybrid cloud, the businesses have more control over cloud components and can get efficiency and flexibility to meet business needs. It also reduces cloud provider bill due to on-demand resources consumption only and increases certain business throughput with the precise workload for the right platform. The issues here are increased latency, poor data transport, increased cost, risk management, and management complexity [4, 7].

Similarly, numerous businesses and organizations have respectable assurance in the public cloud and hence moving all or parts of the data to the cloud, it allows universal availability of data irrespective of user location based on user credentials and authority. It is a long-term trend with scalability, reliability, and high convenience.

3 Benefits and Risks of Cloud Migration

Cloud migration is a complex process and has multi-dimensional facets that require research, comparison, and decision making before moving to data and process relocation. Many scenarios can take benefit of cloud migration [8]:

a. Resource scaling including on-demand allocation to meet requirements.
b. Operational costs reduction.
c. IT efficiency enhancements.
d. Quicker application deployment and operations.
e. Better focus on development with a drop in infrastructure overhead.
f. Business access globally without the need to set up multi-region infrastructure.
g. Cheap sustainable storage with resilience.
h. Easy work and collaboration for distributed development teams including remote employees.
i. Enhanced disaster recovery system compared to the on-site data center. Quick and simple cloud disaster recovery systems allow better control over resources.

j. Easy tracking, versioning, and up-gradation of applications.
k. Automated database backup, software upgrades, and periodic maintenance.

Along with the above-mentioned benefits, there are several risks and disadvantages of cloud migration as listed below [9]:

a. Sensitive data security and availability.
b. Compliance requirements of data storage and backup.
c. On-site proprietary technology may hinder cloud migration.
d. Additional latency of cloud applications over the internet. It might be harmful such as stock market or finance sector.
e. Less transparency and control over fixing performance issues.
f. Less hardware and base OS govern.
g. Cloud provider may use shared resources that are taxing for the sensitive workload.
h. Noisy neighbors on pooled resources at data center.
i. A particular application may not support distributed cloud architectures due to design and operational limitations.
j. Fear of unknown challenges fears such as vendor evaporation, compliance charges, policy change, price hike, data theft, connection reliability, etc.

4   Cloud Migration Considerations

As seconds turns to days and days to years, many organizations are adopting cloud service solutions on a massive scale in order to take advantage of the elasticity of the cloud and its economies of scale. Since people started adopting the cloud, there have been many tools that have been invented to help automate and evaluate cloud migration processes. Some of these tools are performance oriented, which provides analysis on user behavior, application's performance, and client's needs.

Before migration, performance based tools are used to create detailed baseline data concerning the performances of the application to be migrated. This is essential to evaluate an organization's infrastructure needs and to measure the return on investment of a completed cloud migration project.

During migration, the appropriated encryption technologies and migration tools can ensure security and real-time monitoring of application's performance to guarantee end users' safety and security.

After migration, performance tools can enhance the productivity of cloud based applications, to optimize the benefits of the cloud migration for clients and customer. For a cloud migration strategy to be successful the following should be considered precisely [10–12].

4.1   The Application or Data to Be Sent to the Cloud

Although cloud computing comes with the promise of improved flexibility and scalability, which makes it a venture that it's worth diving into, not every application is suitable for the cloud such as legacy applications, mission-critical workloads, and

sensitive information. To use cloud computing without sacrificing sensitive information, enterprises may either use a private cloud or adopt a partially private or partially public cloud strategy.

Also, it is a wise choice to consider the number of resources the applications are using. This will help make a better choice in cloud migration strategy. Because cloud service providers have many tenants renting their servers, the application will share resources with other tenants. Some cloud service providers offer the option of dedicated servers at premium costs. Cloud service providers may autoscale their resources, other users of the resources may still be an issue. The high increase in demand can also run up bandwidth costs and inhibit the application performance.

4.2 Cost of Cloud Services

One of the major reasons for moving to cloud services is cost efficiency. Migrating to the cloud removes the need for buying expensive hardware and hiring IT staff, thus increasing companys' bottom line and profit margins. Taking consideration of the financial benefits differ for each application.

