

Concept of Operations for Three Runway Independent Mixed Mode Operations at Changi, Singapore

To address future operational needs, MITRE is helping the Civil Aviation Authority of Singapore (CAAS) develop a Concept of Operations (ConOps) to maximize the capacity of a planned three-runway system at Changi Airport.

Background

Demand is forecasted to increase at Singapore's Changi Airport, and the airport is preparing to address it by expanding facilities and improving the efficiency of airport operations. CAAS is adding a third runway (see Figure 1) by converting an existing military runway to civilian use. To get the most efficiency out of the future three-runway system, CAAS and MITRE are working on a ConOps for Three Runway Independent Mixed Mode (3RIMM) operations at Changi. Mixed mode means all three runways can be used for arrivals and departures, and 3RIMM is key to meeting

CAAS's goal of maximizing aircraft movements, or total arrivals and departures, per hour.

MITRE has extensive experience and expertise in multiple-runway operations, as well as processes for introducing enhancements into air traffic management (ATM) and communications, navigation, and surveillance (CNS) systems and integrating new technologies into aircraft flight decks. CAAS worked with MITRE to develop a ConOps for 3RIMM that identifies the changes in airspace, surface flow, procedures, and regulations needed to maximize capacity at Changi.



Figure 1. Aerial View of Changi Airport (Current Runways in Green, Proposed Runway in Red)

Creating a Concept of Operations for Three Runway Independent Mixed Mode

In 2017, MITRE developed a preliminary ConOps for 3RIMM at Changi that defined a methodology for maximizing the use of three runways during all anticipated variations in demand for arrivals and departures. MITRE used desktop modeling to create a baseline analysis of airport operations and then designed a process and configuration model that could maximize aircraft movements (see Figure 2). MITRE provided an initial concept for how the airspace and procedures could be designed and a surface flow strategy to run 3RIMM.

Testing the Concept of Operations

In 2018, MITRE is refining the airspace concept and conducting experiments, such as fast-time and human-in-the-loop simulations, at its laboratory in Singapore. MITRE will collect feedback on air traffic controllers' workload, procedural complexity, and other metrics to validate the design and analysis of the ConOps.

Changi Airport and the International Civil Aviation Organization (ICAO), which manages air travel outside of the United States (U.S.), will need procedures and regulations that support 3RIMM.

Currently, the U.S. is the only country with airports that operate three runway independent operations, so the U.S. Federal Aviation Administration (FAA) is the only agency that has regulations and procedures that support it.

In the U.S., MITRE operates the [FAA's federally funded research and development center](#), and has extensive expertise with FAA and airport procedures and regulations.

While validating the ConOps, MITRE is identifying procedures and regulations that will need to be updated or created to operate 3RIMM, and will provide a list of high-level requirements, including regulatory changes, changes to ATM/CNS systems, contingency operations, etc., that will be needed to achieve the desired throughput utilizing 3RIMM at Changi.

At the end of its analysis and testing, MITRE will provide a ConOps for the terminal maneuvering area that CAAS can use to implement 3RIMM operations and thereby greatly enhance capacity and efficiency of operations at Changi. The enhancements proposed in this project may also be adapted to increase the efficiency of a two-runway system at Changi.

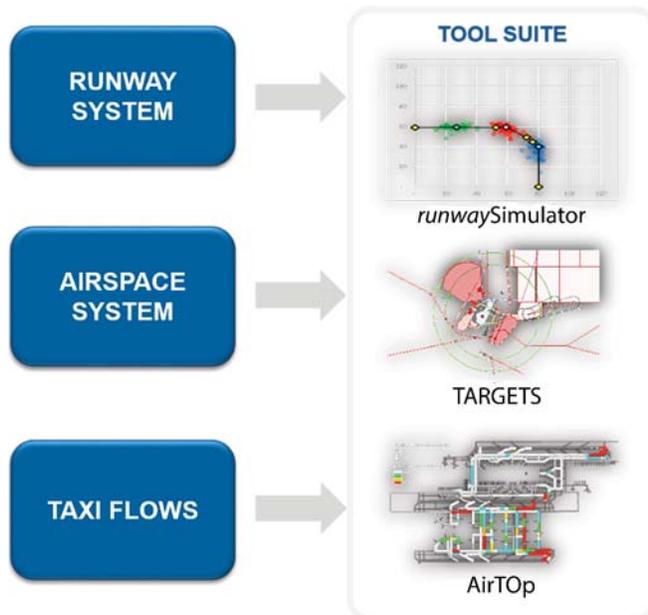


Figure 2. MITRE 3RIMM Analysis Tools and Methodology

runwaySimulator is a MITRE-developed suite of simulation models, methodologies, and software to estimate the capacity of airport runway systems.

The Terminal Area Route Generation Evaluation and Traffic Simulation (TARGETS)—also a MITRE-developed tool—offers a unique combination of capabilities for the design, analysis, and operational assessment of procedures and airspace.

AirTop is a unique rule-based, gate-to-gate desktop fast-time simulator.