

Smart Digital Tower

The “smart digital tower” is a new concept in air traffic control. MITRE recently explored a groundbreaking application of this concept for Singapore’s busy Changi Airport.

MITRE conducted research on the smart digital tower concept on behalf of the Civil Aviation Authority of Singapore (CAAS), the country’s air navigation service provider.

The use of the smart digital tower technology has the potential to transform the provision of airport air traffic control services. At MITRE Asia Pacific Singapore (MAPS)—MITRE’s state-of-the-art air traffic management research facility in Singapore—we conducted research that could enable Singapore’s busy Changi Airport to operate via a smart digital tower.

How Smart Digital Tower Operations Work

A smart digital tower is an air traffic control facility that provides controllers with advanced surveillance and decision support tools to facilitate the management of live air traffic. Controllers observe the airport’s surface and the surrounding airspace using multiple fixed-position cameras on the airport surface that feed images to an array of connected video screens. The feed mimics the panoramic, out-the-window view an air traffic controller would have from a physical tower (see Figure 1).



Figure 1. In the Smart Digital Tower Concept, Video Feeds Projected onto an Array of Connected Video Screens Mimic the Controller’s Out-the-Window View from an Air Traffic Control Tower

The system also includes video cameras that can pan, tilt, and zoom. Just as a tower controller might use binoculars to take a closer look at objects or areas of interest, controllers in a smart digital tower could use these cameras to do the same thing.

The multiple camera placements allow visual surveillance of aerodrome areas from different perspectives, including areas that may be hard to see from the control tower.

Additionally, the large video monitors in a smart digital tower display relevant flight data next to the icon for each aircraft operating at the airport. These so-called “data tags” can provide the controller with valuable information, such as the aircraft’s call sign, speed, altitude, and destination airport. With these flow management statistics clearly displayed on the screen, controllers have greater situational awareness. The use of data tags also better enables controllers to track aircraft in various weather and light conditions.

A smart digital tower is capable of integrating two or more control tower operations into a single facility, if necessary. This will allow air traffic control crews that work in separate towers today to work as one team in the smart digital tower, with the capability of switching between the different tower views. This will reduce the complexity of operations and enhance the coordination between multiple control towers. Because the smart digital tower provides common situational awareness, it will also enhance safety.

Breaking New Ground in Singapore

Between 2014 and 2017, MITRE developed a preliminary concept of operations to define how Changi Airport could operate in a smart digital tower scenario and conducted human-in-the-loop experiments to test the concept.

In 2016, we engaged a production company to set up cameras on the control tower at Changi Airport, capturing footage that simulated what controllers see out the window. Our researchers then ran an experiment to see whether controllers



could have the same level of situation awareness when they looked at the video footage as they did when looking out the tower window. Our research team found that they could.

In another human-in-the-loop study, MITRE worked with controllers to evaluate the throughput that could be achieved at Changi Airport using smart digital tower operations. The controllers rated their smart digital tower operation experience highly, noting that both their workload and situation awareness were comparable to their actual tower experience.

In 2017, MITRE supported CAAS in bringing industry in to build a smart tower prototype system for Changi Airport.

MITRE's research may ultimately enable the first-ever smart digital tower air traffic control operation that can serve all the traffic demand at a high-traffic airport such as Changi.