On the other hand, hidden expenses may be a burden for business moving to the cloud, and as a result of this, organizations need to plan for bandwidth and networks costs. Most cloud service providers offer pricing calculators to estimate the cost of bandwidth, accuracy is also an issue since it is difficult to assume exactly how many hits, and how many tasks will be performed on the cloud by the clients, thus making the prediction of the actual bandwidth usage to be uncertain.

4.3 Type of Cloud Service

While the kind of application and the uncertain cost of bandwidth usage may weigh heavily on an organization considering a migration to the cloud, choosing the right cloud environment is also an important issue to consider. Although all three forms of cloud services (public, private, and hybrid clouds) have advantages, determining the best cloud service that fulfills their needs is an important step in the cloud migration strategy.

Public cloud services such as Godaddy, Hostgator, and Google, provide a highly scalable environment with a pay as you use model. However, they are not suitable for many organizations. Because of lack of control over the hardware and multiple users competing for the same resources, highly regulated industries such as financial institutions, government institutions and gambling services may not consider this as a viable option.

Private cloud services have an advantage that a public cloud service can never offer – absolute control. But this comes at a cost of buying expensive hardware and hiring IT staff to ensure smooth operation of such hardware. Unlike public cloud users, private cloud users are responsible for electricity, security, maintenance, and more.

Hybrid cloud services are a mixture of the public and private cloud environment. Organizations considering privacy and security of sensitive data and also cost of hosting heavy duty applications may apply this cloud migration strategy. Though this

method offers the best of both worlds, performance issues such as latency and dependency may arise.

4.4   Governance and Security

Migrating from private to public cloud or adopting a hybrid cloud strategy may affect an organization's governance. Governance methods that worked for traditional local data center systems may not necessarily work in the cloud. For example, a company may only allow some of its staff to access sensitive data such as age of clients, credit card numbers, etc., when such information is migrated to a public cloud service provider, the service provider will be able to access and view such sensitive information. Therefore organizations must change their governance strategies to rely less on internal security and control, and more on the security of the cloud provider. Organizations should also ensure that the provider is using up to date encryption certifications and security software.

4.5   Cloud to Cloud Migration Challenges

Cloud migration strategy does not only involve the movement of data from private to public cloud service, it also involves moving data from one public service to another public service. Service providers may change hands in terms of acquisition and takeovers, which may result in such movement of data. Moving data from local to public cloud service may prove difficult. Although there are third-party tools to make such task easier, there is no all-in-one tool to handle an entire migration process. Therefore, businesses prefer to come up with their own services.

When migrating from a public cloud service to another public cloud service, a great deal of labor is involved. This labor includes testing of new operating systems, networks, and configuration of applications for virtual machines and more.

4.6   Draw up a Cloud Migration Plan

Having considered all factors mentioned above, organizations will come up with a plan on how they are intending about their cloud migration strategy. It is important to put the plan in writing for reference purpose and easily follow up. This will help organizations to make decisions about how they direct their resources such as finances, staff, and hardware to achieve their cloud migration strategy. For example, a company that intends to migrate from local to public cloud service may choose to sell off its acquired hardware to free up some space for another purpose, and generate funds to further the cloud migration strategy.

5   Cloud Migration Stages and Tools

5.1   Cloud Migration Stages

Cloud and data experts have following recommendations regarding cloud migration [2, 13]:

Pre-migration Stage:

1. Plan for future and speculate about future business IT needs
2. Design a sound cloud control model
3. IT and other staff training before migration
4. Pre-test cloud migration and its related operations
5. Plan IT resources as part of cloud migration
6. Select best-fit cloud vendor

Migration Stage:

1. Start in small steps gradually
2. Systematize certain processes such as data transfer
3. Consider cloud migration as makeover of business
4. Select cloud vendors with fully managed services to avoid individual upgrades/down time

Post-migration Stage:

1. Devise a monitoring approach and evaluate migration success
2. Use tools available from the cloud provider for supervision
3. Test cloud provider support and communication infrastructure for future reference

According to [14] for a cloud migration strategy to be successful the four major steps to follow: Assessment, Planning, Migration, and Validation.

