

## Combined ASIOACG/9 and INSPIRE/5 Meeting, 2014

Dubai, UAE, 12th to 14th November 2014

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### Agenda Item x: Any Other Business

#### "Terminal Area and Runway Efficiency initiatives at Mumbai" (Presented by AAI)

##### SUMMARY

This paper presents a brief about the initiatives at Mumbai Airport that have resulted in 60 percent capacity enhancement in last decade for a single runway operation.

### 1. INTRODUCTION

#### 1.1 Mumbai Terminal Area.

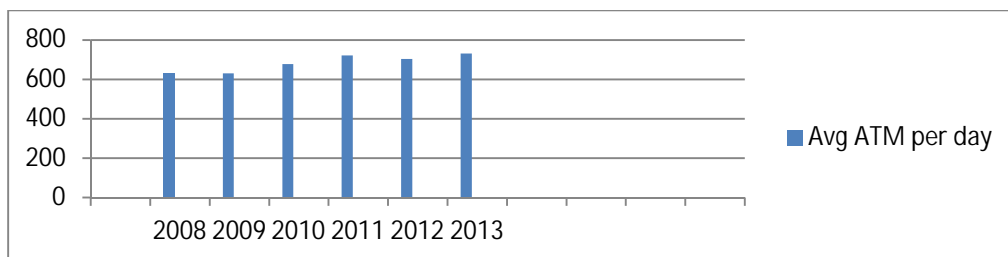
The Mumbai Terminal Area is airspace of 50 Nm around Mumbai Airport with Vertical limit from Ground to FL140. The TMA serves Mumbai Airport as well as some traffic at Pune Airport and multiple Heliports including Juhu.

#### 1.2 Mumbai Airport.

Mumbai Airport has Four Runways 09/27 and 14/32 that intersect each other at about 2/3 rd distance from 14 and 09. Located in the heart of commercial capital of India, i.e. Mumbai it has 740 average movements daily. It is the second busiest airport in India and until five years back was the busiest airport in India.

#### 1.3 The Background.

The Open Sky policy and the economic Boom India witnessed since the beginning of 21<sup>st</sup> century led to exponential growth of aviation sector. The air traffic at Mumbai Airport also grew exponentially during this era as can be seen from the following graph,

