A STUDY ON CLOUD COMPUTING IN AVIATION AND AEROSPACE

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ABSTRACT - Right from the time to establish aerospace and aviation industries till the air vehicle departures safely, passenger information, co-ordination and integration amongst several stakeholders are very crucial. The pressure from customers to get best services has led these industries to roll over to digital technologies used by Big Data, Cloud Computing and Mobile Computing. In Cloud Computing, a cloud itself comes as a package and there will be no necessity to add extra capacity. Operations excellence is a vital part of any business. It includes timely delivery, cost effectiveness, through put of the assembly line and quality. It can be enhanced and achieved by having automated virtualization and Internet-Of-Things (IOT).

Keywords: Cloud Computing, Aviation, Aerospace

I. INTRODUCTION

In olden days aviation and aerospace manufacturers had to establish a large scale plant (assembly line, network, separate workstations for each task) which was very expensive and time consuming. With the availability of Cloud Computing cost has reduced, timely delivery and quality have enhanced.

With the reduction in prices of airline tickets and advancements in technology, there is increase in passenger demand to consume more and more data. In order to meet these demands, it is necessary for any industry to adhere to best technologies to improve their profits. Cloud Computing is one of the technologies to meet demands of customers in an effective way.

In this paper, we conduct a survey on the need of cloud computing in aviation and aerospace industries, various cloud services and cloud based tools used by these industries. We throw light on definitions of aviation, aerospace and cloud computing, types of clouds, advantages and challenges faced on using cloud.

Aviation and Aerospace

Aircraft is a machine that has ability to fly with the help of the air. Two main fields which deal with aircrafts are aviation and aerospace. Aerospace deals with design, manufacture, certification of aircraft systems including helicopters, UAVs, space crafts and satellites within the earth's atmosphere and in space. Aviation deals with the operations, maintenance and management of airports and air traffic and environmental impact of aircraft vehicles within the earth's atmosphere.

Aviation and aerospace industries play vital role in the economic growth of developing countries like India. There is no 'chance' factor in both fields. Everything has to be planned and executed perfectly. Before an aircraft attains its maiden flight, it has to undergo series of analysis and testing. The probability of any catastrophic failures should be zero.

Cloud Computing

Cloud computing is a technology where massive resources are accumulated in large data centres and interconnected to provide consistent, inexpensive and secure services via Internet to huge set of users. Resources include applications, network, compute or host, storage and database.

There are mainly four types of clouds:

1. Public cloud - Here cloud services are available to public. The cloud is usually owned by an organization providing services.
2. Private cloud - Here cloud is operated by an organization and is managed by the owner or by a third party.
3. Community cloud - Here different organizations having similar mission, security requirements and policies collaborate to form a cloud which is either managed by one of the organizations in community or by a third party.

4. Hybrid cloud - It is a combination of any of the above mentioned clouds.

In addition to above types, Kavita Taneja et. al. [5] explains about Inter cloud which is a collection of clouds and Virtual private cloud. Many companies have defined their own Cloud Computing architecture. In general, there are three main layers:

SaaS (Software as a Service) - In SaaS, user has no control over the underlying infrastructure including operating system, storage and network. Users can use the applications provided by the service provider. SaaS mainly offer services like Customer Relationship Management (CRM), Enterprise Resource Planning (ERP), supply chain, portal services, financial management and so on.

PaaS (Platform as a Service) - In PaaS, user has no control on the underlying cloud infrastructure however has control on the implemented applications and its environment. Main area of PaaS is in the software development field.

IaaS (Infrastructure as a Service) - In IaaS, user has control over operating system, applications, storage and network components however, users have no control on underlying cloud infrastructure. Some of the services offered by IaaS are hosting server, load balancing, virtual instances, bandwidth provisioning etc.,

In addition to these there are additional emerging layers like Identity as a Service, API as a Service, Desktop as a Service and Security as a Service [8].

Advantages of Cloud Computing

1. Cloud Computing is cost-effective. It charges users only for services they use.
2. Cloud leverages the advancements in software, networking, storage and processor technologies.
3. Cloud supports elasticity where-in it is possible to easily scale up and scale down resources.
4. Provides self-service on demand.
5. Ensures resource availability by supporting redundant infrastructure components.

Major challenges in Cloud Computing

1. Security - Clouds are more susceptible to DDOS (Distributed Denial of Service), man-in-the-middle attack, flooding data, session hijacking, attacks during live migration and replay attacks.
2. Service availability - The cloud services might not be available during infrastructure failure due to power failure or due to natural calamities.
3. Management of resources - A cloud consists of massive infrastructure. Load balancing, Capacity management, energy utilization are the main challenges.
4. Performance isolation becomes a problem as cloud computing supports sharing of resources.
5. Vendor lock-in - It is difficult for an organization to move from one cloud service provider to another as it is time-consuming and also might lead to data loss.