After planning and evaluation strategy based on the above points, it is important to find and evaluate tools that can ease cloud migration depending on cloud vendor. The major vendors such as Amazon Web Services, Microsoft Azure, IBM, etc. are offering in-house built tools for businesses that can ease whole evaluation, migration and testing procedure. These tools are tested and certified based on certain migration patterns common across businesses and have cloud vendor backed support to facilitate businesses IT staff for data, applications, and processes migration, testing, troubleshooting, and resolution of other issues, if present. Several other third party tools and services including both freeware and commercial tools exist that can ease cloud migration and success appraisal [15]. A recent trend in cloud migration industry is automation of the entire migration process using algorithms and machine learning with a dashboard and diagnostic reports. Migration of complete server with everything was a most crucial task in cloud migration process in the past but new sophisticated tools facilitate it now.

5.2 Cloud Migration Tools

Cloud migration tools are software tools that ease data, applications, and processes migration to cloud infrastructure or moving data, applications, and processes from one cloud provider to another cloud provider. These tools accelerate cloud migration efforts by automating certain processes and ensuring complete relocation. There are variations in organizational structure and business objectives, but still, certain patterns exist that can ease cloud migration [16].

The migration tools are a mix of manual and automated processes that require professionalism on both ends: cloud partner and customer. Here is the list of major

cloud migration tools and services: Azure Data Migration Tools, AWS Cloud Data Migration Tools, Live Migration – CloudEndure, IBM Cloud Migration Tool, RacemiDynaCenter, CloudVelox One Hybrid Cloud, CloudAtlas Cloud Migration Tools, Dynatrace Cloud Migration and Operations, RISC Networks CloudScape, Bit-Titan MigrationWiz, ScienceLogic, AppDynamics, DynaTrace.

There are some other tools including free utilities that can ease cloud migration, but they are manual and require a lot of technical expertise to operate successfully. The above tools support many kind of migrations such as data, application, integration, networking, and other processes. Out of the above-listed tools and services, the first four options are widely used due to cloud vendors support and better integration than third party tools. Moreover, it costs less to use cloud vendor migration tools along with support and troubleshooting opportunities. These cloud migration clients are developed and well tested in the field by their respective cloud vendors, i.e., Microsoft, Amazon, and IBM.

Azure Data Migration Tools. Microsoft provides this tool at no cost, and it is better integrated with the Azure cloud. In a statement from cloud migration service, Microsoft has stated "Migrating to the cloud doesn't have to be difficult—or slow. Speed your digital transformation, and start realizing the benefits of Azure faster with our comprehensive cloud migration process that takes you from custom assessment to optimize workloads to continuous improvement" [17]. The cloud migration tools are simple and offer custom assessment before actual migration to cloud by using computerized discovery tools that evaluate workload and other details. Based on this appraisal, Azure cloud migrations also suggests a business and technical plan including remodeling, right sizing, and re-architecting by using smart procedures and rules set. It also supports hybrid cloud migration and has flexibility and faster execution. Microsoft also offers a test run for Azure data migration tools including SQL database and other tools.

AWS Cloud Data Migration Tools. There are the tools offered by Amazon to move data via networks, snowball, storage gateways, and technology partners using specific acceleration tools. As the data for an enterprise can be in few hundreds of gigabytes or even several hundred terabytes, Amazon has derived a formula to calculate a number of days for data transfer [18]. Amazon has been innovative in the field of cloud computing ever since it ventured into the cloud computing business. It identifies the cost of transportation of data from on premises data centers to the Amazon's cloud as a major problem to cloud migration, and offers a way of transporting it on downtime period without much cost. Amazon makes a suggestion on how much data should be stored on its servers based on the bandwidth being used on its servers. In solving the issues of cloud migration, its suggests some tools that could be used by its customers to transfer data into the cloud such as rsync which is an opens source tool used to copy data directly into S3 buckets, S3 command line interface which is also another data transfer tool just like rsync (but instead uses commands by the user to transfer files), and Glacier command line interface which is used to move data into Glacier vaults.