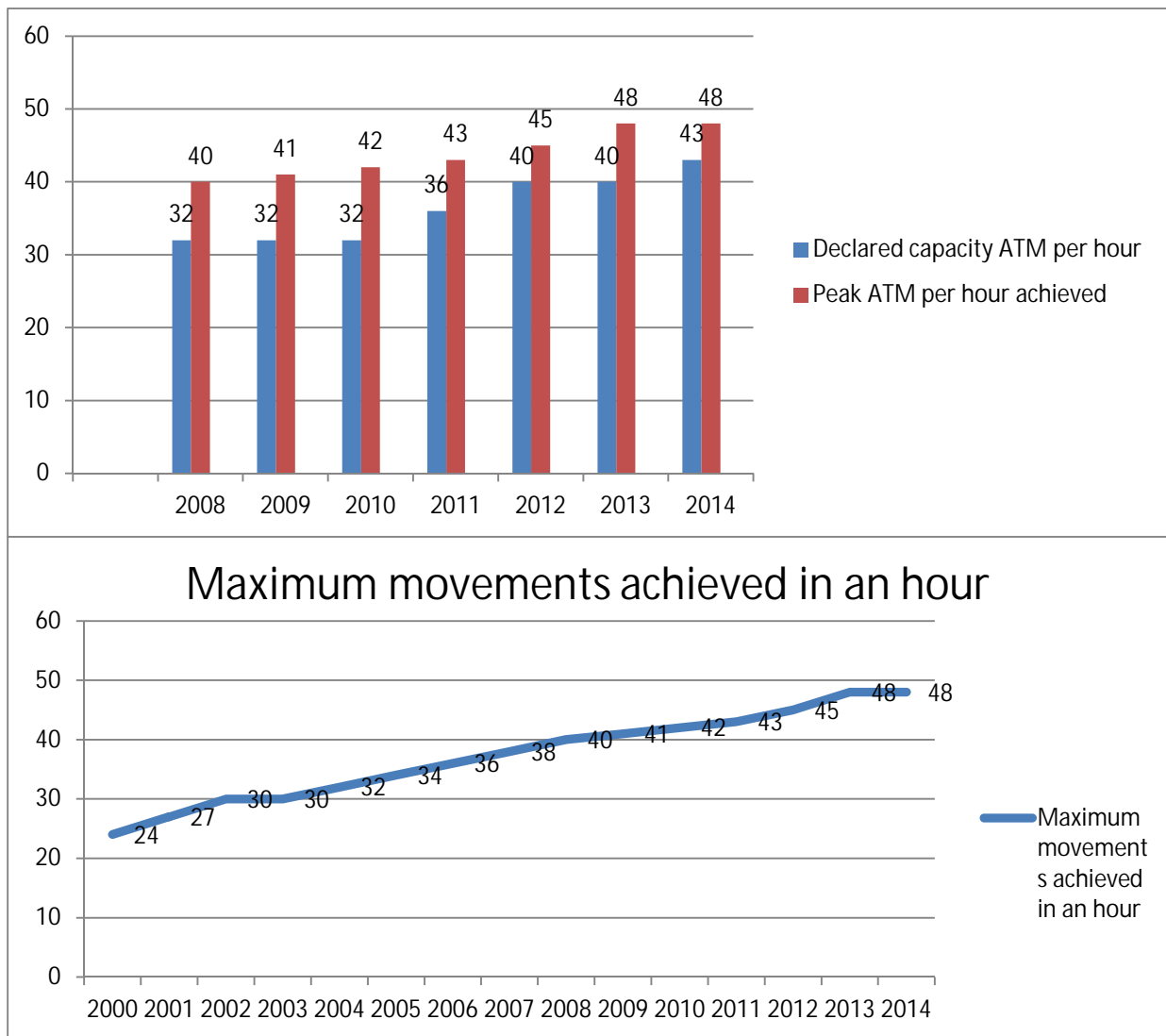


The result of this exponential rise in air traffic resulted in delays to arrivals and departures. The Air Navigation Service Provider, Airports Authority of India moved swiftly and launched many initiatives that have resulted in steady improvement in declared capacity and hourly movements per hour. The delays have reduced considerably and the efficiency of airspace and runway traffic flow has improved.

## 2. DISCUSSION

### 2.1 The improvements,

The declared capacity and peak air traffic movement achieved per hour have steadily increased and on time performance has improved considerably as seen below,



**[60 percent improvement in efficiency in a decade (2003-2013)]**

The steady improvements are the result of series of initiatives launched by AAI over last five years with the support of Airport (Mumbai Airport International Limited, MIAL), IATA and the regulator i.e. Director General of Civil Aviation, India. The initiatives are based on in-house expert opinion and research and the recommendations of the consultants, Massachusetts Institute of Technology Research Establishment (MITRE) engaged by AAI and NATS, UK engaged by MIAL. AAI has also engaged industry partners through forums like Operational Safety and Capacity Enhancement Team (OSCET) and Runway Utilisation Improvement Group (RUIG) for identifying and implementing the initiatives.

One of the key and first objective identified is developing sustained capacity of 48 movements per hour for the main runway i.e. Runway 27. AAI is leading this project as directed by Government of India and already substantial gains have been achieved. 48 movements per hour have been achieved and the efforts are on achieve the sustainable capacity of 48.

## 2.2 The TMA initiatives

### 1) PBN Based RNAV1 SIDs and STARS

The PBN based RNAV 1 SIDA and STARS have been promulgated for all the four Runways at Mumbai. This has ensured lesser track miles, efficient climb and descent profiles.

### 2) 3 Nm RADAR separation

Allowed reduction in inter arrival and inter departure spacing and efficient climb and descent profiles.

### 3) Uniform Speed Control

The AIP supp on uniform speed control measures at all the major airports have facilitated efficient traffic flows and consistent inter arrival spacing resulting in increased capacity and efficiency.

### 4) Strategic Slot Management and Tactical Arrival Management

The slot allotment for each schedule is done in a collaborative way between Airport, ATC and Airlines. For tactical slot management during congestion Mumbai ATC practices a procedure of advising each arriving traffic at 150 Nm of time to Touchdown so that flights can adjust speeds to avoid holding and fuel burn.

