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Analysis of Air Traffic Management Models

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Abstract: ***The high growth of air traffic flow has increased more bottleneck traffic issues in the air traffic management (ATM) system. The challenges between flight flow, air traffic control service and airspace are the major key parameters which support capability of domestic and international air transportation need to be looked by stakeholders. Many models are designed to incorporate to address the potential bottleneck issues of ATM. However, in these models' analysis was not clearly presented. The proposed research review paper presents an analysis and insights of different models used in an air traffic management which includes, Big Data, Artificial Neural Network, Cloud Computing and Enterprise models.***

Keywords: Analysis, Air Traffic Management, Artificial Neural Network, Big Data, Cloud Computing, Enterprise Model.

I. INTRODUCTION

An Aviation industry is a standard body which projects that; worldwide air traffic is predicted to increase by 4% yearly by 2022 [1]. It is projected to increase the yearly growth rate of 4.3% and 3.9% for air commuters and cargo aircraft simultaneously is mentioned in [2]. In Recent days, large number of customers are using flights to travel, due to this air traffic management has grown to a different level. It is extremely important to accommodate this increasing growth, by making sure that Air Traffic Controllers (ATC) are ready to handle the growth and traffic. Extreme awareness and variant technologies and techniques are essential to support Air Traffic Controllers to handle the air traffic in a better way. This increasing growth, lead to an urgent need of proper communication and control between air traffic control automation systems, collaborative decision-making (CDM) systems and electronic flight strip (E-Strip) systems [3]. In next 20 years there are chances that air traffic management system will reach to the different level. However, it is also researchers predicted that efficiency of air traffic management may decrease 1% by every year [4].

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Researchers are trying to analyze which method or technique would suffice the growth of air traffic management. With respect to alleviate the capability and able to sustain the growth various techniques are incorporated.

This paper provides an analysis of various techniques used to achieve maximum amount of alleviation of capability and traffic services to customers from the proposed models.

II. RELATED WORK

In this section, associated work of different techniques are reviewed. Some preparatory work is being done in collaborative Air traffic Management (ATM) for next-generation ATM is mentioned in [5]. However, this traditional approach does not consider to scale up and not includes heavy traffic. This is due ineffective communications between Air Traffic Controllers and other channels. By incorporating dynamic reconfiguration architecture in the communication network of ATM [6], reliability of the air traffic can be achieved. And also, it is very much important to have safe, secure, sustainable air traffic management system at local levels, regional levels are mentioned in [7]. When the traffic is increasing, obviously big data is referred. Big data includes large amount of organized and unorganized data mentioned in [8].

Chinese aviation industry includes big data technique to manage their air traffic in their metropolitan cities. Big data methodology is defined in [9]. In a way air traffic risks cannot be neglected when considering with huge traffic and having effective communication using Air traffic controller system. Various air traffic risks and warnings are considered in [10]. General monitoring and defining the perfect frame for air traffic management system is also important part of the aviation industry. General awareness and suitable framework to be adopted is mentioned in [11].

The enterprise architecture is used globally to incorporate business makeover in different domains and how it is included in air traffic management to deliver the mandatory transformations to make arrangements for increasing air traffic demands given in [12].

III. TECHNIQUES

A. Big Data Platform for Air Traffic Management (ATM)

To enable secured air traffic management system, big data-based air traffic management system is designed [13]. Here different systems such as Advanced Surface Movement Guidance and Control System (ASMGCS), Electronic Fight Data System (EFS), THALES and LES traffic control system weather system,

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air traffic system, voice recording system, aeronautical information system, digital clearance system are connected with each other so that all information gets updated in all other systems to ensure easy and safe air traffic management system. Fig.1 shows the signal system connection with all systems with big data platform. Whenever there is a large amount of data, especially need to air traffic information, big data plays a very important role in such context. The output of the data is captured and accumulated in different system for further processing by using air traffic [14].

