With air traffic doubling every 15 years, the need to effectively manage increased demand is crucial to ANSPs, airspace users and airport authorities throughout the world.

Air traffic flow management (ATFM) – a service that ensures air traffic control capacity is utilised to the maximum extent possible in a safe and orderly way – is key to the future of air travel.

Yet ATFM cannot be a one-size-fits-all solution. Understanding the key components and architectures is crucial to ensuring that a country or region has the most effective and efficient solution.

Automated ATFM

A key component of ATFM is the proven method of strategic, pre-tactical and tactical adjustments to departure times to balance demand with available capacity. Such automated ATFM measures as ground delay programmes assign calculated take-off times (CTOTs) for flights arriving at an airport to balance demand with available capacity during periods of heavy traffic.

Operational benefits from these ATFM measures include reduced airborne holding, fewer emissions and less fuel burn, as well as increased predictability for ANSPs, airspace users and airport authorities. The delivery of these benefits depends on having a sufficient quantity of flight arrivals to the constrained airport receiving CTOTs.

If a ground delay programme is used with a low participation of flights complying with allocated CTOTs, the tactical result will exhibit undesirable airborne delay measures, and therefore flights receiving CTOTs will receive an inequitable amount of delay.
To understand the threshold of participation required for effective automated ATFM, Metron Aviation performed simulation analyses to determine the rules of thumb for equitable and effective flow management. This analysis showed that a minimum of 70% of arrival flights should be assigned a CTOT and that the participating flights should depart from origins within 1,500 nautical miles (NM) of the destination airport.

Metron Aviation confirmed the simulation results through an analysis of operations under existing operational deployments of ATFM. The rule of thumb participation percentage is met in the US, Europe, and Australia. Consistent with the rule of thumb, the US does not assign CTOTs to west coast departures for east coast capacity problems. Similarly, in Australia, CTOTs are not assigned to Perth departures destined for east coast airports.

If an ANSP contemplating the implementation of automated ATFM does not have sufficient domestic traffic to meet the rules of thumb, then a regional ATFM approach is required to achieve flow management effectiveness. Increased participation can be achieved through cooperation with ANSPs that have departing flights within 1,500 NM of the constrained airport.

Figure 2 shows the 1,500 NM rule of thumb applied for the US, Europe, and Australia. Consistent with the rule of thumb, the US does not assign CTOTs to west coast departures for east coast capacity problems. Similarly, in Australia, CTOTs are not assigned to Perth departures destined for east coast airports.

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Figure 3 on page 13 shows an analysis of arrival percentages that can be controlled for major airports in the Asia Pacific region and in the Caribbean, Central America, and South America regions.

Both bar graphs show that very few of these airports can achieve the required 70% participation by issuing CTOTs to domestic departures only; however, most can achieve the required participation rate by including international departures within 1,500 NM.

Therefore, most major airports in the regions can effectively implement ATFM ground delay programmes through cooperation with other ANSPs by controlling departure flights within the range of effective automated ATFM.

If the rules of thumb are not met, even with additional participation from other ANSPs, then alternative approaches are certainly required for effective demand capacity balancing.

Alternatives include:
• Airspace user delay intent to support participation for long-haul flights as defined by the Asia Pacific Regional ATFM Operational Concept
• A combined ATFM measure that uses both CTOTs and tactical in-trail separation restrictions to achieve an effective and equitable measure
• Tactical in-trail separation restrictions as used today.

Increased participation from other ANSPs, combined ATFM measures, and the use of airspace user delay intent are part of the Asia Pacific regional ATFM operational trials. This initiative is being led by the ANSPs from Singapore, Thailand, China and Hong Kong and
is being supported by Australia, the International Air Transport Association (IATA), and CANSO.

Multi-nodal ATFM

The rules of thumb establish the operational conditions for effective and equitable ground delay programs. An independent ATFM system implementation, including automation, processes and personnel can be successfully performed by an ANSP. However, when multiple ANSPs in a similar geographic region deploy an ATFM system, architectural consideration must be taken into account to ensure that stakeholders can access all required data and perform required actions without requiring direct access to each ANSP’s ATFM systems. Failure to provide a proper architecture for interoperation will imply that air traffic controllers, airspace users and airport authorities will be expected to interact with multiple user interfaces to perform their function (see Figure 4 on page 15). This will not be acceptable to the involved personnel.

To address this operational limitation, the multi-nodal distributed ATFM architecture has been developed in support of the Asia Pacific regional ATFM operational trial. The fundamental requirements of the architecture are to provide autonomy in ANSP ATFM system implementations and to provide stakeholders with access to a single user interface that can access all ATFM measures throughout the region.

The end user interface requirement is not a requirement for the same user interface; it is a requirement for access to a single interface for all necessary interactions. Some stakeholders may interact with the user interface from one ANSP and others may interact with the user interface from another ANSP.

As long as each ANSP’s ATFM system user interface can provide the data and functions necessary to interact with all ATFM measures throughout the region, the single user interface requirement is met.

By establishing an ATFM-system-to-ATFM-system interface that supports the sharing of data and controls, the multi-nodal distributed ATFM system architecture can be implemented for each ANSP that deploys an ATFM system in a region.

Figures 5 and 6 on page 15 show two alternative approaches to sharing data that retain the autonomy of ANSPs with regard to ATFM system implementation and operations. Figure 5 represents the case where ANSPs in the region do not support the centralisation of any functionality or systems.

ATFM systems can be data platforms for data sharing and do not require a centralised data approach. Concepts such as System Wide Information Management (SWIM) can be implemented with each ATFM system contributing to the solution as the multi-nodal network expands.

Figure 6 on page 15 represents the case where ANSPs in the region do support...
the centralisation of functionality or systems. A centralised data platform can effectively share data and functions among the ATFM systems in the region. The ATFM-system-to-ATFM-system interface must still be defined and supported by each ANSP’s ATFM system, but the centralised data platform can efficiently perform data sharing in regions that support such an approach.

Regardless of the approach selected, both architectures meet the need for multi-nodal distributed ATFM that retains the autonomy of ANSPs in their ATFM system implementations and provides stakeholders with access to a single user interface for data and functions.

Additionally, as shown in the multi-nodal alternative architectures, the establishment of an ATFM-system-to-

ATFM-system interface supports the introduction of value-added, third-party vendor solutions for stakeholders.

Understanding the operational and architectural basis for regional ATFM and multi-nodal distributed ATFM allows ANSPs and their stakeholders to work together to implement efficient and equitable ATFM measures in areas that require regional coordination.