Amazon Web Service cloud data migration tools such as DirectConnect, AWS Snowball, and Snowmobile offer features that either optimizes or avoids the internet, which will help an organization in reducing transfer costs. In addition provides friendly interfaces to make it easier to use S3 with an organization's native applications.

Amazon Database Migration Service. The major purpose for this tool is to make data migration hassle free even at downtime periods (periods of no service) as Amazon made it clear that "The source database would be fully operational in the migration process, which further reduces downtime to applications that are database dependent".

When it comes to cloud computing, Amazon has been the household name for it and they have been providing solutions to it ever since they ventured into the cloud computing platform since 2006.

Live Migration – CloudEndure. This third party service supports several cloud vendors such as AWS, Google Cloud Platform (GCP), Microsoft Azure, VMWare, Open stack, Oracle, etc. and ensure complete workloads migration including databases, legacy application, homegrown applications, and other processes [19]. The company has stated CloudEndure® Live Migration technology offers reducing migration complexity and eliminating risk. To guarantee full data integrity, the solution automated migration utilizes block-level continuous replication, application stack orchestration, and automated machine conversion. CloudEndure Live Migration provides you the flexibility and security enterprises need to succeed in today's fast-paced digital ecosystem when you migrate to or within clouds [19]. There is CloudEndure Agent that can be installed on all machines that need migration when the target is selected, continuous replications start working on a continuous basis and offers testing at the end to match migrated data without any disruption of work or quality. It also has cut over an option that isolates on-site server and connects applications with the target cloud vendor. The unique feature of CloudEndure is that it offers data migration back from cloud to on premise server or from one cloud vendor to another cloud vendor.

IBM Cloud Migration Tool. IBM has a company named SoftLayer that offers cloud migration expertise with a fast deployment in less than 48 h. It supports different workloads and web applications to the cloud. There is a questioner (14 queries) to facilitate the potential customer and offer support [20]. SoftLayer has some free workload migration options and offers help in case of incompatibilities.

Racemi DynaCenter. Live server image capture and deployment on AWS with full optimization for performance in the cloud offers by this tool [21]. The charges are $299 per completed migration and support multiple deployments (AWS Marketplace, 2017). It is firewall friendly and offers flexibility to ensure data integrity. It has been stated, "Racemi simplifies cloud transformation by offering discovery and automation technology to accelerate the cloud journey" [21]. It supports Amazon Web Services and Microsoft Azure.

CloudVelox One Hybrid Cloud. It is a versatile service that supports migration from the data center to cloud, cloud to the data center, data center to data center, intra data center, cloud recovery, cloud deployment and cloud test. It is a fully automated process, which supports diverse workloads such as physical, virtual, Linux, Windows, and

other processes [22]. It has integration with Cisco and supports various cloud platforms. CloudVelox has patented automated application blueprinting approach based on dynamic and holistically characteristics. The company PR suggests, "Manual cloud DR and migration tasks lead to heightened risks, costs and project delays. One Hybrid Cloud ™ software automates those processes, allowing your team to easily and safely leverage the cloud without typical cloud deployment risks and costs".

CloudAtlas Cloud Migration Tools. It is an EU General Data Protection Regulation certified cloud migration service consisting of a suite of solutions that support cloud strategy, migration of data and applications, and workloads with efficiency. It supports hybrid migration for SaaS, IaaS, and PaaS. The website notes, "Effectively migrating from a traditional, on premise IT environment to a Hybrid IT environment that may include elements of SaaS, IaaS, and PaaS requires a logical set of steps" [23]. Moreover, it mentioned with reference of Gartner that an organization migration to the cloud is part of the phased evaluation and plan to move to the cloud. It has CloudRecon application for discovery of assets, CloudPilot and CloudOrigin for correct application deployment securely and efficiently. For monitoring, the company is offering CloudSupervisor service with reporting to ensure compliance.