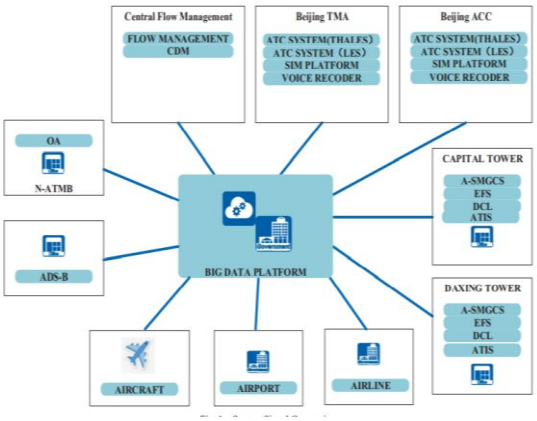

Fig. 1.System Signal Connection

1) Connected with Capital Airport Tower
   Here big data platform is connected to ASMGCS, EFS, DCL and ATIS. The trajectory of the planes direction in which plane is moving, will be send by pilot to the big data center. Based on the data obtained the route planning will be done for the next flights.
2) Connected with Daxing Airport Tower
   The same information above mentioned will be send to the Capital Air Towers.
3) Connected with Beijing TMA and Beijing ACC
   THALES is main traffic control system and LES is a backup system which will work if the data in main center is lost or sudden problem with main system occurs. Satellite images collected will be used to check the traffic and these details will be uploaded to the big data platforms for managing air traffic.
4) Other Systems
   The other systems help in getting information about departure and arrival time of different flights. The parking information, flight status all will be obtained and will be updated in the big data platform.

This big data method is used to extract meaningful information from the noisy, fuzzy, and random data collected from various sources like satellites and store it in a proper manner, process them and apply functional methods to give useful information about various aspects like route findings, track is free or not, direction in which flight needs to take and help in air traffic management [15].

B. ANN model in Air Traffic Management (ATM)

1. System Architecture

The Figure 2 shows the block diagram of air traffic control system. This system is mainly divided into two blocks viz. Inputs to decision maker and Back Propagation Network (BPN). Inputs to decision block will be having many information like Air data, meteorological data, radar and communication systems, which will collectively function to decide the working of the flights. They will consider various parameters related to weather parameters, landing clearance parameters and midair traffic parameters to decide when a flight can takeoff and when it needs to be halt and all to avoid accidents in the air traffic [16]. The Back Propagation algorithm works on principle of artificial neural networks to find the best fit shortest path without any hindrance and all for the flights in the movement. The output will vary as number of flights get updated in the database.

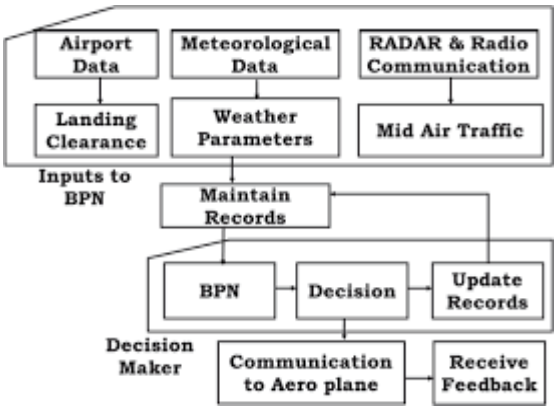

Fig. 2.Block Diagram of Intelligent Air Traffic Control

The parameters used in building model is seen in Table 1

Table- I: Parameters Considered in ATC Simulator

Weather Parameters	Landing clearance Parameters	Midair traffic Parameters
Temperature	Runaway Availability	Flight Level
Wind	Hangars	Fight heading
Rainfall	Departures in progress	Destination
Humidity		Speed
Fog		Planes in vicinity

2. System Design

System is divided into two stages neural network layout and system algorithm.

Neural Network Layout: This stage is divided into 3 modules:

Module 1: Weather conditioning of the input holds each parameter for 5 input nodes and 2 output nodes.

Module 2: Midair traffic controlling holds good for 5 input nodes, 2 concealed nodes and 2 of the output nodes.

Module 3: Clearance related to landing aircraft comprises of 3 input nodes, 2 concealed nodes and 2 output nodes.

System Algorithm:

This is nothing but the artificial neural network algorithm which comprises of input, concealed and output layers from each module on random basis and for each input some weights will be fixed to check whether given input value is correct or not. And this will determine the plane roues, start and departure of flights. The advantage of this model is as we increase the number of epochs for training the loss function value will be reduced and accuracy obtained will be more and thus a better prediction model for air traffic management can be obtained.

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The system will consider dynamic updates in detecting the routes and helpful in real-time air traffic control management systems.

C. Cloud Computing Technique

The cloud technology is used to modify the scaling and firmness of the air traffic management from various viewpoint. With virtualization and VM tolerance, regaining of server would be 30 times faster as compared to legacy Air Traffic Management system.

By using cloud techniques, there is no limit on the expansion hardware limit and also internal network expansion would be free of cost. The Figure 3 represents the Software Architecture of ATFM system

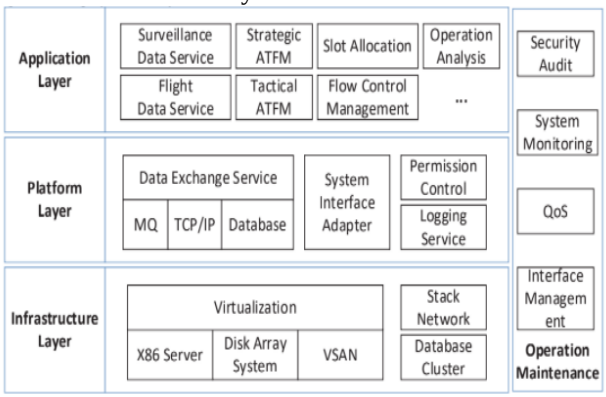

Fig.3. The Software Architecture of the ATFM System

At the Infrastructure level the virtualized clusters or groups are included, in order to create a small private cloud network to include ATFM systems.