II. LITERATURE SURVEY

Cloud implementation in Aviation and Aerospace

Nitha Rachel et. al. [3] depicts how cloud computing is used to host services on ground station which then provides services to aircrafts moving in range. When aircraft moves from one geographical network to another, VM (Virtual Machine) will also be moved from one node to another node on a different cloud in a new geographical area. It also describes an aircraft data network with a virtual private cloud where cloud services are provided via IPSec tunnel.

Amrutha et. al. [2] proposed a cloud based VOIP application in aircraft data network. VOIP is installed in the cloud to provide VOD, PDAs, video conferencing and other services to customers in the flight. Here, information like flight current status, position, routes and so on are sent to the nearest ground station which is connected to a cloud via satellite communication. The cloud in turn is connected to a SAN (Storage Area Network). Through SAN other ground stations get access to the data.

Need of Cloud in aviation and aerospace fields

Cloud deployment has become a critical factor in aviation and aerospace fields. It addresses the challenges aerospace, aviation and defence companies' face and provides faster solutions to the changing environment. Cloud computing avoid companies to invest on entire infrastructure and paves a way to pay only for services they use.

With cloud, it becomes easier to simulate each aircraft component rather than building a physical prototype. Operations and management in air industries mainly depend on huge sets of data. Gathering, ranking and extracting these data are major challenges and these can be addressed by a cloud-based database.

The internet service within aircraft is via satellite communication and it is very difficult for satellite network alone to meet the demands of passengers. With a frequency band called Ka-band [4], business executives can have access to VPN networks, video conferencing, cloud computing, email, internet, e-commerce and other entertainment services within the flight.

Cloud computing can be used in maintaining highly critical data such as defence information, government related data etc., Rashi Gupta et. al. [11] describes that cloud can be used in real time analytics which helps in predicting weather conditions and air traffic and also in business intelligence to simulate aircraft parts and test aircraft device as a whole.

Most of the aviation and aerospace industries are moving towards Cloud. Eric Carlson et. al. [16] proposed a Cloud computing strategy that involves migrating IT services on to cloud, designing architecture, integrating it with Enterprise architecture and then implement a cloud providing security. Aerospace Industries Association (AIA) [26] suggests for frequent press meetings to have consistent cloud services and standards for aerospace and aviation industries.

Reinhard [20] describes an aviation cloud which helps real time tracking of air bodies. It can provide optimized routes. Customers could be well informed regarding weather conditions and ticket reservation prior the airplane flies.

The whitepaper [10] explains how cloud computing is used in Shopfloor. Shopfloor is a place where the aircraft parts are assembled. Previously, a dedicated workstation was used to keep track of regulatory information, service information manuals, orders, forms and business procedures. This was prone to single point of failure. But with cloud computing, mechanics have right information at right time in their hand. The paper also describes a few cloud based applications like Reference Library App which provides access to maintenance libraries for manufacturers, Profile and Compliance App which gives detailed information on components of aircraft, Parts Exchange App which lists parts and alerts when a part is needed and Resource Management App to keep track of customers and aircrafts.

Weather forecasting reports and radar data are not provided in detail and these come in different sources with no standardization and uniformity. Virtualised cloud can be used to deal with such heterogeneous set of data [12].

Balaji et. Al. [15] discusses that aviation and aerospace industries are moving towards cloud for analytics, design and testing. In order to store data efficiently and securely manufacturers move toward cloud as a solution due to its high scalability feature in terms of storage and compute.

Mobile service is the major concern in almost all airline companies. Senthil [23] explains that using mobile services, these companies can address solutions to customer relationship management, finance, business management and loyalty. With high priority given to mobile communication within an aircraft, mobile cloud computing comes into picture. Amreen Khan et. al. [9] says that with mobile cloud computing, users need not download apps on their handsets instead they can directly access the applications on cloud. [26] discuses that providing access to social network sites such as Facebook and Linked In becomes very easier via mobile cloud computing. However, main challenges occur due to change in location (crossing cell boundaries or client mobility), intermittent connectivity and delayed transfer due to high traffic mainly during festival seasons.