### 5) RNAV 5 City Pair Routes

Eight RNAV five city pair routes have been introduced between Mumbai - Delhi, Mumbai -Kolkata, Mumbai – Chennai and Mumbai – Thiruananthapuram. The RNAV 5 routes have shortened the flight paths and improved efficiencies.

### 6) The Dynamic Continuous Descent Operations (DCDO)

The DCDO being facilitated at Mumbai is a result of procedures and techniques developed in-house by AAI. ICAO Doc 9931 defines a C D O as primarily a flight operating technique, enabled by airspace design, procedure design and

facilitation by ATC, in which an arriving aircraft descends continuously, to the greatest possible extent, by employing minimum engine thrust, ideally in a low drag configuration, prior to the final approach fix/final approach point (FAF/FAP).

Even though airspace design and procedure design are important enablers of a CDO, in airspace like Mumbai, wherein airspace design & procedure design are yet to be in place for having CDO operations, Air Traffic Control proactively facilitates a CDO by catering to various parameters as required by on board Flight Management Computer (FMC). The CDO thus facilitated can be termed as a Dynamic CDO catered to by considering the vital instantaneous variables for each individual flight such as position of the aircraft in 3-dimensional space, aircraft load, aircraft performance and most importantly the ambient atmospheric. With enhanced onboard computing power available in most of the modern day machines, aircraft specific individualized Dynamic CDO routes can be generated in real time by the on board avionics that are both laterally and vertically optimized on noise/emissions/fuel parameters.

ATC proactively facilitates a CDO by conveying to the flight of the ATC's plan about the aircraft's trajectory, inclusive of altitude at which a CDO has to be commenced, pre computed distance to touch down information, which could be a varied combination of headings/ direct to DME fixes/ waypoints in RNAV environment, along with appropriate (terrain restricted) descent clearances & intermediate speed/level restrictions (interventions). This information, along with available on board information on aircraft load and ambient atmospheric, will help FMC compute Optimized Profile Descent (OPD) segment/s. The creation of this optimized trajectory is facilitated by the on board L NAV/V NAV (Lateral/Vertical Navigation) capability in the FMC. These OPDs are then flown by the cockpit crew/ FMC culminating into a CDO.

The DCDO trials have been in progress at Mumbai since July 2012 and the sample data has demonstrated on an average 184 Kgs of fuel savings and 580 Kgs of Carbon Emission savings per flight. The DCDO trials have also commenced at Ahmadabad since May 2013 and at Shamshabad since February 2013. The DCDO trials have commenced at Delhi from November 2013. The sample data on savings due to CDO at Mumbai,

Month	Number of flights which submitted fuel saving data	Fuel Savings (Kg)	Carbon Emission Savings (Kg)
Feb 2013	11	1925	6063
Mar 2013	86	14235	44840

Apr 2013	46	8035	25310
May 2013	111	8532	26875
<b>Total savings</b>		32,727	<b>1,03,088</b>

- 7) The VFR Routes termed as “K” routes were introduced for helicopter traffic allowing them to operate clear of Mumbai Airport traffic to and from the heliports in the vicinity. It also reduced workload and R/T congestion.

### 2.3 The Runway Initiatives

#### 1) ROT mapping

The runway occupation times are being mapped by the Airport Operator MIAL continuously and are being presented every month to the RUIG chaired by AAI. These statistics across different categories like aircraft type, class of aircrafts, airline wise are then used to discuss and decide strategies to reduce ROTs and standard deviations in target ROTs. The gradual standardization in ROTs has been brought in through these efforts which has allowed AAI to reduce inter arrival spacing.

#### 2) Standardised Runway Vacation Procedures

The runway vacation procedures have been standardized and the exits specified for RWY27. The standard exit of N8 for RWY 27 has resulted in reduced ROTs.

#### 3) Reduced Inter Arrival and Inter Departure spacing

The improved and standardized ROTs, reduced separation and tactical RADAR vectoring have enabled ATC to reduce inter arrival spacing steadily from 8 Nm for Arr-Dep-Arr to 6 Nm and Arr-Arr spacing from 6 Nm to 4 Nm. The Dep-Dep interval is 1 min for departures in different directions and 2 mins for same direction departures.

#### 4) Improved R/T procedures

The best practices in R/T procedures like auto changeover from Air frequency to TMA frequency after departure and from Air to Ground frequency on vacation of Runway have been adopted to support the various measures and reduce R/t congestion particularly on Tower/Air frequency.