At the platform layer, the data exchange happens with the help of various protocols like MQ (Message Queue), TCP/IP. At the Application layer, based on two services like Surveillance data service and flight data services are updated in such a way that they are compared to legacy Air Traffic Management system.

D. Enterprise Architecture

There is a specific requirement or the framework needed to accomplish enterprise architecture in the air traffic system. The framework is defined as a group of techniques and concepts that can be put forward to interpret and accomplish enterprise architecture [12].

The various frameworks are:

1. Zachman Framework: The number of firms like Health Canada and the United States incorporate Zachman framework because the Zachman framework uses a number of data points to elaborate on the business and information. They are in turn organized into people, data, networks which are aided by enterprise business necessities.
2. Department of Defense Architecture Framework (DODAF): This kind of framework is basically built for military use and is also utilized for public and private organizations like MODAF (Ministry of Defense Architectural Framework). DODAF is also widely used in the US department of defense[12]. The basic views are all view, operational view, services and technical standard. Based on DODAF and MODAF, NATO (North Atlantic Treaty Organization) Framework is defined.
3. The Open Group Architecture Framework (TOGAF): The Open Group Architecture (TOGAF) supports and contains architecture related to business, information architecture and technology confront specifications of the architecture. The challenge with ATM is used to satisfy multiple stakeholders requirements.

Air Traffic Management transformation using enterprise architecture:

In order to meet the demands of legacy air traffic management to have a potential to contain the future of air traffic and increase the Research and Development activities certain transformation is needed.

There are 2 transformation techniques are used:

- Next Generation Air Transportation System: There are two tasks to assist NextGen Integrated plan are Concept of operations (Conops), architecture related to enterprise and complete collaborative activity sketch is mentioned in [12].
  Conops describes the vision and transformed state of NextGen while Enterprise Architecture provides the technical details and finally integrated work plan specifies the timing and interdependencies of the multi-agency research, developments and validations [17].
- Single European Sky ATM Research (SESAR): This is whole sum and integrated Air traffic research program, which is included in providing Unsegregated roadmaps on how different Research and related techniques can be incorporated. Development can be utilized by stakeholders to achieve profit and higher improvements and various views on the complete enterprise architecture.

IV. ANALYSIS

The analysis of different models of Air Traffic Management is shown in Table -II below.

Table- II: Analysis of Different Models of Air Traffic Management

Model	Key Insights of each model	Analysis of Each Model	Identified issues in each model	Research Gaps
Big Data Model	This model will reduce complexity in data processing by removing unwanted, fuzzy and noisy data.	It is observed that there is express development of flights however the airspace and energy are limited in air traffic management system. So Big data platform must	With higher complexity the model may lead to higher false discovery rate.	How to improve utilization of air space ensuring security, how to reduce workload of controller, some of these aspects can be improved.

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Artificial Neural Networks	The model found adaptive to conditions which was changing dynamically after every 10 seconds or less.	The model was tested using three different modules namely weather parameters, mid-air traffic control, landing clearance each parameter is tested for six planes simultaneously.	Finding number of hidden layers for each module is very difficult.	Only three modules are defined using some basic parameters but many modules with more parameters can be considered for future work and also superior neural network models can be built in future.
Cloud Platform	The model improved the expansion capability and stability of the air traffic management system.	The model has high computing power and storage compared to ATM models. By Virtualization, processing units are distributed over many devices.	Time required to retrieve all data is more. Security is major concern	A work on how uniform information exchange of messages in air traffic systems can be done.
Enterprise Model	The model presents various frameworks to be incorporated to support the growing demand of air traffic. Based on the kind of application, the different frameworks are adopted.	The enterprise model will use transformation functions which help to cope up with future technologies also.	Compared to other models' capital required is much more.	Optimization, Provision, Integration in R&D can be applied on existing enterprise model by stakeholders to achieve business improvements.

V. CONCLUSION

This paper discusses few techniques used in case of air traffic management system. Each technique has its own way of managing and supervision of various flights through various parameters. The paper tries to analyze 4 techniques to understand and apply it to air traffic management. Separate parameter management and comparison yields in detailed comparison which can be utilized for further study in air traffic management system.

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