Dynatrace Cloud Migration and Operations. Dynatrace deals cloud migration and cloud operations solutions for public and private cloud infrastructure including hybrid deployment. The website states, "Cloud is essential to your business strategy" [24]. The insight service offers current application details such as resource consumption, dependencies, usage, etc. and hence precise appraisal for migration. It supports fast migration and offers automated troubleshooting during data transfer. It is artificial intelligence powered service for proactive issue recognition and solution and seamlessly links application services after completion of migration. It supports a wide range of cloud vendors including AWS, Azure, IBM, GCP, OpenStack, Oracle, VMWare, Cloud Foundry, Kubernetes, OpenShift, Mesos, and several others. There is a free trial available as service demo.

RISC Networks CloudScape. CloudScape is cloud migration as well as insight service from RISC Networks. It supports AWS, Azure, and GCP. The core theme of CloudScape is performance analysis for the cloud, data center, and infrastructure projects but also suggests and assists in cloud migration [25]. It is mostly an assistive service for performance analysis for cloud migration. This application helps an organization in understanding its need for cloud migration by monitoring its data, how it's been transferred, and the best way the data can be organized. After analyzing the data for a period of seven days, it will then recommend the best cloud services that would be fit for the organization (or individual) by comparing prices of the different cloud services available. When an organization implements the recommendation from

CloudScape, it will then help measure ongoing data trends to see how decisions made on cloud computing will affect the finances of the organization.

BitTitan MigrationWiz. It is migration service with low cost due to long term 12 months licensing scheme and supports data protection and zero customer downtime. It supports multiple cloud workloads in an automated way using the MSPComplete platform and migrates email, archives, documents, and other data from any source to any destination. The unique feature of this service is no software installation on any computer or server [26].

ScienceLogic. This is a useful application tool that will offer a detailed and compatible IT data analysis and monitoring. This service has a simple user interface that helps in parsing large amount of information. ScienceLogic is used by understanding the progression of analytical activity. It gives an organization a better understanding of the way its business operates and determines how to classify network activity. Monitoring this system will help develop a map of the relationships between various groups within the organization and with such information, an organization can use cloud based automation techniques to further relive staff for duties that are only meant for humans [27].

AppDynamics. This tool helps track user experience by recording every instance of crash or slow loading of pages, and looks for ideas to help fix the problems that may lead to loss of customers. It has a built in proprietary "Business IQ" system which will further help an organization to show how its third party applications affects performance. This tool is very useful for companies that are anxious about its customer negative feedback as a result of migrating to the cloud [28].

DynaTrace. This tool gives an easy to understand data analysis. With this tool, organization can measure how well users/customers appreciate new features by measuring the rate at which it is used, looks for dependencies within applications, and identify the major issues before they escalate into problems for a user/customer. In addition to these features, it has an AI enable assistant named Davis. Davis is a front line support tool which is available 24/7 to help users of DynaTrace with their questions [29].

6   Comparison of Cloud Migration Tools and Services

The diverse nature of cloud migration tools and services can be summarized in a Table 1 as given below:

Table 1. Summarized different cloud migration tools.

Tool/service name	Vendor name	Nature of tool/service	Cloud type support (public, private, hybrid)	Cloud platform support	Support migration of		
					Data	Application	Process
Azure Data Migration	Microsoft	Dynamic	All	Azure	Y	Y	Y
AWS Cloud Data Migration	Amazon	Dynamic	All	AWS	Y	Y	Y
Live Migration	CloudEndure	Dynamic	All	AWS, Azure, GCP, VMWare, OpenStack, Oracle	Y	Y	Y
IBM Cloud Migration Tool	IBM	Dynamic	All	IBM SoftLayer	Y	Y	Y
DynaCenter	Racemi	Dynamic	All	AWS, Azure	Y	Y	Y
One Hybrid Cloud	CloudVelox	Dynamic	All	AWS	Y	Y	Y
Cloud Migration Tools	CloudAtlas	Dynamic	All	Azure	Y	Y	Y
Cloud Migration and Operations	Dynatrace	Dynamic	All	AWS, Azure, OpenStack, Cloud Foundry, Mesosphere, Pivotal	Y	Y	Y
CloudScape	RISC Networks	Static	All	AWS, Azure, GCP	–	Y	Y
MigrationWiz	BitTitan	Dynamic	All	All	Y	–	–
Science Logic	ScienceLogic	Dynamic	All	AWS, Azure, IBM, VMware, SoftLayer, CloudAir	Y	Y	–
App Dynamics	Cisco	Dynamic	All	AWS, Azure	Y	Y	–
Dynatrace	Dynatrace	Dynamic	All	All	Y	Y	Y

