

Airport Tower Automation

With the construction of Bergstrom International Airport in South Austin, the FAA has decided to automate the traffic control at the new airport.

Your team has been contracted to design and implement the traffic control system. It must manage the gates, hangars, taxiways, runways, air traffic pattern, and incoming airplanes. The control system will be called the “tower” and it will automatically allocate the resources of the airport.

The new airport has two runways that cross in the middle. Collisions most often occur during take-offs or landings, so the tower must ensure proper spacing between airplanes. Only one runway can be used at a time, and only one plane can use a runway at a time. There should be a three minute spacing between an airplane taking off from a runway and an airplane landing on the same runway. There should be a five minute spacing between an airplane landing on a runway and any other activity on that runway. There should be a five minute spacing between an airplane taking off from a runway and a second airplane taking off from the same runway. There should be a one minute space between any use of one runway and any use of the other runway. These times are all minimum times, and may be increased but never decreased.

Before an airplane can land, it must enter a holding pattern. The plane is given a landing priority value when it enters the pattern, and the plane with the most priority in the pattern gets to land first. The holding pattern is finite and can only accommodate a limited number of planes at a time. If the holding pattern is full when an arriving airplane contacts the tower, the plane with the lowest priority will be routed to another airport. Clearance to land is granted as soon as a runway is available, so during times of low traffic, a plane may stay in the holding pattern for a very short amount of time.

Once a plane lands, it leaves the runway for a gate or for a hanger via a taxiway. Taxiways are modeled for this problem as point to point paths between the runways and gates. Each taxiway has a finite capacity for airplanes though they do allow two-way traffic. Each trip on a given taxiway takes a fixed amount of time. If a taxiway is full, a plane will have to wait at its current location until space is available for it. The tower must ensure that a gridlock situation does not happen.

Gates are owned by airlines, but they are adaptable to fit any size airplane. An airplane may only berth at a gate if it belongs to the same airline as the gate, and the gate is empty. The airport has a limited number of gates, and if all gates are full, the airplane must wait on the taxiway until a vacancy occurs.

Planes only remain at gates for specific amounts of time. In order to leave a gate or hangar, they must get a runway assignment from the tower and then get clearance to take the taxiway to their assigned runway. The tower will grant this clearance in a manner to ensure proper traffic flow.

Planes are owned by an airline, have a unique id number, and are of a certain size. Planes have a finite amount of fuel and can only remain airborne for a limited amount of time. When the fuel tanks reach 1/4 full, the plane enters an emergency status. A plane in emergency status is given priority over all other planes in the pattern or on taxiways. If more than one plane is at emergency status, the plane with the least remaining fuel is given precedence.

The tower communicates with the airplanes via radio and controls all air and ground traffic for the airport. Communication is considered instantaneous, but the tower can only communicate with one airplane at a time. Airplanes are responsible for contacting the tower for instructions when they wish to enter the traffic flow of the airport. These events include: entering a taxiway from a hangar, runway, or gate; entering a runway, hangar, or gate from a taxiway; entering the air traffic pattern from the air. An airplane is contacted by the tower when it is authorized to enter the runway from the pattern, and the runway to use is specified at this time. When an airplane is cleared to enter a runway from a taxiway, it is also cleared for immediate take off.