#### 5) Improvements to IAL procedures

The following three changes in procedures also improved the efficiency of traffic on the runways,

- Turning missed approach for RWY 27 for de-conflicting departures with aircrafts carrying out missed approach.
- Reducing the GP angle for RWY 27 from 3.3 deg to 3 deg for enhancing stabilized flights.
- Reducing the OCA for VOR DME Procedure RWY 32 for increasing accessibility.

## 2.4 The Technology Initiatives

### 1) ATM automation System

The modern ATM system AT3 has all the features like Short Term Conflict Alert, Medium Term Conflict Alert, and Minimum Safe Altitude Warning etc.

### 2) ASMGCS

The Advanced Surface Movement Guidance and Control System uses Surface Movement Radar and MLAT inputs to present accurate picture of Aerodrome Traffic. The Time to Threshold feature aids Tower control decisions about Runway Usage and the display at Approach Control helps Approach Controllers to anticipate and plan expeditious traffic flows

### 3) Clearance Delivery through Data Link

The Pre departure clearances are issued through data link in a swift and accurate manner.

### 4) Collaborative Decision Making Platform

AAI team is developing a web based CDM platform that will share information and generate Targeted Start Up and Targeted Take Off times reducing delays and on ground fuel burn.

### 5) The new ATC Tower

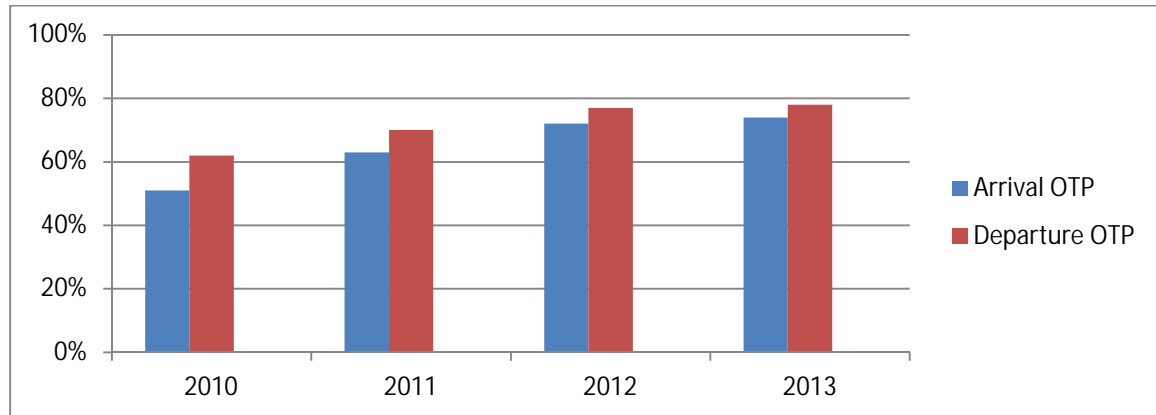
The new ATC tower which is about 100 Ft taller than the present one and is ready to use will give further fillip to efficiency as it helps in better surveillance. The demolition of old tower will pave the way for construction of parallel taxiway for RWY14/32 improving efficiency. The demolition will also improve the usability of RWY 14/32 as some airlines considered the old tower to be an obstacle for the RWY 14/32

### 6) The Integrated Air Traffic Simulator

The modern simulator is being used for skill enhancement. Eight controllers can be trained simultaneously on different positions and various unusual occurrences, complex air traffic scenarios and high intensity traffic can be simulated and used for training and skill enhancement of controllers.

## 2.5 Increase in capacity, improvement in OTP.

The terminal Area and Runway efficiency at Mumbai has substantially improved at Mumbai and as can be seen there has been more than 20 percent increase in Runway and TMA capacity in five years. The achievement is remarkable considering that the improvement has been achieved simultaneously with the Airport development projects like construction and redesign of Aprons, Construction of five new taxiways, and upgradation of Runways to code F compliant. It was like making an athlete undergoing an operation to sprint. The improvement in the On Time Performance as a result of these initiatives



As the fruits of various initiatives are realized it is expected that the improvement will continue at even faster rate in future.

### 3. ACTION BY THE MEETING

#### 3.1 The meeting is invited to

- a) note the information in the paper
- b) AAI is ready to actively engage in discussions to share our experiences and also learn from best practices followed elsewhere.

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