7   Conclusion

Cloud computing is receiving more attention for different sectors due to its remarkable features. Industry leaders have classified cloud platform as a second generation with the potential to operate high complex businesses and processes over the internet. In order to transfer to the cloud environment, many processes and decisions are taken. Decision making is the first approach to cloud migration, and that section expands on the necessary ways to come up with the best methods for cloud migration as well as determining the feasibility of these movements and cloud service providers. Migration

methods focus on the ways to move software by converting from basic system code to leverage code, thereby enabling a successful move to the cloud. Development aids focused on the tools needed to transfer the converted legacy code to a cloud platform. Although, there are a lot cloud migration these days, there are very few information on using cloud migration tools. Consequently, how we can migrate to the cloud and what are available tools there? Our work is to investigate in depth analysis and comparison on different migration tools. The innovation such as quantum computing is taking it to further heights where real-time processing will be a new norm for business insight and processing. Cloud computing attracts businesses and enterprises to move data, applications, and processes from on-site companies own servers to remote data centers. Due to sensitive nature of data and specialized applications, companies opt to use cloud migration tools and services to ensure data integrity and swift switching to a cloud provider with an aim to trip on long-terms.

Based on studies, it is found that there is a lack of study that discussed on cloud migration generally and cloud migration tools specifically. To the best of our knowledge, we are the first comprehensive study of cloud migration tools. Moreover, cloud migration and services provided by cloud vendor are cheaper and are reliable for cloud migration. Third party tools and services are suitable for a highly complex environment where live server images and terabytes of real-time data require cloud migration with analytics and real-time reporting. Our future work would include more detailed analysis and comparisons of the various tools. In addition, we intend to conduct practical experiments using these tools for specific criteria.

References

1. Hwang, J., Vukovic, M., Anerousis, N.: FitScale: scalability of legacy applications through migration to cloud. In: Sheng, Q.Z., Stroulia, E., Tata, S., Bhiri, S. (eds.) ICSOC 2016. LNCS, vol. 9936, pp. 123–139. Springer, Cham (2016). https://doi.org/10.1007/978-3-319-46295-0_8
2. Bazi, H., Hassanzadeh, A., Moeini, A.: A comprehensive framework for cloud computing migration using meta-synthesis approach. J. Syst. Softw. **128**, 87–105 (2017)
3. Smith, D., Natis, Y., Heiser, J., Petri, G., Anderson, E., Swinehart, H.: Predicts 2017: Cloud Computing Enters Its Second Decade, ID: G00311365, December 2016
4. Alharthi, A., Alassafi, M., Walters, R., Wills, G.: An exploratory study for investigating the critical success factors for cloud migration in the Saudi Arabian higher education context. Telematics Inform. **3**(2), 664–678 (2016). ISSN: 0736-5853
5. Wan, Z., Wang, P.: A survey and taxonomy of cloud migration. In: 2014 International Conference on Service Sciences (ICSS), pp. 176–180, May. 2015
6. Pahl, C., Xiong, H., Walshe, R.: A comparison of on-premise to cloud migration approaches. In: Lau, K.-K., Lamersdorf, W., Pimentel, E. (eds.) ESOCC 2013. LNCS, vol. 8135, pp. 212–226. Springer, Heidelberg (2013). https://doi.org/10.1007/978-3-642-40651-5_18
7. Zimmermann, O.: Architectural refactoring for the cloud: a decision-centric view on cloud migration. Computing **99**(2), 129–145 (2017)
8. Khajeh-Hosseini, A., Sommerville, I., Bogaerts, J., Teregowda, P.: Decision support tools for cloud migration in the enterprise. In: 2011 IEEE 4th International Conference on Cloud Computing, pp. 541–548, April 2011