Sreenivasa et. al. [25] describes the need of cloud computing in air industries using two illustrations: One is, suppose a technician working on an airplane wiring system, which is several feet above ground and wants to know how the system works, then the technician can be provided with a mobile which is a member of cloud and he/she can see the working sitting in aircraft without actually getting down. Another is, sensors are used extensively these days to capture the state and requirements of a system. The information collected by sensors can be sent to related Subject Matter Experts (SMEs) sitting in remote place via cloud securely.

After the mishap of Malaysia Airlines flight MH370, International Telecommunication Union [ITU] has set a group called Focus Group for flight data monitoring using cloud computing. The idea behind is to transmit data from aircraft to ground in real-time. [27] throws light on the type of data to be transmitted, required data rate, security, cost, storage and analysis. The group has identified specific tasks in order to build a cloud: Gather information on current technologies using cloud computing, Generate use-cases on how data analytics and other operations could be implemented, Need of reliability, security, capacity and availability management, Schedule meetings and events and finally produce the deliverables.

Cloud Services currently in use in aviation and aerospace industries

Hong Kong Airlines (HKA) is one of the renowned airline companies globally. To effectively compete with other airline industries and to expand its services to customers HKA built its own advanced, dedicated core IT system for reservation management, baggage management, finance, safety, customer relationships and crew scheduling. With increase in crew, flights and information, traditional dedicated core poses many disadvantages. The system was less efficient, provided very low security and consumed much power. So HKA had to shift from traditional IT system to Cloud Computing with assistance from Huawei. It is now using Huawei's FusionCloud desktop cloud solution. The solution has a cloud-based data centre also called desktop-cloud virtualization platform. The data centre has about 500 VMs and is efficiently managing the airlines [18].

Jet Aviation has choose cloud services from T-systems and uses a cloud computing variant 'Dynamic services for SAP solutions [21]. With the help of this cloud based platform Jet Aviation keeps track of a wide range of its services from engineering to sale of its aircraft. The system is configured for nearly 600 users and can be expanded within a few minutes.

Tulinda Larsen [12], describes aviation community cloud which is an environment with a few organizations having shared concerns with respect to security, policies and compliance requirements. Here various airlines and airports are brought together and can share same infrastructure, applications, bandwidth and storage. The paper also explains about a cloud based big analytics platform - masFlight. It uses a proprietary hybrid cloud which is capable of managing more than 60 TB of structured data. It also supports inbuilt alerting and validation tools to monitor performance metrics such as load balancing, quality and backup.

Avianet [24], an IT company provides services to its clients of aviation industry released a cloud computing service 'A-Cloud' with an intention to provide elasticity, security and infrastructure management services in a cost-effective manner. A-Cloud uses Verizon's Enterprise Cloud Technology, an IaaS delivery model. It integrates individual cloud services into a single application and this cloud has the ability to schedule workloads based on the location so as to maintain data integrity and security.

Cloudsuite as described in [19] is a cloud package from Infor that provides secure infrastructure for aerospace and defence departments enabling faster and cost-effective business. It mainly is concerned with production management, CRM, quality management, planning and scheduling. In addition to these CloudSuite also offers tools for deep analytics and procurement tools to analyse supply chain.

Boeing [28] has developed an application to keep track of flight paths leveraging Microsoft Window's Azure cloud and Amazon Web Services cloud. Another tool named Digital Toll app using Amazon Web service cloud allows integrating various data which helps mechanics to research, conduct test and validate maintenance.

Challenges

The two major challenges aviation and aerospace industries face with cloud computing are:

Customer satisfaction - With real time techniques providing entertainment services such as VOD, use of PDAs it is very essential to minimize latency. Having bandwidth constraints results in delayed response and would not make customers happy Security is a vital concern. Air industries will have to invest on risk assessment to ensure that the system is securely bounded. [14] explains that securing proprietary information is not only a business critical fact, but also a risk on nation's security.

III. CONCLUSION

As cloud computing technology is still evolving, standardization is not yet defined and more emphasize should be given on interoperability and standardization. Stringent SLAs (Service Level Agreement) should be set. Major care should be taken when changing from one cloud provider to another. Sensitive data have to be tracked. Powerful encryption techniques should be used. Periodic data archival and retrieval should be emphasized.

Adoption of cloud computing by various aviation and aerospace industries is growing at a rapid speed. Emerging technologies in Cloud Computing such as Virtual Desktop Infrastructure (VDI), Policy engines, Authentication as a Service (Aaas) and Testing as a Service (TaaS) have great impact on industries and are areas of research.

ACKNOWLEDGEMENT

The work reported in this paper is supported by the college [BMSCE] through the TECHNICAL EDUCATION QUALITY IMPROVEMENT PROGRAMME [TEQIP-II] of the MHRD, Government of India.

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