 9. Gkatzikis, L., Koutsopoulos, I.: Migrate or not? Exploiting dynamic task migration in mobile cloud computing systems. IEEE Wirel. Commun. **20**, 24–32 (2013)
10. Wang, J., Song, M., Chang, Q., Shu, Q.: Capacity planning for telecom operation support system cloud migration. In: Zu, Q., Hu, B., Gu, N., Seng, S. (eds.) HCC 2014. LNCS, vol. 8944, pp. 427–440. Springer, Cham (2015). https://doi.org/10.1007/978-3-319-15554-8_35
11. Menzel, M., Ranjan, R., Wang, L., Khan, S.U., Chen, J.: CloudGenius: a hybrid decision support method for automating the migration of web application clusters to public clouds. IEEE Trans. Comput. **64**(5), 1336–1348 (2015)
12. Jamshidi, P., Pahl, C., Chinenyeze, S., Liu, X.: Cloud migration patterns: a multi-cloud service architecture perspective. In: Toumani, F., et al. (eds.) ICSOC 2014. LNCS, vol. 8954, pp. 6–19. Springer, Cham (2015). https://doi.org/10.1007/978-3-319-22885-3_2
13. Hwang, J., Huang, Y., Vukovic, M., Anerousis, N.: Automation and orchestration framework for large-scale enterprise cloud migration. In: 2015 IFIP/IEEE International Symposium on Integrated Network Management (IM 2015), pp. 1002–1007 (2015). IBM J. Res. Dev
14. Zhau, J., Zhou, J.: Strategies and methods for cloud migration. J. Autom. Comput. **11**, 143–153 (2014)
15. Huang, T., Zhu, Y., Wu, Y., Bressan, S., Dobbie, G.: Anomaly detection and identification scheme for VM live migration in cloud infrastructure. Future Gener. Comput. Syst. **56**, 736–745 (2016)
16. Sefraoui, O., Aissaoui, M., Eleuldj, M.: CIMP: cloud integration and management platform. In: Rocha, Á., Serrhini, M., Felgueiras, C. (eds.) ICSOC 2014. AISC, vol. 520, pp. 391–400. Springer, Cham (2017). https://doi.org/10.1007/978-3-319-46568-5_40
17. Microsoft, Cloud Migration Solutions Homepage. https://azure.microsoft.com/en-us/solutions/cloud-migration/. Accessed 07 Oct 2017
18. Cloud Data Migration, Amazon Web Services (AWS) Homepage. https://aws.amazon.com/cloud-data-migration/. Accessed 09 Nov 2017
19. CloudEndure Live Migration Homepage. https://www.cloudendure.com/live-migration/. Accessed 08 Oct 2017
20. IBM, Cloud Migration Tool Homepage. https://www-935.ibm.com/services/us/en/it-services/cloud-services/cloud-migration-tool/index.html. Accessed 11 Nov 2017
21. Racemi, DynaCenter Technology Homepage. https://www.racemi.com/technology/. Accessed 15 Oct 2017
22. CloudVelox, Cloud Automation and Orchestration for Existing Workloads Homepage. https://www.cloudvelox.com/. Accessed 28 Nov 2017
23. CloudAtlas, Cloud Migration Tools and Management Homepage. https://www.cloudatlasinc.com/. Accessed 25 Dec 2017
24. Dynatrace, Cloud Migration and Cloud Operations Homepage. https://www.dynatrace.com/solutions/cloud-migration/. Accessed 29 Dec 2017
25. CloudScape by RISC Networks Homepage. http://cloudscape.riscnetworks.com/. Accessed 11 Jan 2018
26. BitTitan, MigrationWiz Homepage. https://www.bittitan.com/solutions/migrationwiz/. Accessed 21 Jan 2018
27. Migrating to the Cloud: Workload Discovery with ScienceLogic Homepage. https://www.sciencelogic.com/product/resources/cloud-migration. Accessed 11 Aug 2018
28. AppDynamics, Accelerate Cloud Migration with Confidence Homepage. https://www.appdynamics.com/solutions/cloud-migration/. Accessed 21 Jan 2018
29. DynaTrace, Cloud Monitoring Homepage. https://www.dynatrace.com/capabilities/cloud-monitoring/. Accessed 05 Dec 2017